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Master's Thesis
Academic Year 2019

Amiable KEY: Aromatic Bulletin Board for Enticing Social Interaction in Offline Communities

Keio University
Graduate School of Media Design

LIU LIAN

A Master's Thesis
submitted to Keio University Graduate School of Media Design
in partial fulfillment of the requirements for the degree of
Master of Media Design

LIU LIAN

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Abstract of Master's Thesis of Academic Year 2019

Amiable KEY: Aromatic Bulletin Board for Enticing Social Interaction in Offline Communities

Category: Design

Summary

Proliferation of social media makes it easier to contact old friends, but turns it harder to build connections when people moves to a new environment. However, offline social support is still significant, especially to graduate students who lacks local social ties in an unfamiliar community.

This research shed light on the challenge of building stronger social bonding in offline communities. The objective is to entice peer interaction with Amiable KEY, an interactive bulletin board designed to enhance writing and reading by reducing proximity in space and distance in psychology. With ambient smell for attention and cognitive reactions to message contents, Amiable KEY behaves like a friend, supporting members to become mutual acquainted and appreciated.

The concept of Amiable KEY was realized with two prototypes, and was proved through user experiments. Results indicate Amiable KEY shows positive potential in fostering social connections. Through increasing presence awareness of peer and community, and facilitating constant interactions with enjoyable experience, it fosters emotional attachment and enlightens closer community connections.

Keywords:

Peer Communication, Social Interaction, Bulletin Board, Propinquity Effect, Ambient Smell, Offline Communities, Presence Awareness

Keio University Graduate School of Media Design

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Chapter 1
Introduction

We are witnessing huge changes in communication habits brought up by the proliferation of social media. In particular, the young generation has been used to being accompanied by "virtual friends" online. Even so people still need to join offline communities for social resources, such as workplaces and classrooms. Besides keeping in touch with the people we are familiar, how can we create social ties among similar but unfamiliar peers to get social support in a real world? This paper aims to answer this question in the scenario of offline communities of graduate students, which serve as typical examples of the situation.

The goal of this research is to entice public interaction for social bonding. The paper focuses on utilizing technology to support public bulletin boards, an usual effort in social activities. The research proposes Amiable KEY, a bulletin board that enhances participation of public interaction in Social Space[1]. It draws attention from users with robust smell, entices participation frequency with spontaneous reactions to users' activity. In addition, it reduces physical propinquity by encouraging people to visit public gathering space, and narrows down psychological propinquity with asynchronous communication. With repeated interaction, Amiable KEY provides individuals with a chance of encounters and socializing.

1.1. Similar but Isolated

Nowadays, we are capable of connecting with the world much easily via networking technologies, but still suffer from isolation and loneliness nearly every day. We pretend to be accompanied by gazing at digital devices, but found there is nobody nearby for a casual talk.

---

1 see reference at propinquity

In the past decades, the proliferation of digital information brought huge changes to people's social life, from how people communicate with each other to who they choose to interact. One result was that the young generation has been used to keeping in touch with those they know for a long time. Another change was that people pay less attention to off-line socialization. However, even in an information era, people still need join geographically located communities to get new resources. It happens when people join a school for higher education, or move to a new housing project for better residential environment. This situation requires community member to reside or work with other peers in the same locality.

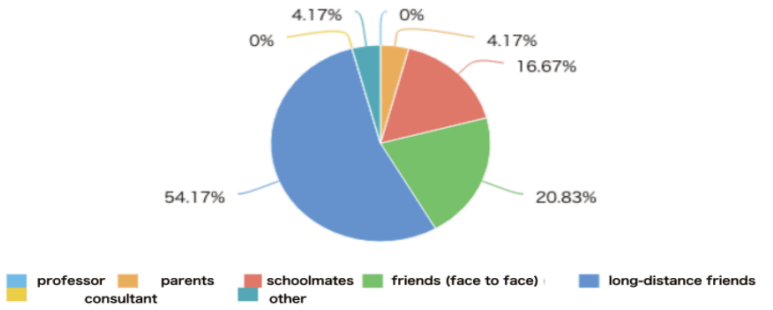
Apathetic to offline interaction may lead to isolation in an offline community. According to a research in 2011, most SNS (social networking sites) relationships reflect "preexisting offline connections" [1]. In addition, virtual connections are hardly translated into real-life connections. When people join a new offline community, face-to-face communication is still significant in building new local connection. Moreover, "young people with more social capital are more likely to engage in behaviors that lead to better health, academic success, and emotional development" [2]. Without enough offline interaction, new members can hardly build new social connections, and have no access to "informal assistance and information sharing" [3]. A study by the Carnegie Mellon University suggested that the use of digital devices may lead to social isolation and individual stress [4].

This situation is extremely common in communities of graduate students, like classrooms and dormitories. Generally, graduate students are students pursing master or PhD degree in graduate schools. They are young adults who leave their families and friends back in hometown or home country, but have limited time to build enough connections during their study in graduate schools. For international graduate students, they face more stress from language, financial or culture-difference [5]. Although many of them live and work with peers with similar social background and sharing anxieties, they can hardly have enough offline interaction. It is partly originated from the varied schedule among peers, and partly resulted from limited channels to enlarge social network. Also, some people are not used to meeting complete strangers in parties or gathering because of their introvert personality. Many graduate students choose to reply on remote communication for support, but remote support cannot be helpful with

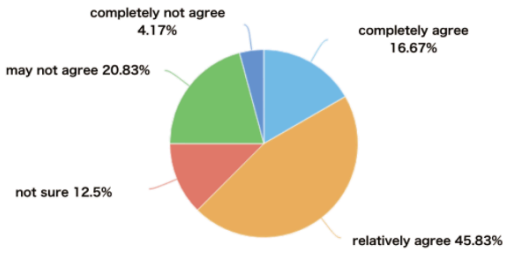
local problems.

To find out the real situation among graduate students, an online survey has been conducted with 29 participants during April, 2019. As illustrated in Figure 1.1 shows that there is homogeneity of communication habits among graduate students: more than half of the participants (54.1%) showed that they prefer remote communicate, but confessed they could not get good advise or feel relieved.

At the same time, Figure 1.2 shows there is high homogeneity of source of stress: research problem (66.67%), job hunting (58.33%) and interpersonal relationship (50%).



Questionnaire about: who do you often turn to for help?



Questionnaire about: sometimes you feel not being understood by parents or friends?

Figure 1.1 Many graduate students show they cannot get enough support by communicating with parents or old friends remotely

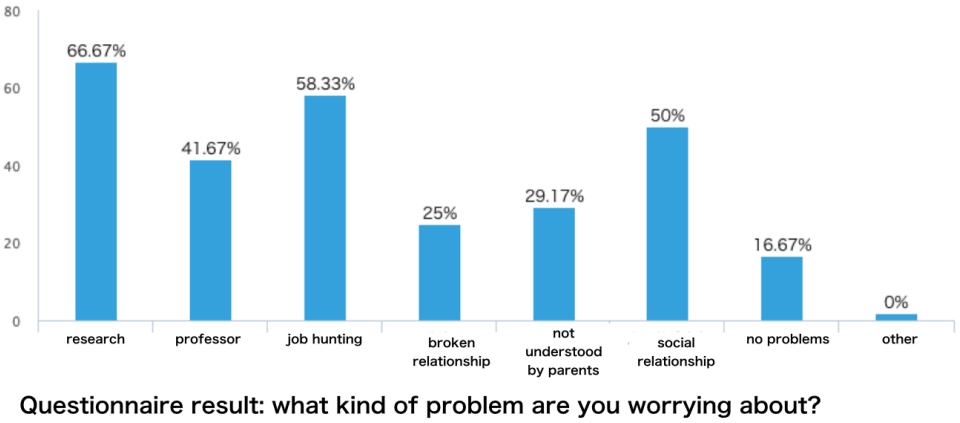


Figure 1.2 Result of Questionnaire

1.2. Forgotten Bulletin Board

Information sharing plays an initial role in community activities. It fosters *community of practice* by sharing inclusive knowledge and providing mechanism superiority [6]. Hence, offline communities emphasizes the importance of peer interaction to enhance quality of life [7]. Among abundant efforts made to enhance interaction, one of the most common example is bulletin boards, ranging from white boards to public displays. As illustrated in Figure 1.3, bulletin boards are usually located in public gathering space available to every member in offline communities, like entries, lounges and cafeterias. Besides the basic function of imparting community information in an efficient and inspiring way, bulletin boards can help to support community and social activities [8]. In cases that members are allowed to post their own messages, bulletin boards also serves to foster asynchronous communication by reducing the time management barrier in communication.

Moreover, bulletin boards facilitate social interaction among community members by increasing “social encounters” and “communication opportunities” [9] [10]. Prior studies indicated that interaction requires both scheduled, ad hoc meet-up as well as frequent spontaneous exchanges. The latter one refers to informal interaction and depends on physical proximity. A study revealed that around 80%

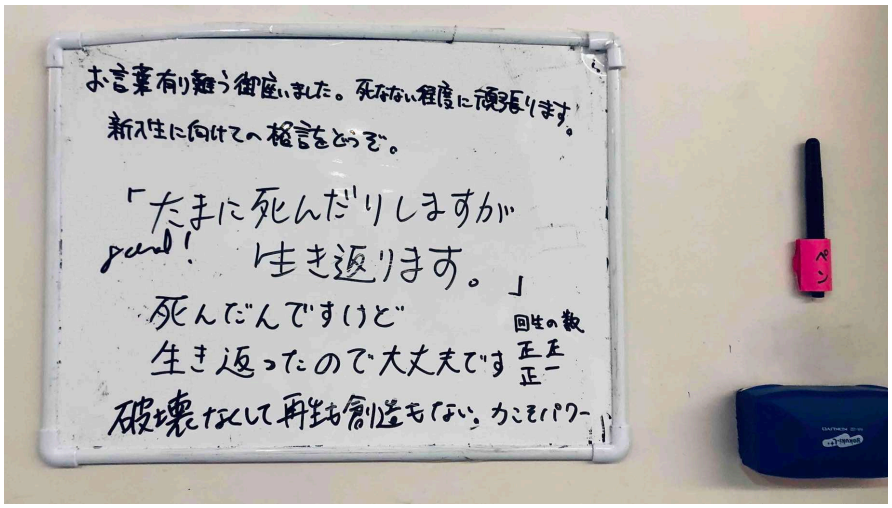


Figure 1.3 A bulletin board outside a classroom at Keio University Graduate School of System Design and Management (2019)

to 90% of interpersonal interaction in workplace are not planned [11]. The added value of bulletin board can be proved with *the Propinquity Effect*: individual will tend to build close interpersonal relationship most with those closest to them [12]. When people stop by a bulletin board for information, they have larger potential of encounter and passive contact with other members. Repeated exposure contributes to a chance to find out similarities sharing in the community.

However, the function of physical bulletin boards have been forgotten gradually. With the rapid development of networking technology, people turn to gather group information through online bulletin board system. Community also changed the method of information distribution by social networking sites or e-mail system. People do not visit gathering space for information any more. Gradually, they have less chances to encounter peers physically, and lose reasons to visit public space. Propinquity, serving as readiness of communication, is drawn back gradually [12].

The situation is also common in graduate schools or dormitories, despite bulletin boards are commonly used in cafeterias, classrooms, and dormitories. Even though graduate students are members in offline communities with a high homogeneity along the dimensions of age, occupation, research interests, background, cause of anxiety, they don't visit gathering space as often as in the past, and don't have enough interaction to build strong social connections. Eventually, both physical

and psychological distance has been drawn back among peers.

1.3. Research Purpose

The purpose of the research is to entice social interaction for social connection and emotional tie in offline communities. Although people can keep in touch with friends even remotely, many people still suffer from isolation a lot, especially graduate students in a new environment. Network connections would appear only when group individuals know each other, communicate frequently, or feel emotionally attached [13]. Hence, a main reason is due to the huge proximity among community members. In particular, declined interaction in public space is the main cause.

Considering bulletin boards play significant role in supporting community connections, this research chooses bulletin boards as the object of public interaction. The objective is to entice interaction with a bulletin board in public gathering space. In particular, the target is graduate students who suffer from isolation.

The paper is about understanding what is the barrier to public interaction and how can overcome them through improving the design of a bulletin board. The focus is on how people behave around public bulletin boards, the way they are drawn attention, move toward them, read contents, change from onlookers to participants, and continue the behavior.

This paper aims to study these questions through Amiable KEY, an aromatic bulletin board, in the hope of reducing propinquity, empowering emotional attachment to the location of Amiable KEY for social bond in communities.

1.4. Thesis Organization

The thesis is made up of six chapters:

- Chapter 1 gives introductions to background, current problems and research purpose of the thesis.
- Chapter 2 mentions prior studies on the research questions: propinquity, public displays, and smell. Related works are described as well.

- Chapter 3 describes the concept of Amiable KEY by following the design process from target personae, fieldwork, ideation to narrative design.
- Chapter 4 illustrates two prototypes from setting-up, observation to revision.
- Chapter 5 proves the concept with an user experiment via the second prototype by deploying the method of "Wizard of Oz".
- Chapter 6 discusses achievements as well as limitations of the concept, and development of the future design was mentioned as well.

Chapter 2
Related Works

Considering the final goal to strengthen social connections and emotional tie in an offline community, this research is concerned with the situation when people initiate closer interpersonal relationship. From this perspective, space plays crucial role in social connection formation, which is rooted in the theory evidence of propinquity, the property of being close together in distance or space. Propinquity (or close distance) can foster closer relationship through interactions like encounter or passive contact, and amplify the positive effect of social similarities among community members on tie strength. In addition, the added value of public displays has been examined in this chapter as an example of how sharing can support social activities and increase encounters by emphasizing propinquity in space and information. Lastly, the research delves into the power of smell as an ambient cue to enhance public interactions through social awareness and emotional attachment. Based on the review of literature and related works, key components of an interaction-encouraging bulletin-board design emerged.

2.1. Propinquity Effect

2.1.1 Nearness as Attractiveness

People can only develop relationship with those they meet. That's why people choose to leave for new social groups or communities to meet those similar to themselves. In offline communities, individuals work, reside, and act with peers sharing similar goals or social indicators. In this scenario, propinquity (nearness in distance) serves as a crucial element to create chances of encounter.

Propinquity means proximity or physical closeness, and increases psychological closeness for closer interpersonal relationship. The notion of *Propinquity Effect*,

people tend to associate with those close physically, was observed in the classic study of a university dormitory in the 1950s, that friendship was determined between neighbors close to one another in distance through high probability of "passive contacts". Propinquity determines occurrence and frequency of passive contact [12]. Repeated exposure to other members' presence provides individuals with opportunities to discover similarities and become tolerant of their differences [14]. Mutual or compatible interests lead to familiarity or attraction. Once individuals can find out that they are actually less different as they perceived before, they are more likely to be attracted by those like-minded peers [15]. This effect is particularly remarked in homogeneous communities, whose members are normally selected by the same standard.

Propinquity Effect also indicates the significant role of interaction in connection formation. Frequent communication leads to better acquaintance. Even if similarities are obvious, connections will not appear automatically without the acquaintance process. Available empirical evidence indicated that "social connections is strong when individuals involved have known each other for a long time, communicate frequently, or feel emotionally attached" [13]. However, "individuals attempt to minimize effort by interacting with those physically closest to them" [16], especially during the early stage of relationship formation. Hence, propinquity can amplify positive impact that similarities have on social ties by making interaction more available.

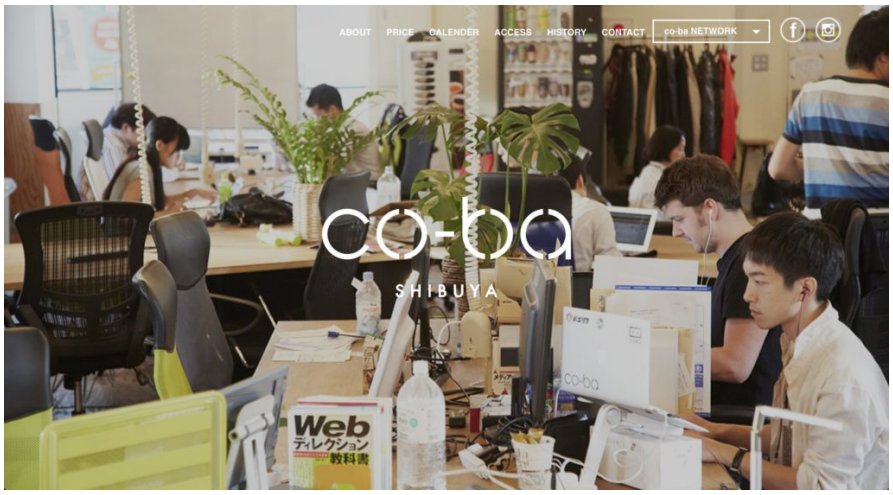
Based on the literature review mentioned above, the design of Amiable KEY concerns about emphasizing propinquity (or close distance) to foster positive social interactions. For graduate students surrounded by unfamiliar peers with abundant similarities, ranging from age, education to professional tenure, they are in need of frequent interactions to be better acquainted for stronger interpersonal attraction. Considering close physical and psychological distance can increase occurrence as well as frequency of interaction among group members. The focus is to increase participation frequency of public interaction by reducing physical distance as well as psychological distance.

2.1.2 Spatial Design for Propinquity

As defined by Fesinger in the classic dormitory experiment, distance determined friendship formation through physical distance and functional distance. Physical distance is one of the factors of "whether or not passive contacts will occur". Functional distance determines "the number of passive contacts that position and design encourage" [12]. If there is two elevators at both ends of the floor, people living at opposite ends may rarely meet. It means spatial design has significant influence over membership in a local community.

With the believe that closeness in space can lead to connections in affection, public gathering spaces are popular infrastructures in locality-centered communities for community activities, such as parks in residential communities, and cafeterias in in school campuses. When people accommodates in public gathering space designed for specific reasons, they are more likely to encounter other members. Physical distance between them will be reduced as well.

One example is the proliferation of coworking spaces in mega-cities. Coworking space refers to a workplace physically shared by individuals practice coworking [17]. Figure 2.1 shows a general image of coworking space, where people work with unfamiliar people on either fixed or unfixed tables. According to the data in 2014, there are close to 7,800 coworking spaces worldwide used by approximately 300,000 people, and more than 350 facilities in Japan [18]. Most of the users are freelances who rent working place for communication and socialization. Besides its basic function of information sharing, this kind of "collective, community-based approach" is supportive to creative work in need of inspirations, by working in a collaborative atmosphere and social relationships created by propinquity in space [19].



(Source: co-ba SHIBUYA [20])

Figure 2.1 A coworking space in Shibuya, Tokyo

2.2. Public Displays

In this section, prior researches in improving public displays are examined to shed light on how to increase participation of publicly located bulletin boards for inclusive physical communities. As discussed in the previous chapter, public bulletin boards can facilitate community interactions by emphasizing propinquity of space and information. Hence, bulletin boards, a conventional of public display, are used in this design.

Initially, the concept of social space need to be discussed to better understand the factors leading individuals to public space. As described by the geographer Maximilian Sorre in 1943, social space was perceived as a collection of physical areas where interaction and consequent perceptual overlap among a group living in close propinquity. Past research indicated that individuals spend most of their lives in area where they feel comfortable, and seldom move out [15]. People leaves comfortable zone for a reason. In the terms of general graduate students communities, like classrooms, libraries and dormitories, people prefer staying in their own seats or individual rooms to lounges or public pantries. They only "move out" for everyday needs like going to toilet or smoking. However, "move out" also takes place in case of surprises or attractions created by parties, workshops or

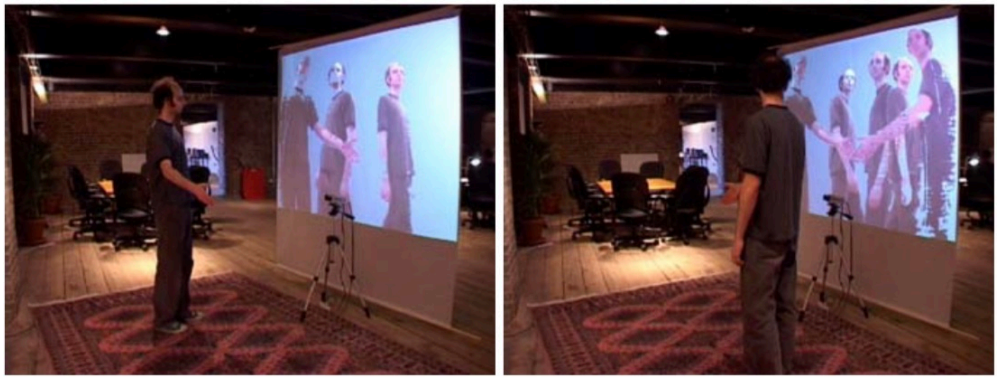
events they are interested.

It suggests that participation of interaction in public space requires benefits as well as attractiveness. Past researches of improving public displays have mainly focus on two perspectives: how to support social activities; how to entice participation in public.

2.2.1 Apply Sharing to Strengthen Bonds

As discussed in the previous chapter, information sharing activities, especially informal meet-up, serve a prominent role in community activities. Some of the researches have been exploring how to augment sense of community even over time or space. Researches concerning digital displays have been centering around fostering subtle encounters and informal communications via multiple functions.

One innovative design is the Palimpsest by the the Human Connectedness research group from MIT Media Lab Europe [21]. The installation loops videos created from superimposed images of participants several seconds ago, creating the recent history of a space. Passers-by can saw the video generated by the prior people earlier. If participants stop, they would see multiple layers of delayed copy of themselves. As illustrated in Figure 2.2, passers-by can interact with other members or even themselves. Even if they just stand along in an empty space, they are able to become part of a group on the screen. This design succeeded in reminding people of other members' presence by lingering effect, revealing a hidden community, and creating the feeling of "being together", despite they couldn't meet each other physically for time management issue.



(Source: Designing Displays for Human Connectedness [21])

Figure 2.2 An interaction example of Palimpsest at MIT Media Lab

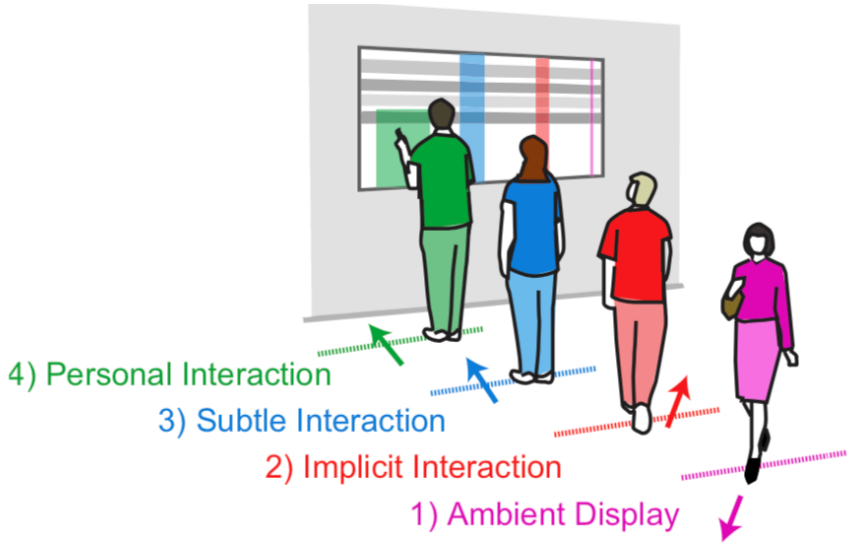
Another example is XRCE's Community Wall [6]. It is an interactive bulletin board consisting of a screen display and relative hardware. Hardware works to manage screen content and performs content selection, enabling users to post and reply. Besides the basic function of sharing community information through a digital screen, the Community Wall makes it possible fore members to ask for help or address collaborative problems. Touch-screen technology was utilized to facilitate and reinforce "mechanisms and interactions already in place in the organization".

2.2.2 Easier Participation with Clearer Invitation

Other ongoing researches concerns about how to overcome psychological embarrassment and encourage participation with public displays. Through two empirical experiments, Brignull and Rogers developed a model of public interaction flow for implications of public displays design [8]. They found out that key points in public participation include: (1) the efforts in attracting users to approach; (2) the efforts in persuading them to participate. Similar to "engagements among the unacquainted", getting "first-kick" from passers-by has been regarded as the fundamental challenge in promoting interaction with public displays [22].

To transform passers-by from on-lookers to participants, sensory modalities have been utilized to make participation looks like easier to achieve even at a distance.

One attempt was the design of Animate Objects in the Stanford University [22]. With several experiments with on a digital screen, positive results showed that motion and physicality can entice people to look and participate actively with stronger impressions. Another example is a research in Toronto University about the utilization of hand gesture and position cues to augment interaction with ambient displays in public [23]. In details, they make improvements to a bulletin board by enabling multiple users to interact with it at the same time without bothering each other. Based on studies of human behaviors, body orientation and position are chosen to trigger implicit interaction at a long distance, while hand gestures or touch screen input turns on explicit interaction at a short distance. The concept of the design is displayed in the Figure 2.3. The design received positive feedback from user tester, who understood their body position was controlling the display quickly.



(Source: Interactive Public Ambient Displays: Transitioning from Implicit to Explicit, Public to Personal, Interaction with Multiple Users [23])

Figure 2.3 Four interaction phases, facilitating transitions from implicit to explicit, public to personal, interaction.

The challenge of enticing interactions with public displays is to overcome the reluctance of people to take action without visible payoff. Foremost, these works mentioned above indicated that applying ambient cues is effective in transforming peripheral awareness to focal awareness without even self-conscious. Moreover, interactions should be approachable and attractive to persuade passers-by to participate.

2.3. Smell as Output Media

Obvious evidences suggest that suitable choices of sensory modality determine the effectiveness of interactions between human and computer controlling systems. The sensory should convey clear messages to potential users of expected behaviors, and deliver results beneficial to make interactions continue. To achieve this effect, this research chooses to utilize smell under computer control as an output medium in the design of public bulletin boards.

Smell is definable as a medium for its capability to transmit information [24]. Past empirical and researches showed that olfactory or smell production is hard, for it needs huge numbers of receptors bonding to different odour properties. Smell shows great potentials as an output medium with its incomparable effects in triggering presence and activity awareness, and sharing ambient information. Keep in mind of the objective to increase participation with a public bulletin board, two remarkable features of smell will be discussed in the this section.

2.3.1 Use Smell to Increase Awareness

Awareness is "the state of knowing about the environment in which you exist, about your surroundings, and about the presence and activities of others" [25]. How to make passers-by aware of public displays determines the effectiveness of public displays, or public bulletin boards in this research. It is worthy mentioning that, human process information via not only "foreground" but also "background" information. For example, we can still sense ambient cues outside like temperature or wind when we have class indoors. However, it has been overlooked in many computer controlled systems.

From this perspective, smell serves as a perfect ambient medium. Foremost, people can hardly ignore smell. It is subtle, ambient as background information, and linger on physical object or space over time. It does not require constant attentions to receive smell information. Furthermore, smell information is easy to notice when changes take place, but would be ignored gradually after a period of time. One example in everyday contexts is the case when someone cuts grapefruit in a room, people can feel immediately and get used to it after a while. Hence, it can be concluded that smell meets the requirements of ambient designs: capable to allow people to easily and quickly shift their focus of attention without breaking the mental continuity [25].

The feature has been utilized in many designs. The design Dollars & Scents attempted to inform people of market trends through smell. Scent of rose is emitted when the market is going up, and lemons is for going down [26]. Another example is the Sensorwake Trio, which wake users up with scent combined with sound and lighting [27]. As Figure 2.4 illustrates, users can plug aroma capsules, and wait for being waken up with the chosen smells, such as espresso, fresh-baked cookies and beach. The capsule needs restocking after thirty days. The idea is that smell can induce awareness unconsciously to slow waking-up down, boosting gradual but high-quality emotion afterwards.

(Source: Sensorwalk Trio: Smell-based Alarm Clock [27])

Figure 2.4 Sensorwalk Trio: Smell-based Alarm Clock

2.3.2 Use Smell to Foster Emotional Attachment

Another unique feature of smell is its powerful emotion-evoke capability. Prior researches indicated that memories triggered by smell is the most emotionally loaded sense [28]. This is originated from the direct connection between the olfactory center and the limbic system in human brains. The limbic system is critical for the expression and experience of emotion [29]. Moreover, there is less intermediate steps in processing olfactory information compared to visual or auditory stimuli [30]. It bypasses the linguistic center managing conscious perception in the brain, making the perception of smell unconscious but definite.

The use of smell in delivering affective information is quite common in daily life. It could be perfume for self-enjoyment, or aromas in shops for marketing. Aromatherapy is also popular for its influence over emotion improvement. One project relative to olfactory communication is the research[1] by Mei Kei Lai at Keio University Graduate School of Media Design in 2016. The research is about *Ludic Odour*, an digital artifact design for family bonding between parents and child with smell experience at family bathing. With MESH[2] application, *Ludic Odour* emits odors in accordance to the strength and duration of scrubbing detected by an artifact soap. Olfactory is combined with haptic sensory to create sharing memory among families. For child's first encounter with olfactory experience, the design facilitate close bonding with sharing olfactory memories.

Nonetheless, there is obvious disadvantages in smell as a medium. It is dispersal and hard to be converted into digital information. Also, differentiation of smells is a difficult task and requires training, for smell intersects with each other quite easily. The emotion-evoked characteristic means people have subjective and varied opinions towards the same smell. Previous studies and empirical evidences suggested that accuracy, intensity and duration needs to be designed carefully.

1 Ludic Odour : Designing a Digital Artefact with Smell at Bathing for Family Bonding, Mei Kei Lai, 2016

2 MESH: http://meshprj.com/en/

2.4. Summary

The final goal of this research is to entice participation with public bulletin boards for social connections in offline communities. In addition, since communities for graduate students are used in this paper as pioneer study, the bulletin board is assumed to be located around lobbies, lounges and corridors in school campuses or dormitories. Connections emerge with frequent interactions, especially informal and spontaneous meet-ups in public spaces where individuals' social space overlaps. Hence, this researches proposes a new insight in encouraging people to interact naturally and unconsciously with a catalyst: Amiable KEY.

Based on the Propinquity Effect, Amiable KEY aims to reduce distance in space and information among members with the utilization of public spaces as what co-working spaces have been doing. To amplify the positive effects of public spaces, Amiable KEY should provide members with sufficient reasons to move out from individual comfort zone. In other words, Amiable KEY should provide functional and emotional benefits to members, similar to what the Community Wall did in fostering encounters and what Palimpsest did in showing peers' presence. Although both two of them contributed to community connections from separate perspectives, Amiable KEY attempts to take the challenge of combining the two attributes together for stronger social bonding.

On top of that, inspired by the review concerning increasing participation with public displays, Amiable KEY chooses smell as an output medium in a computer controlled systems to improve current bulletin boards. The Animate Objects by Stanford University and the improvement to ambient displays by Toronto University succeeded in persuading passers-by to engage in expected behaviors after a swift glance. However, they depend on either touch-screen input or gestures for interactions, which means constant visual attentions are required in the "first-kick" period. It is very likely that they may be ignored easily when passers-by are focusing on other information, like swapping mobile phones, which is quite common nowadays. From this perspective, smell seems to be a more effective media. It can transmit emotion-loaded information to people unconsciously with no needs of seeing or listening. Prior researches indicated that smell can move peripheral attentions to focal extremely quickly.

To sum up, the literature review and related work analysis suggested that,

Public Space, **Bulletin Board** and **Smell** can serve as Amiable KEY components of Amiable KEY. As illustrated in Figure 2.5, this design fosters community connections through frequent informal interactions augmented from an effective bulletin board interaction.

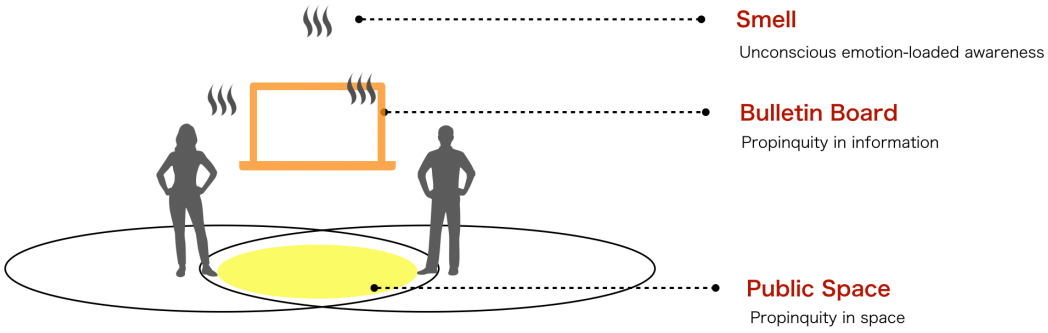


Figure 2.5 Key Components of Amiable KEY

Chapter 3
Concept

3.1. Amiable KEY

Amiable KEY is created to amplify positive effects of public interactions on community bonds with the help of an interactive bulletin board. By interaction with the board, it is intended to foster emotional attachment to public spaces, and enhance informal encounters among community members through passive contacts in the space. It intended to help people to enter public spaces, which works similar to a real key people use to open a lock to another space. Furthermore, Amiable KEY is shaped as a tree to make it look like adorable than ordinary white boards. The idea was inspired from "tanabata" (which means Star Festival") in Japan. On that day, people celebrate by writing wishes on small pieces of paper and hanging them on bamboo. KEY, the name of the design, is originated from the pronunciation of tree in Japanese (木), reminding people of natural aroma of forest. Amiable, a word means friendly and easy to get along with, is used to show personality of KEY.

Based on the studies in the previous chapter, Amiable KEY is designed as a catalyst to enhance interactions in public spaces with smell emitted into public spaces, available to every member. It stays there quietly with ambient scents generated by prior users' messages, but echoes to a new message responsively. Moreover, it is aware of the environment, giving reactions with different smells in accord to message contents. On top of that, it shows telepathy to every one like an amiable friend living there for a long time. It creates a cozy environment not only by sharing useful information to help people getting used to local life, but also by providing opportunities to make people better acquainted with one another.

3.2. Design Process

The general image of the design mentioned above was created based upon design thinking process as well as research analysis. Amiable KEY was created by addressing problems in real-life contexts, and attempted to shed light on a reasonable solution through literature review, ideation, scenario design, prototying and testing. Chapter 1 and Chapter 2 has mentioned the first two steps already, ideation and scenario design will be iterated in this chapter to reach the final concept.

1. **Problem Research**: personal experience motivated the research of the isolation problem in offline communities, and an online questionnaire helped to disclose the lack of local social connections among graduate students.

2. **Literature Review**: literature review and related work studies about propinquity effect, public displays and smell was implemented to seek out three core components and their separate functions.

3. **Ideation**: analysis of the design components and a concept sketch contributed a comprehensive image of the design.

4. **Fieldwork**: a manipulated interaction on a bulletin board helped to understand barrier to public interactions and how can overcome them in real-life context.

5. **Scenario design**: an user-centred method, including user persona, scenario storyboard and user case, helped to consolidate details of a final concept.

6. **Prototyping**: the creation of two prototypes for the realization of the initial concept. Final design details evolved through empirical experience originated a testing.

7. **Proof of Concept**: the effectiveness of the design and possibilities of the concept was tested through the second prototype. An user test adopted the methodology of Wizard of Oz to stimulate spontaneous interactions.

3.3. Ideation

3.3.1 Design Components

Based on research into the addressed problem and literature review, key components were created to consolidate the design as mentioned in the summary of Chapter 2. Emphasis of each components is analyzed as follows:

- **Public Space**: the design aims to reduce distance in space among community members to encourage passive contacts and informal encounters, with the hope of creating emotional attachment to the location, identity of the community. The challenge is to choose space accessible to every member from physical and functional perspectives.
- **Bulletin Board**: the design intends to reduce distance in information to foster communication and strengthen community mechanism. It facilitates interpersonal interaction directly through asynchronous communications. Benefit to users is critical as well as appearance attractiveness.
- **Smell**: the design is utilized to increase presence awareness and create emotional attachment. Therefore it should be robust to move periphery attention to focal unconsciously, and be enjoyable enough to increase participation frequency.

3.3.2 Sketch of Concept

Keep in mind of the goal to amplify positive effects of social interaction on community connections, the design process started with the three components mentioned above. Amiable KEY should emit impressive smell to draw passers-by's attention, and encourage them to read messages by imitating the behavior of "sniffing". In addition, core of a functional KEY is to show amity by creating an atmosphere of free expression, inducing them to write or reply to others.

To achieve it, Amiable KEY adopts the metaphor of "短冊" (tag in Japanese) in Star Festival, or "絵馬" (votive picture in Japanese) in Japan's shrines. The idea aims to produce an aromatic environment similar to shrines, where trees and

plants are widely used to create a holy and peaceful environment. Writing and reading are regarded as natural and beneficial in this context.

Figure 3.1 was used to envision potential interpersonal encounter around two users, and Figure 3.2 was drawn to visualize the concept. After showing them to a group of people to check how people understand it from the first impression. The feedback received are promising. People like the idea of stimulating an interaction of writing and posting messages on an aromatic tree. The concept makes them feel like being purified in a power spot.

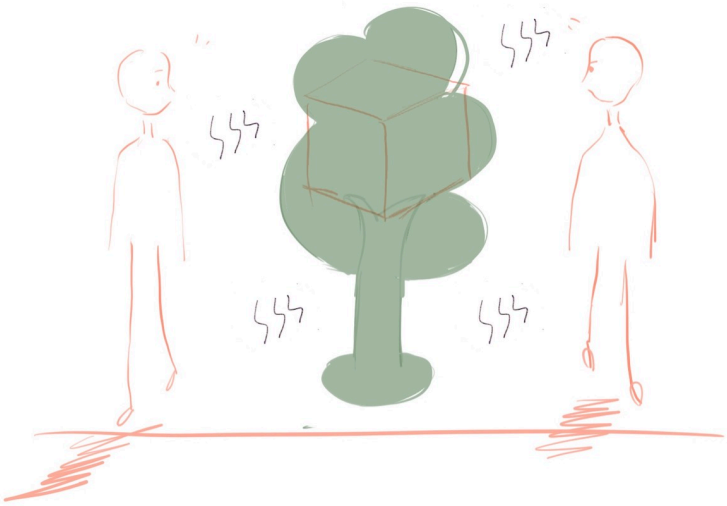


Figure 3.1 Concept Sketch: Envisioned interpersonal interaction between two users. Credits: XIA Yi, 2019

Figure 3.2 Concept Sketch: User interacts with Amiable KEY.

3.3.3 Target Users

As mentioned in Chapter 1, graduate students are targets of the design. In particular, those who have a desire for more communications but lacks channel to achieve it, or those who felt isolated by limited local social support. User interview revealed that the prominent factor is the introvert personal characteristic. It refers to people who are not used to social gathering like parties. Another factor is time management. It happens when community members are busy with individual schedules.

3.4. Fieldwork

In order to find out how graduate students interact with unfamiliar peers in offline contexts, an observation was conducted in the Tokyo International Exchange Center Residence Hall[1], a dormitory for international students from graduate schools in Tokyo. The fieldwork was inspired by the Propinquity Effect[2]. The focus was on how people socialize with a public bulletin board, and their reactions to something new or surprising.

3.4.1 Tokyo International Exchange Center

Previous researches suggested that Propinquity Effect is remarkable in homogeneous communities. That is because close in proximity produces strong tie only when there is mutual interests or motivations. With regards to TIEC[3], the residential project is a homogeneous community with members sharing a high homogeneity: the majority of residents are young single adults; most of the residents are foreign students studying overseas; all residents can be considered to have a high motivation in global communication, as one of the application requirements; residents don't have enough time to build long relationships, for the maximum

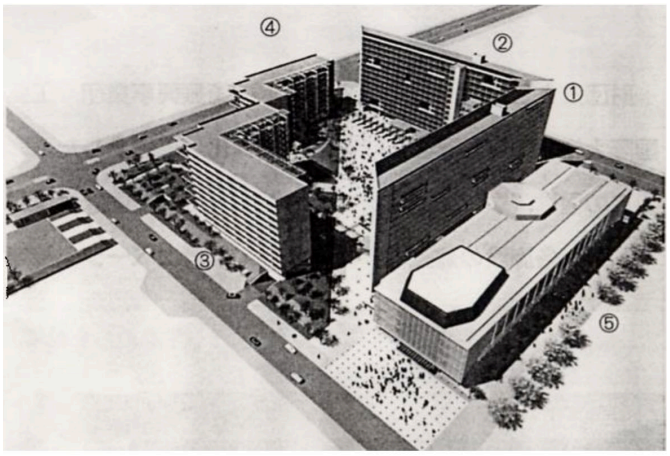
1 `TokyoInternationalExchangeCenterResidenceHall:https://www.jasso.go.jp/en/kyoten/tiec/index.html`

2 See 2.1.1

3 TIEC refers to Tokyo International Exchange Center Residence Hall

period of residence shall be 3 years within the term of study.

On the contrary, there is a decline of participation of public activities in the other years among TIEC residents. As displayed in Figure 3.4, there is a white board for communication on each floor. It is located in the corridor where everyone need to pass on their way to elevator. Normally, community information will be posted on it. Unfortunately, but few communications take place. Someone even chose to leave their name blank.



(Source: TIEC homepage [31])

Figure 3.3 Four residence halls and one meeting facility in TIEC.

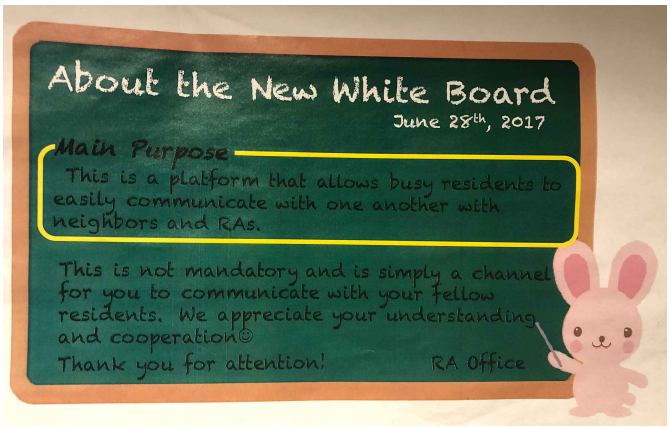


Figure 3.4 Instruction shows the bulletin board is for peer communication.

3.4.2 Interaction on a Bulletin Board

Inspired by the phenomenon that people are more likely to appreciate those they are better acquainted mentioned[4], the observation started with a manipulated setting: using red magnets to make a smile face on the white board. During the first two days, nobody did anything to the smile face. Considering it might be resulted from the fact that people were wary of a sudden change, and consider it as suspicious, the smile face was altered into a blink face in Figure 3.5.

Since that, changes took place continuously. As shown in the Figure 3.6, images keeps changing every morning. At first, someone used it for sharing local information. Gradually, graffiti and words started appearing, such as KAWAII ("cute" in Japanese). After around a week, someone asked for help about Wi-Fi on the white board. However, nobody replied to the sentence.

An inspiring result took place after approximately three weeks. Someone cleaned the red magnets up, for written information like name and nationality were removed by the magnets. By contrast, people initiated another round of communication. Continuous communication appeared concerning a character with emotions. When the character looked happy face, people replied with cheers and beer. When the character looked sad, someone asked about "お元気ですか" ("How are you?" in Japanese). However, the one who removed the SOS message.

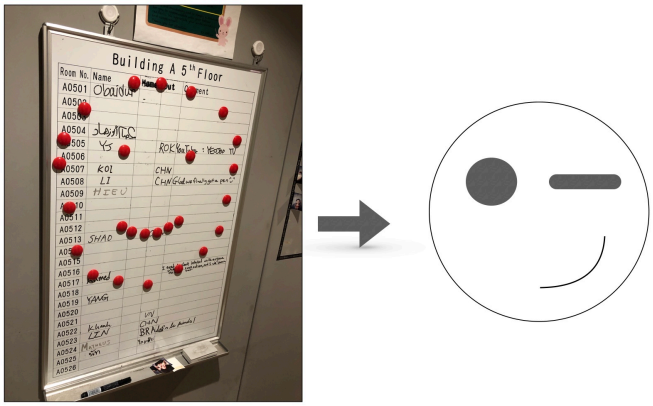


Figure 3.5 The first change manipulated for interaction

4 See 2.1.1

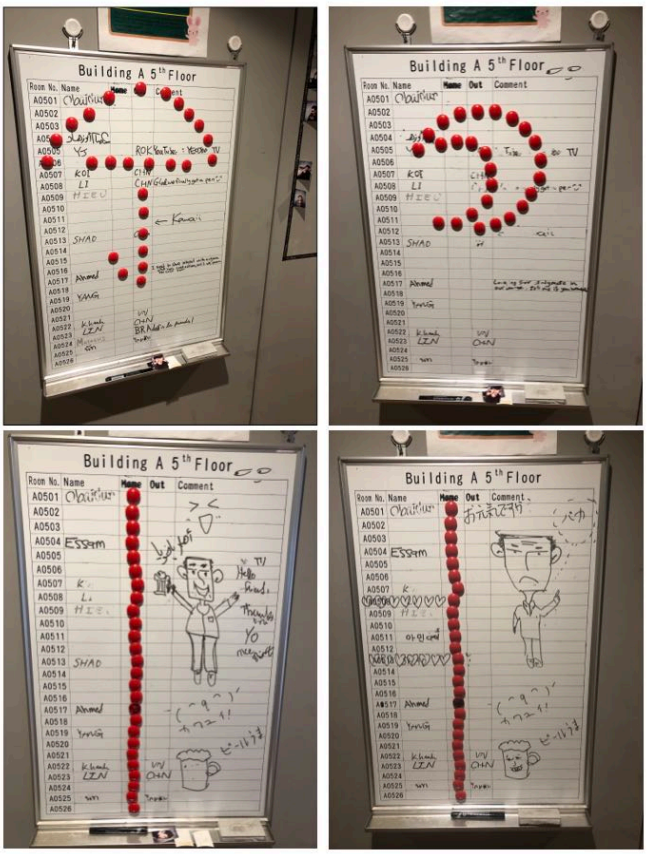


Figure 3.6 Continuous changes on the white board.

3.4.3 Discovery

The observation demonstrated in which situation people will be more likely to interact. In face of a conventional bulletin board existing for a long time in the location where community member would pass by, people ignored it instead of communicating with one another on it. However, changes happened once reactions took place. In other words, people needs motivation to take actions.

More than that, the episode of a "SOS message" suggested that people may be wary of messages from a specific person, but more open to anonymous messages. Because the white board is designed with room number, the "SOS message" revealed which room he or she lives. Considering residents have not built strong connections yet, this kind of direct interactions may be regarded as insecure or

uncomfortable. Reply to specific people means potential losses in time or other sources. By contrast, individuals only make efforts to interact with those they are familiar.

3.5. Scenario Design

3.5.1 User Persona

An user-centred method was adopted to emphasize the crucial role of interpersonal relationships in this design. Two user personae are built up as follows:

- **The Writer**: refers to Bao introduced in Figure 3.7, representing who writing messages as the first person. The person needs help and suggestions for problems emerging constantly after joining in a new community. However, there is few social resources available to her, despite there are many people experienced nearby. The users tries to talk with friends remotely, but finds it is hard to get valuable suggestions. The value proposition to this person is the the desire of community information. This person serves as an ideal user of Amiable KEY for a topic to start an interaction.
- **The Reader**: refers to Yang introduced in Figure 3.8, representing who reading and replying to messages on Amiable KEY. This person has rich experience in the community, but suffers from losing old local friends as well as low interests in formal gathering. This person is likely to be attracted by new information easily and is willing to give a reaction. The value proposition to this person is to have the desire of new stimulation and inspiration. This person serves as an idea user of Amiable KEY for the willingness to engage in a new interaction.

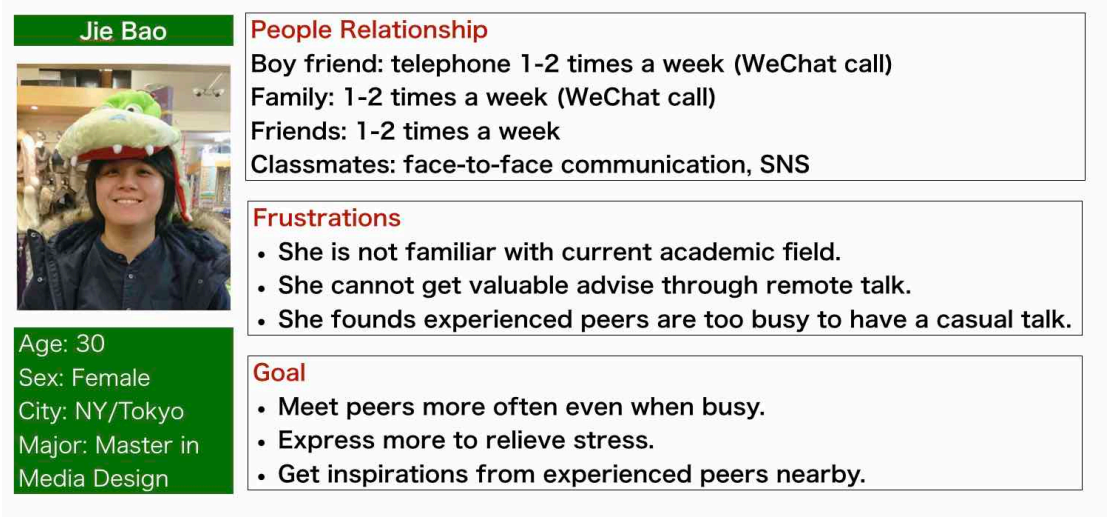


Figure 3.7 Persona 1: Bao as the Writer

Figure 3.8 Persona 2: Yang as the Reader

3.5.2 Scenario

Storyboard works to visualize an ideal scenario of Amiable KEY with the two target users created above. Expectations and motivations are defined as well.

Storyboard: while digital devices enable us to keep in touch with old friends remotely, people are too busy to build new social connections, especially when moves in a new community. The situation seems to be even severe in graduate schools, where people from different backgrounds are all busy and have limited opportunities to meet each other.

Bao, a girl from China, is studying for the master degree of art management in Tokyo. Although she has no experience in art, she loves art exhibitions and plans to become a gallery manager after graduation. However, excitement disappears gradually. She founds her classmates are either talented or experienced in the field, and it seems hopeless to catch up soon. She is confused, looking for someone experienced people to talk with, but she does not know any one of them well enough.

After being frustrated for several days, she decided to try Amiable KEY. It is a small tree that appeared in her dormitory the other days. Everyone can leave messages about everything to help the tree grow up.

When Cindy arrived, she approached and sniffed the tree to take a deep breathe, evoking her memories of high schools back in China, the smell similar to the one she smelt on her way home from school with her friends. She decided to write down her anxiety about art studies, just like those dreams she used to share with her friends. With a new message, the tress started emitting the smell of scorching. “At least the tree understands what I mean.” Cindy said to herself, feeling a little bit comforted, and went back to the library.

At night, when Cindy went for dinner, as usual, she passed by Amiable KEY once again and notices the scorching scent is gone. A brand new aroma lingered around. Being curious, Cindy decided to take a look and found there was a new message sticking to her old one, saying “Hi, we have a group for art gallery every week. Join us! It is too early to give up.”

Cindy felt so touched by the message, and added a big smile to the reply, making the tree emit sweet aroma of the silk flower. A girl, attracted by the aroma, waited outside. When Cindy got out, the girl asked if it was Cindy that

left the first message there. Cindy nodded in surprise and started talking with the girl. Afterward, Cindy joined the group and enjoyed discussion about galleries.

3.5.3 Use Case

To understand how users will interact with Amiable KEY and outline a computer-controlled system to make it work, use cases was adopted to understand touch points that starts the process. Each step in a complete interaction process was broken down to clarify inputs, outputs and potential errors. As illustrated in Figure 3.9, different use cases have been created to visualize possible interactions.

1. **Writing messages to Amiable KEY**: the interaction is between a user and the bulletin board. The user has the motivation to express and Amiable KEY can provide with a channel. Smell is generated by the message, and emitted into the air. Duration of emission should not be overwhelming in case of unpleasant effects. Moreover, category of the smell should be in harmony with message content to encourage repeated interactions.

2. **Reading messages on Amiable KEY**: ambient smell, generated by prior messages, lingers around Amiable KEY in the space. User will be attracted by the smell and have a chance to read messages. This phase is critical, for it determines whether interactions will continue or not.

3. **Interaction between users**: the user can decide to interact with other users. Interaction includes asynchronous communications by writing and shows awareness of others' presence by altering the smell.

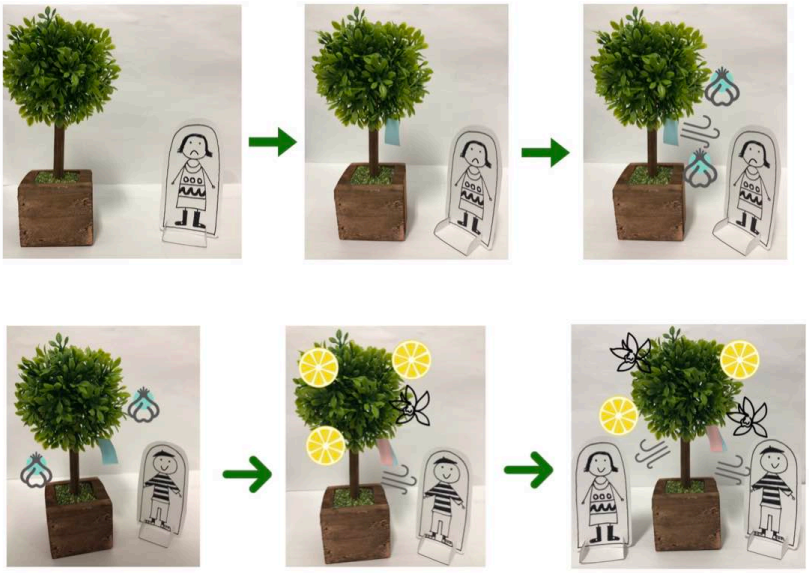


Figure 3.9 Use case

3.6. Concept Summary

To sum up, Amiable KEY is an interactive bulletin board that fosters social connections among unfamiliar peers in offline communities. It is shaped as a tree, emitting smells into public gathering spaces. The prominent features of Amiable KEY are:

1. KEY reacts to users' written messages with smell. It embraces expression, in the form of writing, by showing responsive feedback to users and making them feel less wary of the space.

2. Key draws attention from users with ambient smell. It increases presence awareness of other members as well as a physical community, even beyond the time barrier.

3. KEY has cognitive capabilities towards message contents with amity. It entertainment users with different smells, delivering a playful and enjoyable experience to foster constant interactions.

Amiable KEY shows novelty through its utilization of smell as an output medium to amplify the positive effects of interactions on interpersonal connections:

- It draws attention unconsciously by moving peripheral attention to focal even without constant attention on the target object.
- It encourages constant interaction with enjoyable and playful aromatic experience.

As supported by the Propinquity Effect[5], Amiable KEY will encourage informal encounters and foster emotional attachment by enticing public participation. The evidence can be clarified as follows:

- It reduces distance in physical space by promoting activities in the same location, encouraging them moving out from individual space to public space.
- It reduces distance in psychology through asynchronous communications, through which members will have more chances to be acquainted with one another and discovering similarities.
- It reduce distance in information by sharing and broadcasting, with which members will be more likely to learn about community information and be aware of community mechanisms.

The initial concept was consolidate through testing on two prototypes. All the details concerning prototyping and setting of user tests will be described in the following chapter.

5 See 2.1.1

Chapter 4
Prototype

In this chapter, the initial concept formed with two prototypes. Testing with the first prototype in an ideal scenario suggested the power of smell in drawing attention. Afterwards, the second prototype was assembled to realize the cognitive feature of Amiable KEY.

4.1. First Prototype

According to initial concept, the first prototype was built up to testify whether smell is robust enough to raise awareness of a public bulletin board, and entice them to interact with it by writing and reading, a user test was conducted to estimate whether and how people interact with a bulletin board combined with olfactory effect in the real world.

4.1.1 Setting-up

With regards to Amiable KEY components of the design mentioned before, the first version of prototype was assembled with a portable tent, a tiny whiteboard with colorful paper, and two types of smell. Details of the prototype were shown in Figure 4.1 and Figure 4.2.

The choice of tent is based on the advantages in smell, which is dispersal and may evoke subjective opinions by different people. Therefore, an half-enclosed space was considered to be comparatively safe, similar to a smoking room. In this case, the prototype can avoid unnecessary impacts to too many people during a pilot testing. The tent is sized by 160x130x115cm when setting up. It can hold 2-3 adults at one time with a sitting position. A paper outside the tent instructed people that “Please enter for free”. In addition, a whiteboard (35.7x28.1cm) was

located inside the tent, along with colorful memo paper, and three permanent pens. A short instruction was written in advance, showing people can write anything they want. lastely, a diffuser in the shape of a white cat (7.2x7.2x20.8cm) was placed in the front part of the tent. Two AAA-700-size dry batteries power the diffuser with no cables. The diffuser is capable of diffusing raw materials rather than artificial aroma. Two kinds of smell used in the user test: burnt knitting wool (100% cotton) at first and dry lavender during the late period.

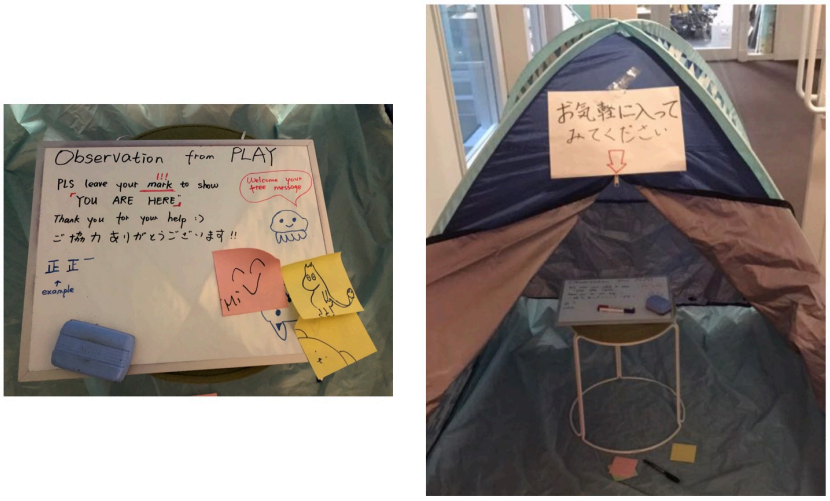


Figure 4.1 First Prototype in KMD (May, 2019)

Figure 4.2 Burnt wool and lavender used in the first prototype

4.1.2 Testing and Results

With regards to location of the testing, it was the third floor of the Collaboration Complex[1]. The observation was conducted for a week during May 2019, as a non-participant observation. No interventions took place during the observation.

In details, the prototype was located in the main corridor of KMD, beside two main classrooms, near a garbage can, and a closed exit of a hacking studio. The space is an inclusive space with an access control system for the community. In addition, the space is on the way to many vital facilities, including the only smoking room on that floor. Most of the students and professors in KMD will pass by the location every day. Furthermore, since it is the very early stage of a new academic year, members of the new batch were still unfamiliar with each other. From this perspective, This place an idea testing location for this design.

Focuses of the observation are on: how passers-by react to the prototype; whether people will be attracted by the smell or not; whether people will enter the space and engage in writing.

After one week, the observation attracted a total of 15 visitors and received 13 messages. During the observation, many students showed curiosity to the prototype and glanced at Amiable KEY on their way to the classroom or the smoking room. Many students were shocked at the sudden appearance of Amiable KEY. Verbal comment were observed as well. Two young male students expressed surprise at the tent to each other and started discussing how they feel like KMD life.

During the weekend, many messages appeared suddenly. Most of them are graffiti, such as animation characters and animals. Some of them were combined with interjections like “Ah!”. Considering the observation was during the period when many students were stressed with their thesis or assignment, the word “ARASHI”(the name of a Japanese idol group) or “Fighting” also appeared at high frequency. However, appearance of new messages slowed down gradually. To promote more participants, a questionnaire post was put inside asking for help, but it found out that nobody answered the questionnaire. Someone zipped up the

1 Collaboration Complex serves as main building for KMD (`http://www.kcc.keio.ac.jp/english/index.html`)

tent, and someone left an empty water bottle inside.

Interview was conducted among recognized participants to figure out user experience as well. Many of them enjoyed the writing experience without face-to-face interaction. One participant said she was not sure what to write as the first actor. The person who drew some cartoon images explained that she just need it to relieve stress from thesis. The one who zipped up the tent said she saw the empty bottle and tried to stop it.

However, feedback about the scents were not positive. The burnt odor disappeared too quickly after the first several hours. On the other hand, the lavender scent from the diffuser was weak as well, hardly to notice when walking by.

Figure 4.3 Messages by students in the tent

4.1.3 Revision

The observation showed promising results concerning the initial design. Foremost, Amiable KEY succeeded to attract amount of passers-by's attention. Next, it reached the goal of engaging people in writing messages. Someone sent messages ("Fighting") to people who are working on thesis rather than simple self-expression. More than that, verbal communication was observed as well, including short comments as well as further discussions. In addition, a trend of convergence appeared in those messages, such as cartoon characters and "Arashi". It suggested that Amiable KEY can help people to discover mutual interests and similarities.

However, some observations indicated that further revisions have to be done to complement the design objective of enticing writing and reading on a bulletin board.

1. **Public Space**: observations suggested that an enclosed space is not suitable for public interactions despite the consideration of the dispersal feature of smell. It turned out to increase embarrassment in public spaces.

2. **Output Media**: smell used in the observation show subtle effects in attracting attentions. It indicated that the combination with other sensory might make the design more impressive and attractive. Besides that, combination can also help with situations when users are unable to receive smell information, such as having a cold.

3. **Reactions**: the decline of new messages later in the observation implied that responsive reactions are necessary to maintain constant interactions. When people got used to its presence, they stopped interactions suddenly for the lack of emerging surprise. Communications didn't appear among the written messages as well. Responsive feedback from Amiable KEY should be used to utilized to make the interaction enjoyable as well as beneficial.

4.2. Second Prototype

Based on the first test above, revisions have been made to better the interactive experience of Amiable KEY. Since Amiable KEY has shown positive results in

attracting attention from passers-by, focus of the second prototype is to complete the capability of Amiable KEY to show telepathy.

4.2.1 Revised Interaction

Amiable KEY should behave as an amiable friend through cognitive responses to messages contents. By delivering an enjoyable and playful interaction experience, users are assumed to increase participation frequency. Furthermore, the first test suggested that combination with other sensory is necessary to leave stronger impression to users, even when they are used to smell or when they are not able to recognize smell.

Input

As described in the summary of Chapter 3, Amiable KEY should behave like an amiable friend through cognitive responses to messages contents. By delivering an enjoyable and playful interaction experience, users are more likely to increase participation frequency emotionally. Based upon it, the interactivity trigger is given by the valency of messages. To achieve it, two kinds of paper are provided to users before writing: red paper for neutral or positive messages; blue paper for emergent or negative messages. Instructions will be used to inform users of the mechanism.

Output

On the other hand, the second prototype chooses visual signals to support smell output. Since the objective of the design is to encourage interactions with a bulletin board by writing and reading, visual attention is a basic element in the initial design. Furthermore, visual effects can serve as appearance design, without making the interactions become overwhelming for overloaded stimuli. Hence, projection was adapted was adopted as synchronous output. Contents of the projection should be in harmony with different smell generated by corresponding valency of messages.

Tracking System

In order to convert input information (color of paper) to output effects (projection and smell), a tracking system was built up with a TCS3200 Color Sensor Module (8.3x7.2x2.4cm)[2]and an Aruino Uno[3]. The Arduino Uno helps to control a projector and a diffuser based on the light information captured by the color sensor from paper.

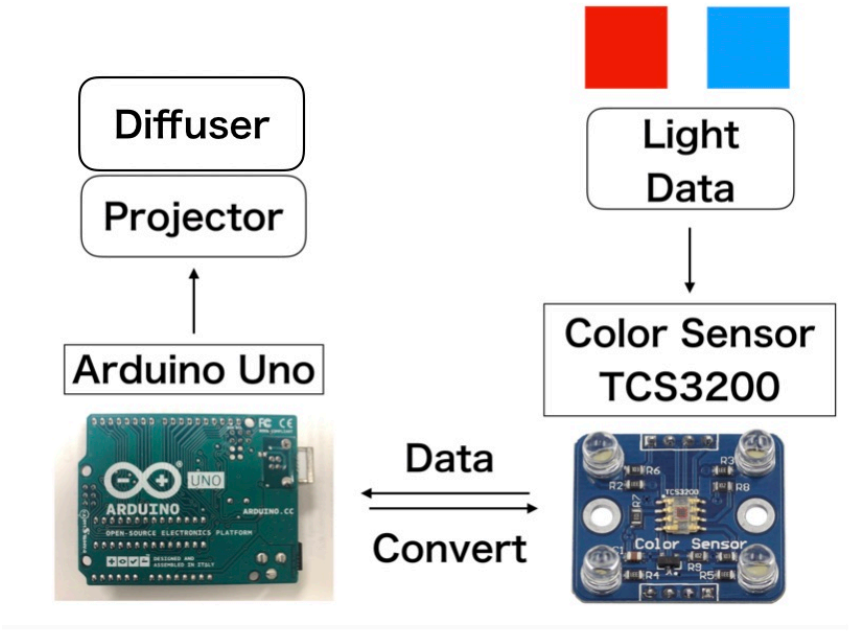


Figure 4.4 Procedure of Amiable KEY's Interaction System

2 TCS3200: `https://ams.com/tcs3200`

3 Arduino Uno: `https://www.arduino.cc/`

4.2.2 Setting-up

The modified design was assembled by a latter-cut tree, a mini projector, a diffuser and a tracking system described above. Based on previous researches and observation results of the first test, setting of the second prototype will be described as follows:

Public Space

Considering the space should be accessible to every members from perspectives of physical and functional distance, public spaces with specific functions will be used to locate Amiable KEY. In this pioneer research, gathering space for peer communications were used, such as public lounges or corridors to an elevator, which are designed for free entry and convenience. In the future, location of Amiable KEY can be expanded to any public spaces, ranging from lobby of library to dormitory entry. A public kitchen in the Hall A of TIEC will be used for as user test space for the second prototype.

Public pantry on the fifth floor of Hall in TIEC, the same location of the pretest described in 3.4.1, serves as the location of Amiable KEY. The space in on the way to the only elevator and stairway, making sure every member has the need to pass it nearly every day. In addition, the space is designed as a gathering space for cooking as well as communication. Residents can study, have meals and hold parties there. Furthermore, the space is equipped with air conditioner, good ventilation, and abundant light. The glass door is always open, enabling passers-by to see what is happening inside as well.

Bulletin Board

As illustrated in the concept sketch and explained in 3.1, the image of tree was adapted to create a natural scenario friendly to writing and reading. Hence, the bulletin board is a laser-cut tree, made of two wooden boards. In order to make it attractive and approachable to passer-by, the tree is sized to be 60x90x0.25cm with a cardboard box (28x50x15cm) beneath, ensuring it is comfortable enough for people to take a closer look. Small holes are created on the “limb” for people to tie paper.

Smell

Smell is the most critical element in the prototype. Since smell is utilized to attract attention from passers-by and create an enjoyable experience, two kinds of smell were selected from around ten kinds of essential oil and scent product, based upon the level of recognition and feasibility. Through testing with different people, it showed that orange can be detected most quickly. At the same time, orange received most positive feedback compared with the others. On the other hand, eel sauce scent is used as smell for negative messages, for its uniqueness and endurable features shown in the test [32]. Most people regard it as fun and scare. Figure 4.5 shows products used in the prototype.

With regards to the style of diffusion, the AROMIC flow (160x90mm) is used [33]. The choice was chosen for its capability of emitting 100% essential oil without water, creating robust and impressive effects. More than that, the device can support endurable aroma experience in space up to 36.481 square meters (20 畳). It ensures people can easily recognize the smell even at a distance. To tighten the connection between Amiable KEY and the scent, the diffuser is located on the cardboard box beneath the laser-cut tree.

(Source: Makuake [32]; AROMIC flow [33])

Figure 4.5 Smell in the second prototype

Projection

As an important output information in the interaction, it is projected behind the laser-cut tree by ELEPHAS RD606 Mini Wifi 3D Imaging Pocket Projector (100x108x40mm) [34]. The projector, with embedded battery, is equipped with automatic adjustment and wireless mirroring function. With +80% brightness, 1000:1 contrast ratio and up to 1080p resolution, it provides extremely colorful visual experiences even in the daytime. It is supposed to be hang above from the ceiling out of people's sight. However, since it is not available to realize in TIEC, the evaluation location of the second prototype, the projector is places on a high chair. Moreover, because the projector supports USB connectivity, it is covered by decoration cloth without cabling, in case participants might be distracted.

Figure 4.6 is screen-shot image of the projection appearing with orange scent in the case of red-paper message. It is a tree with blossom flower, showing Amiable KEY is nurtured by people's messages. Figure 4.7 illustrates the image of the blossom-fall projection. It serves as the reaction to blue-paper messages together with eel sauce scent.

As described in the section of "Revised Interaction", the projector and the diffuser is controlled by Arduino UNO with a color sensor, connected to a computer with cable. In addition, blue and red sticky memo paper is placed nearby for free use. It may look like a lush tree cultivated by people's messages.

In summary, the second prototype is rooted in the initial concept, and revised from the observation and results of the first test. The capability of showing spontaneous reactions to messages should be the core function of the second prototype.

Figure 4.6 Image of the projection for red-paper messages

Figure 4.7 Image of the projection for blue-paper messages

Figure 4.8 Second prototype settings

Chapter 5
Proof of Concept

With the second prototype emphasizing the cognitive feature of the design to augment continuous interactions, another user test was run to prove the effectiveness and possibilities of the concept.

5.1. Methodology

Method adopted in the second prototype are described as below:

- **Wizard of Oz**: this method works to stimulate interactions easy for people to perform, make them believe that they are "interacting with a real system" [35]. Instead of controlled laboratory settings, WOZ is effective in validating Amiable KEY, a complete system in need of cognitive capability.
- **Berkeley Expressively Questionnaire**: a tool to check the willingness of emotion expression [36]. 16 statements are scored from 1 (Strongly disagree) to 7 (Strongly agree) to check whether testers are ideal targets for the design.
- **User Experience Questionnaire (short version)**: with eight items, UEQ[1] was adopted to understand testers' comprehensive impression of the design quantitatively [37].
- **Qualitative Methodology**: it consists of observation and interview. Observation of behaviors took place once tester arrived, and interview was deployed after two rounds of user test for direct feedback and further expectation.

1 UEQ refers to User Experience Questionnaire (short version).

5.2. Settings and Deployment

The second prototype was located in a public kitchen in TIEC[2] as public gathering space. As described in 4.3.2 and illustrated in Figure 5.1, the kitchen is located on the route every resident need to pass to the elevator. The building is secured by an IC door system, ensuring this is an inclusive environment open only to community members. Besides, the test took places on a normal Monday to make sure residents are on their regular schedules. Most of invited testers came to the test location before or after going to school or part-time job. More than that, the test started from 9:00 am to 7:00 pm. Changes of light over time also help to check whether the design is functional all over the day. Finally, considering the design aims to foster communications via informal encounters and asynchronous communications, they were asked to arrive at the location individually to stimulate a real scenario. The sequence of test was scheduled to avoid scheduled encounters. It took every participant around 30 minute to finish the whole experiment.

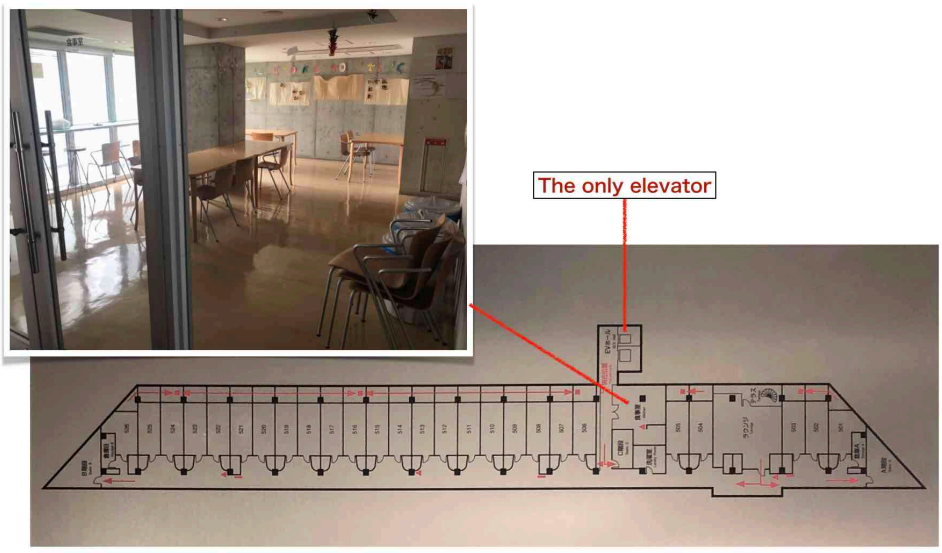


Figure 5.1 Experiment location: a public kitchen in TIEC, Hall A.

Following the method of Wizard of Oz, the interaction was manipulated by the

2 See 4.1.1 for details of TIEC.

observer. Before the test, all testers were informed that they need to engage with something interactive. At the same time, they were told some of the effects might be manipulated by the observer, but they need to pay attention to the interaction output itself, rather than figuring out the operation system. Moreover, the color sensor module connected to Arduino UNO besides the KEY helped to persuade the testers that the reaction is controlled by a computer system. Beside these information, neither the purpose or mechanism of the Amiable KEY were revealed in advance. Only after they approached, they can get instructions about choosing paper, writing and sharing messages on the laser-cut tree. In this case, testers' first reactions to the space and to the Amiable KEY could be detected.

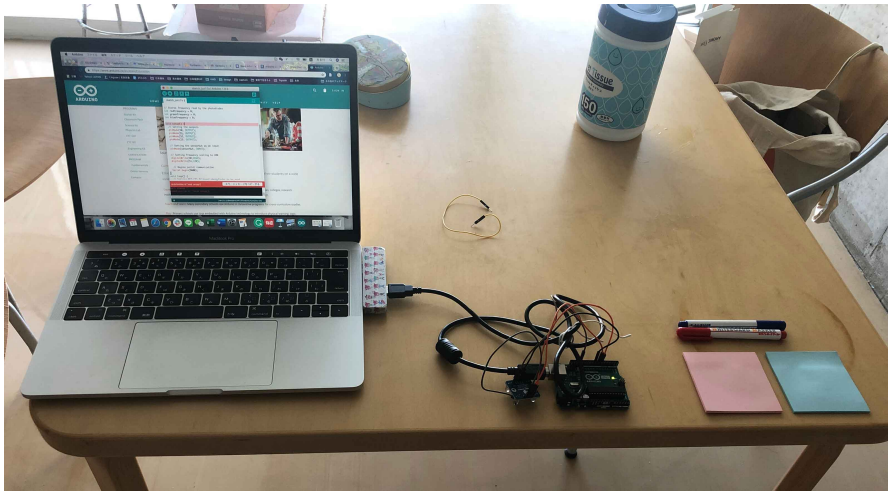


Figure 5.2 Second prototype sensor

In the user test, orange smell was emitted from the diffuser by a light and fast touch from the observer. On the other hand, the eel sauce scent was sprayed to the paper when participants were sticking by the observer. Next, the projector was turned on when the testers were writing messages. A cover on the projector lens stopped the projection from showing on the wall. Once paper being pasted, the observer took the cover away, simulating it was triggered by their messages.

Procedure of the whole user test was conducted following the sequence listed below:

1. **Pre-test**: fill out the Berkeley Expressively Questionnaire and a basic information questionnaire before arriving at the location.
2. **First test (smell)**: different smell appear based on testers behavior.
3. **First UEQ**: fill out UEQ based on the first test experience.
4. **Second test (smell and projection)**: different smell and projection appear based on testers behavior.
5. **Second UEQ**: fill out UEQ based on the second test experience.
6. **Interview**: give feedback about general impression of test: how they feel during the test; which test enjoyed more; what other interaction they desire.

5.3. Result

A total of 11 TIEC residents took part in the experiment. Among all the participants, there are 9 Chinese, 1 Egyptian and 1 Taiwanese. 3 of them are male, 1 participant is PhD students and 10 participants are in master program. The age of the participants ranged from 23 to 29, common among graduate students. 9 of them have been living in TIEC more than one year, and 2 of them moved in around half a year ago.

5.3.1 Pre-Questionnaire

Two pre-questionnaire were adopted to make sure whether participants are ideal targets for Amiable KEY. As shown in Table 5.1, 10 participants have frequent remote communication (every day or every 2-3 days), while 5 participants have few local communications (seldom or never). 9 of them regards TIEC as friendly and 2 considers it as indifferent.

Table 5.2 shows results of the Berkeley Expressivity Questionnaire, generated from on online tool by Princeton University. With 16 statements scored from 1

(Strongly disagree) to 7 (Strongly agree), the majority of participants (10 out of 11) are willing to express, with scores higher than the average. In particular, 9 out of 11 participants are more willing to express positive emotions to negative emotions.

Results indicates that most participants match the image of the target persona, who have motivation to express or communicate, but lack enough opportunities to realize it in current community.

Table 5.1 Basic Information of Testers

	Age	**Sexuality**	**Grade**	**Length of Living in TIEC (Year)**	**Prequency of Remote Communication**	**Prequency of TIEC Communication**	**TIEC Impression (1: friendly - 7: indifferent)**
1	24	F	M2	2	Often(every 2-3 days)	Seldom	3
2	29	M	M1	0.2	Everyday	Everyday	2
3	24	F	M2	1.5	Everyday	Often(every 2-3 days)	3
4	23	M	M1	0.75	Everyday	Everyday	2
5	29	F	Ph.D.	2	Everyday	Often(every 2-3 days)	1
6	24	M	M2	2	Every a few weeks	Everyday	2
7	24	F	M2	1.5	Everyday	Never	5
8	25	F	M2	1.5	Often(every 2-3 days)	Never	3
9	24	F	M1	0.25	Sometimes (per week)	Everyday	2
10	25	F	M2	2	Everyday	Seldom	6
11	24	F	M2	2	Often (every 2-3 days)	Sometimes(per week)	3

Table 5.2 Testers' Expressivity Level

	1	2	3	4	5	6	7	8	9	10	11
Expressivity Level	4.7	4.9	5.1	4.6	4.5	4.4	3.75	5.2	4.3	3.95	5.0
Positive Expressivity	5.75	6.25	6.25	6.25	5.25	7	5.0	5.0	4.0	5.0	5.5
Negative Expressivity	4.7	4.2	5.0	3.8	3.8	2.55	3.8	5.0	4.5	2.6	4.2
Emotion Strength	4.5	4.8	4.6	4.35	4.6	4.4	3.8	5.2	4.3	4.5	5.5

5.3.2 UEQ

As introduced above, participants took part in two user experience tests: with only smell feedback; with both smell and projection feedback. Every one filled out the questionnaire after each test. The questionnaire helped to measure general impression of the design as qualitative evidence. It needs to mention that, although the number of participants is small, result of the questionnaire implied potential possibilities of the design.

Figure 5.3 shows the 8 items in UEQ, scaling into values from -3 (negative) to +3 (positive). The former 4 items measure Pragmatic Quality (practicability), and the latter 4 items assess Hedonic Quality (pleasure), serving to be the general scale of "attractiveness" [38].

		-3 0 +3	
Pragmatic1	obstructive	o o o o o o o	supportive
Pragmatic2	complicated	o o o o o o o	easy
Pragmatic3	inefficient	o o o o o o o	efficient
Pragmatic4	confusing	o o o o o o o	clear
Hedonic 1	boring	o o o o o o o	exciting
Hedonic 2	not interesting	o o o o o o o	interesting
Hedonic 3	conventional	o o o o o o o	inventive
Hedonic 4	usual	o o o o o o o	leading edge

Figure 5.3 User Experience Questionnaire (short version).

Figure 5.4 lists complete results of the two user tests. Figure 5.5 analyzes the data from the attributes of Pragmatic Quality and Hedonic Quality. It shows the second test (smell and projection) received higher scores in both attributes, showing most participants considered interaction with both smell and projection more attractive to the interactions with only smell. In addition, the Hedonic Quality shows a much higher value than the Pragmatic quality in both tests. Conclusions came that both interactions show active playfulness compared with practicability.

Test with Scent

Item	Mean	Variance	Std. Dev.	No.	Negative	Positive	Scale
1	1.8	0.6	0.8	11	obstructive	supportive	Pragmatic Quality
2	1.1	3.5	1.9	11	complicated	easy	Pragmatic Quality
3	1.9	0.7	0.8	11	inefficient	efficient	Pragmatic Quality
4	0.9	2.3	1.5	11	confusing	clear	Pragmatic Quality
5	1.6	1.1	1.0	11	boring	exciting	Hedonic Quality
6	2.0	0.6	0.8	11	not interesting	interesting	Hedonic Quality
7	1.8	0.6	0.8	11	conventional	inventive	Hedonic Quality
8	1.5	0.5	0.7	11	usual	leading edge	Hedonic Quality

Test with Scent and Projection

Item	Mean	Variance	Std. Dev.	No.	Negative	Positive	Scale
1	2.0	1.4	1.2	11	obstructive	supportive	Pragmatic Quality
2	1.1	3.7	1.9	11	complicated	easy	Pragmatic Quality
3	1.6	1.7	1.3	11	inefficient	efficient	Pragmatic Quality
4	1.9	1.5	1.2	11	confusing	clear	Pragmatic Quality
5	2.1	0.7	0.8	11	boring	exciting	Hedonic Quality
6	1.9	1.7	1.3	11	not interesting	interesting	Hedonic Quality
7	2.3	0.8	0.9	11	conventional	inventive	Hedonic Quality
8	2.1	0.5	0.7	11	usual	leading edge	Hedonic Quality

Figure 5.4 Interpreted values of the two UEQs

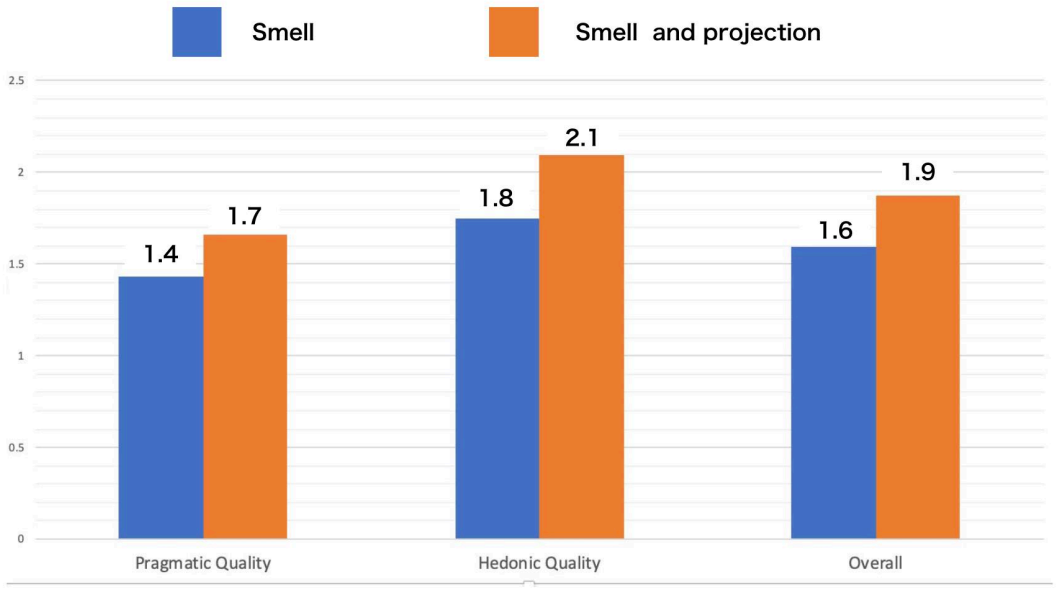


Figure 5.5 UEQ results of two tests

Figure 5.6 is an item-by-item comparison between the two rounds of test. The hugest gap took place in the "Pragmatic 4" item (confusing to clear). The interaction with smell and projection was scaled to be clear, while the scent one was considered to be comparatively confusing. The result suggests that projection succeed to help delivering a clearer message to participants.

To sum up, UEQ results show that most participants preferred interaction combined with smell and projection. Projection helped to make them understand the design. Also, they perceived the design as playful in comparison to practical.

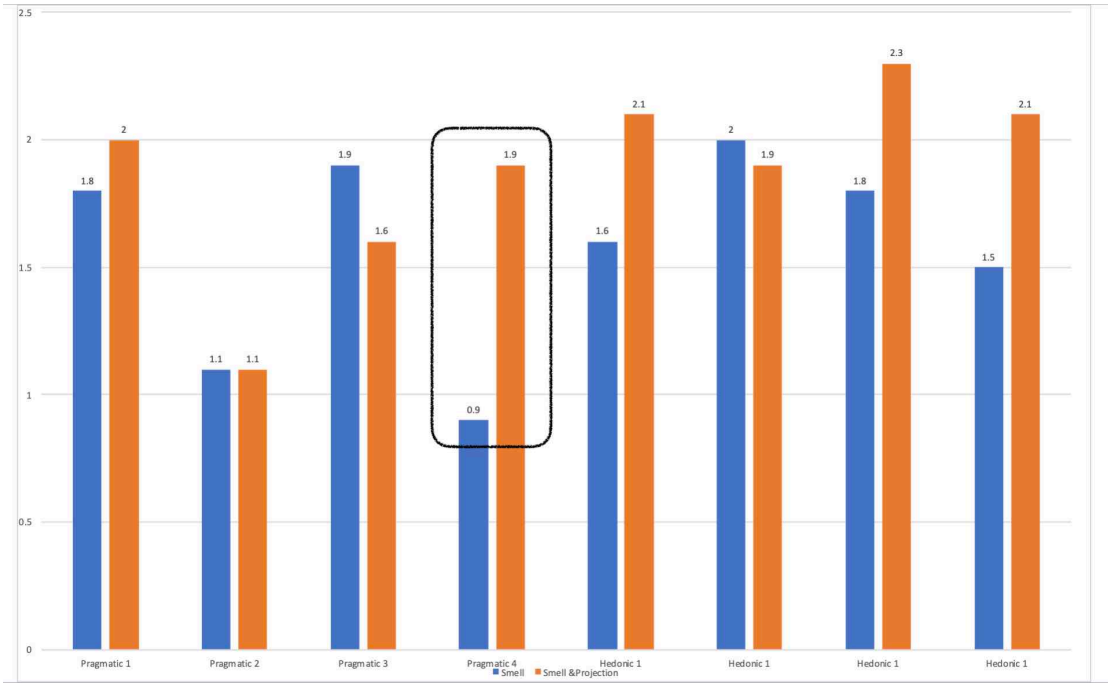


Figure 5.6 Item-by-item comparison between two tests.

5.3.3 Observation and Interview

Considering Amiable KEY aims to foster interpersonal interactions, qualitative methodology plays a crucial role in the evaluation of the user experience, as an user-centred approach. It consists of behavior observation and direct feedback after user experience.

According to the WOZ method, observation focuses on:

- Whether smell can attract people's attention to Amiable KEY and read messages on it.
- Whether the interactive experience can increase participation frequency in the gathering space.
- Whether the aromatic experience can evoke emotional attachment to the location.

Individual interview was carried out at the end of experiment procedure for first-hand feedback and potential expectations. Questions centres around:

- How do you feel during the interaction?
- Which part do you like most?
- Would you like to play with it even in daily life?
- How do think of it compared to current bulletin boards on the corridor?

Findings of both observation and interviews are summarized as follows:

Attracted Attention

Obvious evidences suggest that Amiable KEY attracted attention from participants, especially by smell. Observation started once participants showed up outside the glass door, including their first reactions when walking into the space. Initially, 8 out of 11 participants showed extremely strong reactions to Amiable KEY before approaching, with comments or questions. Without instructions, they approached to Amiable KEY and tried to figure it out. Also, 3 participants tried to guess what kind of aroma it was suddenly during test. Besides, the projection also received positive reactions from participants. As shown in Figure 5.7, they gazed at it and tried to figure out what it about.

Moreover, many residents passed by the location. Among them 6 uninvited passers-by showed interests to Amiable KEY at a distance, including 1 people who was dashing to the elevator. 2 of them stopped and gazed at the KEY for a while. Lastly, 2 uninvited people talked with the observer about the experiment and the prototype. It was the first time they met and talked in TIEC.

Figure 5.7 Participants were attracted during user test.

During interview, 10 out of 11 participants expressed they were drawn immediate attention to Amiable KEY by the smell lingering around, for it was too impressive to ignore. 10 people said they would like to interact with Amiable KEY in daily life. Smell, in particular the orange smell, encouraged them to take a closer look. 8 of them said they would like to write or reply messages on it, and 1 participant said she would participate with only reading messages, at least at the beginning. Moreover, in comparison to current bulletin boards, 9 participants confessed that they seldom paid attention to it. They only passed by quickly. 2 of them said they only stopped by the board when their friends left messages for them.

Increased Participation Frequency

A high willingness to write and read messages was observed during the experiment. Initially, many participants decided to write numerous messages even without requirements from the observer. After the whole experiment, 16 blue-paper message and 23 red-paper messages were left on Amiable KEY. In addition, 5 participants decided to wrote more messages on red paper, for they would like to enjoy the orange aroma for longer time. 3 of them stopped writing on blue-paper messages, resulted from a dislike for the eel sauce scent. 9 participants decided to

write more messages after reading previous ones. Furthermore, many participants spent a long time reading messages. Some did it when they were considering what to write or reply, and some did it for personal curiosity.

on contrary, interview revealed that although 10 participants tried to communicate with neighbors via the current bulletin board, but 7 of them stopped participation soon. 2 participants said they stopped because they have witnessed negative information on current board, such as dirty words. It made them feel a little bit uncomfortable. In the case of Amiable KEY, most participants expressed strong interests of continuous participation. A typical case was a female participants, who felt sick before the test. The orange aroma helped her to get refresh magically, leading her become glad to interact with the aromatic bulletin board even every day. She though it would make her energetic for daily research before leaving the dormitory. 1 participant said she became much happier with the bright projection. She would like to interact with it more.

Figure 5.8 Participants enjoyed smell after writing more messages.

Emerged Emotional Behaviors

Emotional attachment to space and community was observed as well. As illustrated in Figure 5.9, 6 participants looked pleased when they found someone wrote similar messages as theirs, such as stress from job hunting or thesis, and sharing happiness with a good weather. Moreover, local information drew the most attention from participants. There was a message about an earthquake in the morning. When people read it, nearly every one showed strong interests, and expressing their feelings immediately. Also, 10 participants gave comments to other messages, even though they had no ideas of who left it. Some people tried to guess the writer. Some people tried to guess writers' personalities by their message contents.

2 participants stated in interview that they felt getting closer to their neighbors, once they found out similarity among them. With regards to current bulletin board, most participants showed indifferent to it. 1 participant even confessed she has already got used to the apathetic atmosphere in the dormitory, but the aromatic experience made her feel like the pantry turned to be alive with fun reactions. She showed a high willingness of continuous interaction.

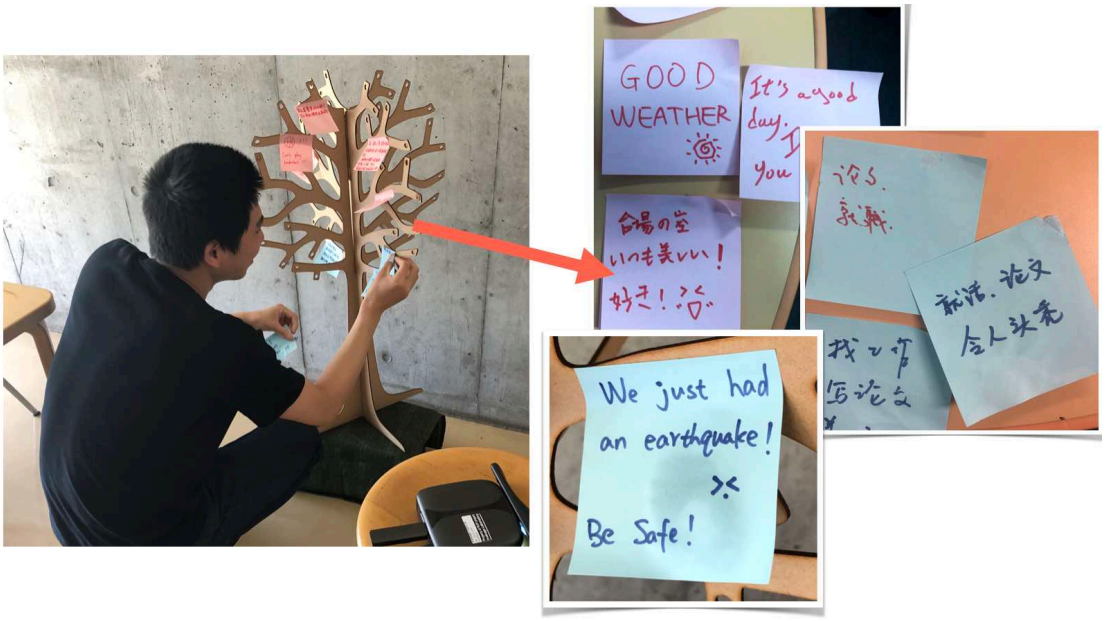


Figure 5.9 Participant smiled at messages similar to his.

5.3.4 Other Expectations from Participants

During interview, nearly every participants expressed their wish of a reply function on Amiable KEY. They hope they can be informed of personal reply, and even further interpersonal communications. Next, a large portion of participants expressed their hope of more choices of aroma. If smell can change frequently, they would be more motivated to interact. Lastly, many participants wanted to write on an digital screen instead of paper.

5.4. Considerations

Positive results were observed in the user experiment for proving effectiveness of the initial concept: entice interactions in public spaces for stronger social connections in a locality-centred community through Amiable KEY, an aromatic bulletin board.

Increase Presence Awareness

In Amiable KEY, ambient smell serves to increase presence awareness of peers as well as a physical community. Firstly, it attracted people's attention by moving individuals' peripheral focus to focal unconsciously. This was witnessed when uninvited passers-by headed for the elevator without constant attention to the public kitchen. Next, smell generated by prior people's messages revealed the presence of other peers in the same community over time barrier, even though they did not meet directly. Lastly, behavior of reading messages enable people to realize the presence of community through local information sharing. It was observed from the messages about earthquake and good weather.

Entice Constant Interactions

Amiable KEY shows the capability of engaging people in constant participation with an enjoyable interaction. Results of UEQ suggested most participants regarded the interactions as playful and fun. User tests witnessed increased participation frequency with plural messages from the same participant. Also, participants' feedback about feeling refreshed from the orange smell suggests that it also

keep interaction on by providing benefits to users.

Foster Emotional Attachment to Community

With increased awareness and repeated participation, Amiable KEY amplifies mutual attractions among peers by fostering informal encounter and asynchronous communication. Foremost, past studies suggested repeated exposure leads to better acquaintance. Observations showed that Amiable KEY can enhances encounters or passive encounters by encouraging people to interact in the same space. As witnessed in the experiment, the observer to make acquaintance of a neighbor because of chat topics provided by Amiable KEY.

Moreover, Amiable KEY shows potential capability of helping people to discover social similarities. The study of Nahemow shows that individuals are more likely to be attracted by those like-minded peers [15]. As observed in the experiment, participants were glad to read messages similar to their own. It can be regarded as the reduction in psychological distance.

To sum up, results of user experiment implied positive possibility of the initial goal. However, limitations of the user experiment exit. The experiment was conducted in a stimulative scenario, in which real reactions from participants were not able to record. For example, they might be less wary of the prototype or the space, for the existence of the observer. Also, duration of experiment was short, and the number of participants was limited. More empirical evidences need to collect to validate a long-term effects in real world.

Chapter 6
Conclusion

The proliferation of social media in the past decades altered communication habits of the young generation. While people pretend to be accompanied by "virtual friends" online, they spend less time participating in offline interactions, leading to a decline in local social tie. In particular, graduate students who are emerging adults, do not have limited time to build strong local social ties.

6.1. Contributions

With regards to the situation, this research shed light on the challenge of augmenting public interaction for stronger social bonds in locality-centered communities. The objective is to entice peer interaction with a bulletin board in public space. To achieve it, Amiable KEY, an aromatic bulletin board shaped as a tree, is proposed. It serves as a catalyst to enhance interactions by reducing proximity in space and distance in psychology. Ambient scents generated by prior users' messages lingers around it to attract attention from users. Once they enter the space and join the interaction, it echoes to them responsively with smell and projection suitable to the content. Amiable KEY behaves like a friend familiar with abundant information, supporting members to become mutual acquainted and appreciated.

The concept of Amiable KEY was realized with two prototypes, and was proved through an user experience experiment based on the second prototype. It shows novelty in fostering emotional attachment and moving peripheral attention to focal with the utilization of aroma. Focus of the experiment was to evaluate the possibility of the concept in fostering social connections: whether it can increase awareness with ambient smell; whether it can create an enjoyable interactive experience to augment public interactions; whether it can foster emotional attachment

for closer relationships in a local community. Overall, both qualitative and qualitative results show positive possibilities that Amiable KEY has the potential to promote peer interactions in public gathering spaces. At the same time, limitations of current design along with insight from the final evaluations leave room for future improvements. Details are described in the following section.

6.2. Future Works

Results of the user experiments conducted to prove the concept pointed out potentials of Amiable KEY in fostering social connections and limitations in current design. Future work will be discussed in the section.

6.2.1 Connections Between Spaces

Initially, as a catalyst to promote interactions among peers in the same community, Amiable KEY aims to reduce distance in space physically in real-life scenario. Two locations were used for testing with two prototypes sequentially: a corridor of for a graduate school; a public kitchen in a residential project for graduate students from different universities. However, even all members in each community don't have the same possibility of visiting those space. In the term of the graduate school corridor, some students are working in other campuses or laboratories. As for the residential hall, the space is used as gathering spot for residents on the fifth floor instead of all residents. It means only a limited number of members are accessible to the design. With the objective to enhance social connections, it is expected to build connect not only one space, but multiple spaces at the same time.

6.2.2 Digital Bulletin Board

As mentioned in 5.3.4, many participants expressed their wish for a digital screen to share message instead of paper. Language is the one prominent factor, especially in a global community. They wish the digital screen could be equipped with translation functions. In that case, their messages could be understood by more peers, and their social connections could be enlarged to the most extends.

Moreover, some wished a digital screen for reply function. Considering Amiable KEY is designed for promoting interpersonal connections, a follow-up function is considered to be helpful for further interactions in cases of mutual interests. Lastly, digital screen may support medium in various forms, such as GIF or pictures. Without worries about language or writing, Amiable KEY may facilitate more approachable interactions in real life contexts.

6.2.3 Customized Smell Experience

From participants' feedback, there people showing personal dislike to orange or eel sauce scent, which may have negative impact over user experience. Moreover, many people said they would like to experience different smell every a few days. Otherwise, they may get used to it soon without attention to it any more. If the smell could be changed every a few days, or be chosen by the input of the users, more fun and beyond-expectation design could be created. In this case, content design of smell ingredients together with a functional diffuser is necessary to achieve it.

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Appendices

A. Emotion Condition among Graduate Students

1. Sexuality
- Female
- Male

2. Grade
- M1
- M2
- Phd

3. Age: _____

4. Major: _____

5. Current city: _____

6. You can realize negative emotions directly? (e.g. stress, anxiety, angry…)
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

7. You can express your emotion with facial expression and postures.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

8. What do you think of negative emotions?
- Accept
- Escape
- Not care
- Other: _____

Figure A.1 sample of questionnaire:page1

9. Your negative emotions often influence interpersonal relationship or study.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

10. When you feel bad, what do you often fo to relieve? (multiple choices)
- Writing diary
- Eating
- Drinking/Smoking
- Entertainment (shopping, music, drama…)
- Taking a walk alone
- Posting on websites
- Other: _____

11. When you feel bad, you tend to think by yourself to figure out solution.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

12. When you working out for solution, you tend to: (multiple choice)
- Writing diary
- Posting on social network sites
- Talking with others for advise
- Other:_____

13. When you feel bad, talking with others can help you figure out solution.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

Figure A.2 sample of questionnaire:page2

14. When you feel bad, you tend to communicate with
- Professor
- Parents or elderly
- Schoolmates or classmates
- Local friends (face to face)
- Long-distance friend (remotely)
- Professional consultant
- Other: _____

15. You tend to take the following actions to relieve negative emotions (multiple)
- Text (pen and paper)
- Word (digital)
- Image (e.g. stamp)
- Video
- Face-to-face communication
- Other: _____

16. You can relieve negative emotions by talking with others.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

17. Sometimes, you feel you cannot be understood by friends or parents.
- Applied to me very much, or most of the time
- Applied to me to a considerable degree, or a good part of time
- Applied to me to some degree, or some of the time
- Did not apply to me at all

18. Have you ever experienced the following feelings during communication (multiple)
- The other part cannot understand your feeling
- You cannot get practical advise

Figure A.3 sample of questionnaire:page3

- It is too complicated to explain problems about research
- Privacy related anxieties
- Worry about being judged by others
- Other: _____

19. Choose emotions you feel recently (multiple)
- Calm
- Agitated
- Anxious
- Lonely
- Hollow
- Bored
- Fear
- Sad
- Joyful
- Rage
- Other: ____

20. You feel depressed when ____ (multiple)
- Research goes wrong
- I am apologized by professor
- Job hunting is not okay
- Lovelorn
- I am not understood by parents
- I seldom feel depressed
- Other: ____

21. Would you like increase communication with people with common problems?
- No
- I want to discuss about research with schoolmates or people in the same field
- I want psychological support
- Other: ____

Figure A.4 sample of questionnaire:page4

B. Berkeley Expressivity Questionnaire

For each statement below, please indicate your agreement or disagreement. Do so by filling in the blank in front of each item with the appropriate number from the following rating scale:

1	2	3	4	5	6	7
strongly disagree			**neutral**			**strongly agree**

____ 1. Whenever I feel positive emotions, people can easily see exactly what I am feeling.

____ 2. I sometimes cry during sad movies.

____ 3. People often do not know what I am feeling.

____ 4. I laugh out loud when someone tells me a joke that I think is funny.

____ 5. It is difficult for me to hide my fear.

____ 6. When I'm happy, my feelings show.

____ 7. My body reacts very strongly to emotional situations.

____ 8. I've learned it is better to suppress my anger than to show it.

____ 9. No matter how nervous or upset I am, I tend to keep a calm exterior.

____10. I am an emotionally expressive person.

____11. I have strong emotions.

____12. I am sometimes unable to hide my feelings, even though I would like to.

____13. Whenever I feel negative emotions, people can easily see exactly what I am feeling.

____14. There have been times when I have not been able to stop crying even though I tried to stop.

____15. I experience my emotions very strongly.

____16. What I'm feeling is written all over my face.

****

Scoring:

```
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compute beq08r=(8-beq08).
compute beq09r=(8-beq09).

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compute beq.pex=mean(beq06,beq01,beq04,beq10).
compute beq.str=mean(beq15,beq11,beq14,beq07,beq02,beq12).
compute beq=mean(beq.nex,beq.pex,beq.str).
```
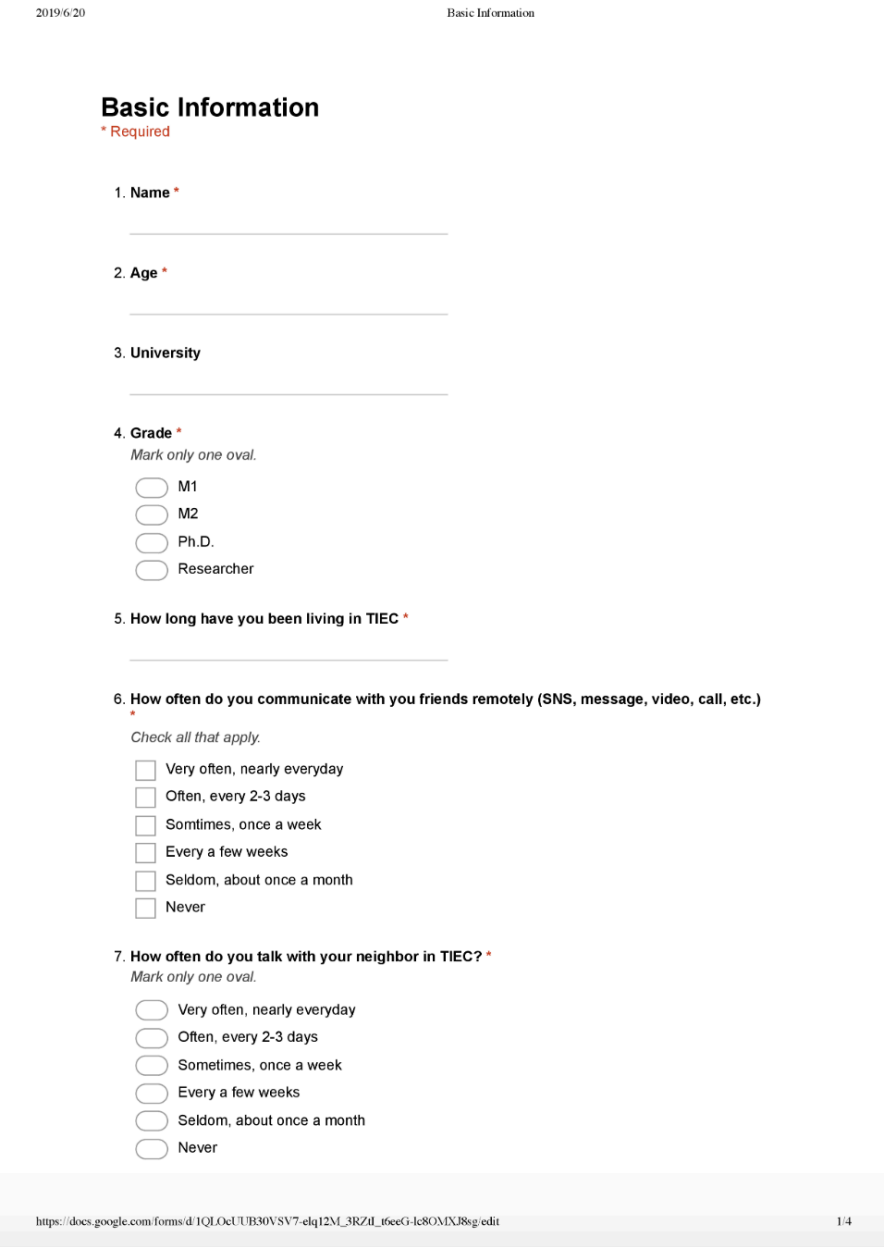

Figure B.1 Question list of Berkeley Expressivity Questionnaire

C. Questionnaire for Validation



2019/6/20 Basic Information

Basic Information

* Required

1. **Name** *

2. **Age** *

3. **University**

4. **Grade** *
Mark only one oval.
- M1
- M2
- Ph.D.
- Researcher

5. **How long have you been living in TIEC** *

6. **How often do you communicate with you friends remotely (SNS, message, video, call, etc.)** *
Check all that apply.
- Very often, nearly everyday
- Often, every 2-3 days
- Somtimes, once a week
- Every a few weeks
- Seldom, about once a month
- Never

7. **How often do you talk with your neighbor in TIEC?** *
Mark only one oval.
- Very often, nearly everyday
- Often, every 2-3 days
- Sometimes, once a week
- Every a few weeks
- Seldom, about once a month
- Never

https://docs.google.com/forms/d/1QLOcUUB30VSV7-elq12M_3RZtI_t6eeG-lc8OMXJ8sg/edit 1/4

Figure C.1 Basic information of participants

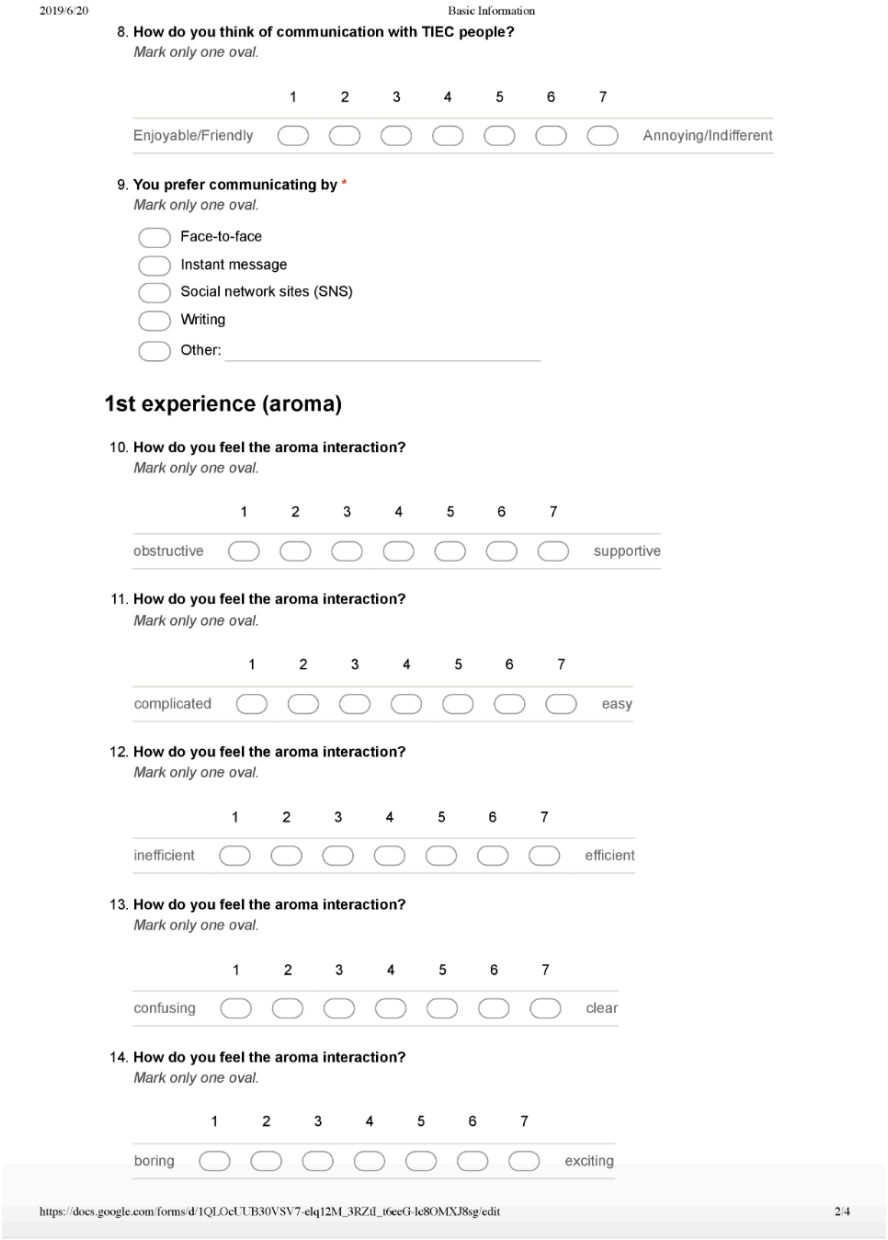
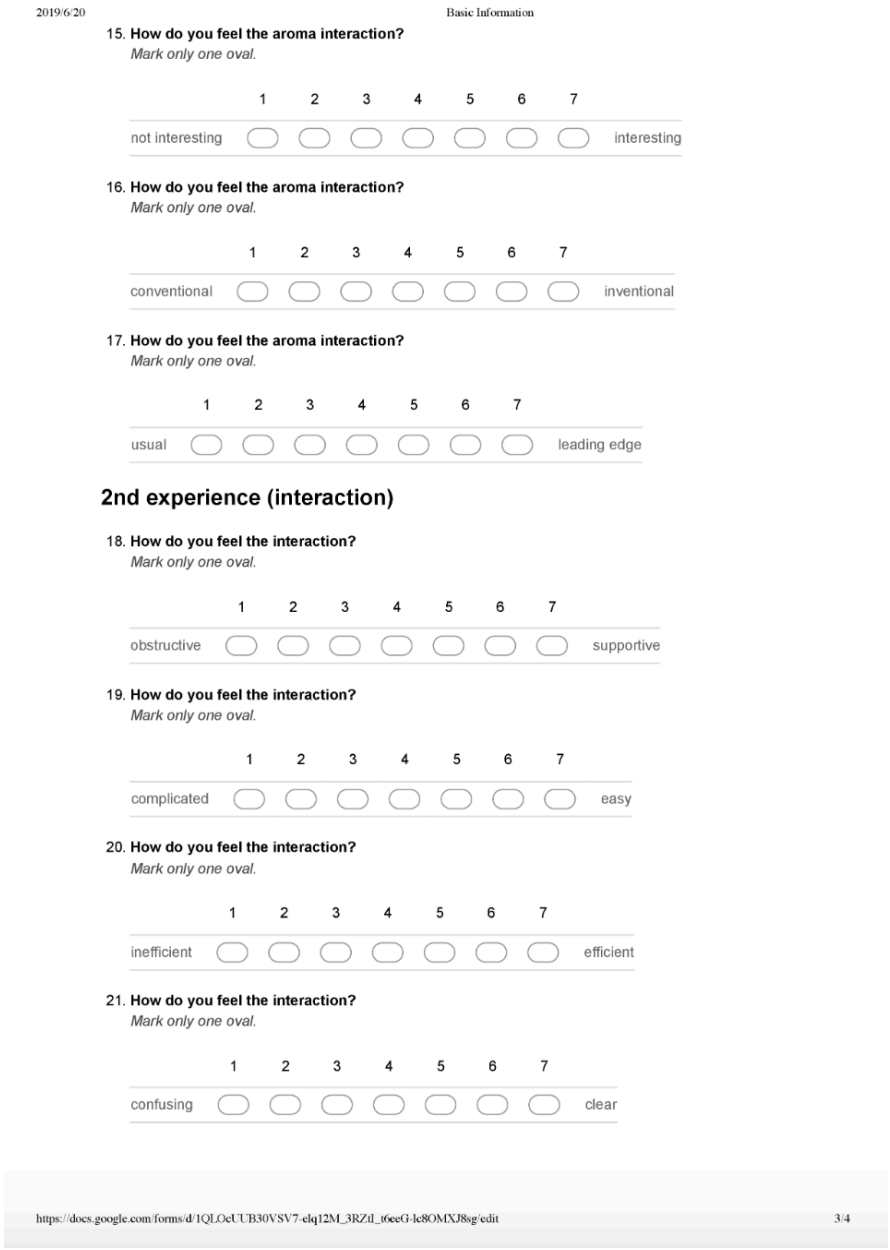


Figure C.2 User Experience Questionnaire-1



2019/6/20 Basic Information

15. **How do you feel the aroma interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
not interesting	◯	◯	◯	◯	◯	◯	◯	interesting

16. **How do you feel the aroma interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
conventional	◯	◯	◯	◯	◯	◯	◯	inventional

17. **How do you feel the aroma interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
usual	◯	◯	◯	◯	◯	◯	◯	leading edge

2nd experience (interaction)

18. **How do you feel the interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
obstructive	◯	◯	◯	◯	◯	◯	◯	supportive

19. **How do you feel the interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
complicated	◯	◯	◯	◯	◯	◯	◯	easy

20. **How do you feel the interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
inefficient	◯	◯	◯	◯	◯	◯	◯	efficient

21. **How do you feel the interaction?**
Mark only one oval.

	1	2	3	4	5	6	7	
confusing	◯	◯	◯	◯	◯	◯	◯	clear

https://docs.google.com/forms/d/1QLOcUB30VSV7-elq12M_3RZtL_t6eeG-lc8OMXJ8sg/edit 3/4

Figure C.3 User Experience Questionnaire-2

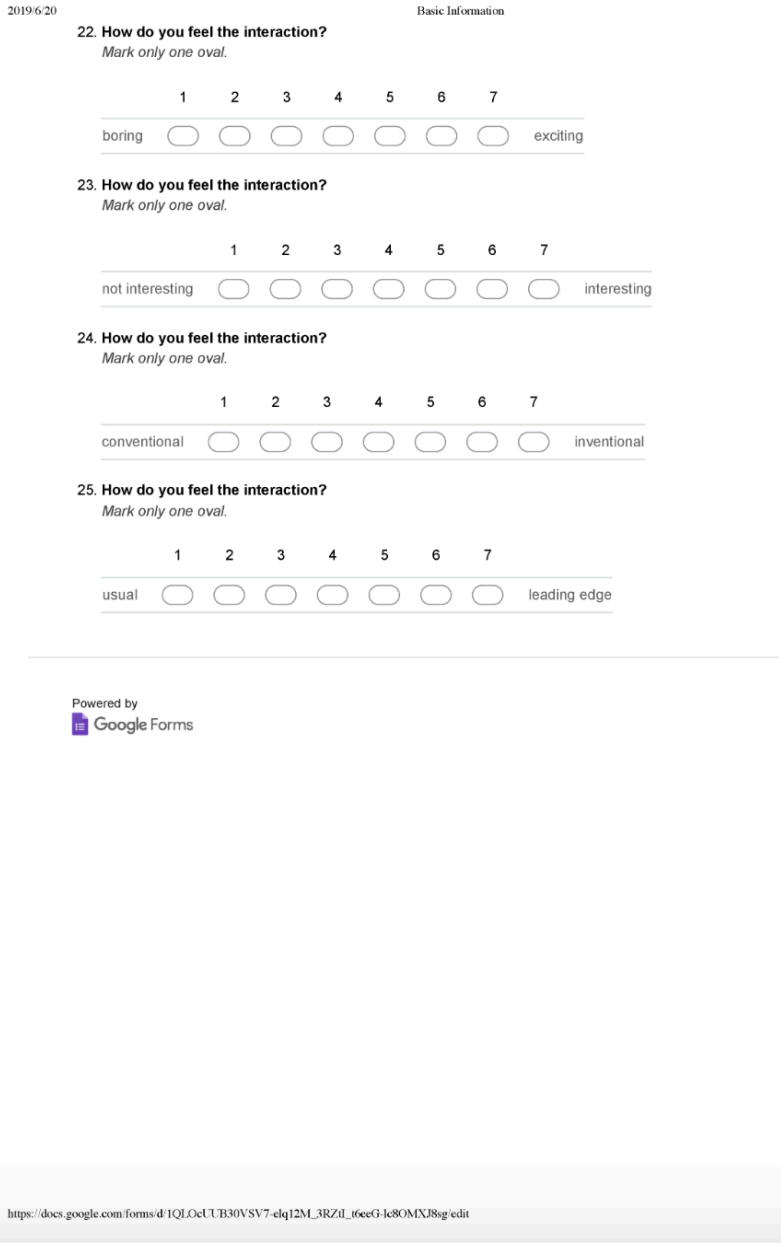


Figure C.4 User Experience Questionnaire-3