User Participatory Sketching: A Complementary Approach to Gather User Requirements

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ABSTRACT
This paper proposes User Participatory Sketching as a complementary approach to user requirements gathering methods, applies the approach in an empirical study and investigates its potential benefits in the early interaction design stage. The findings from the case study suggest the proposed "User Participatory Sketching" can complement conventional user requirement gathering techniques in the aspects of: (1) tangibilizing communication; (2) contextualizing design concepts; and (3) unveiling underlying thoughts. The sketches created by the users may also facilitate design by providing recourses for idea exploration, documenting the users' requirements in a visual way and allowing for further interpretations.

Author Keywords
Sketch; Design; Methods; User Centered Design; Design Process.

ACM Classification Keywords
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

General Terms
Design, Human Factor.

INTRODUCTION
The development of information technology is continuously reshaping our everyday lives. Digital artifacts, built around a core of information technology, surround our world [18]. Simultaneously, our interactions with digital artifacts are becoming more and more complex, as Norman puts it "…we move from the world of stand-alone objects to social structures, complex, intelligent products, and a heavy dominance of services…" [21]. A big challenge within interaction design is shifting from the usability of a single interface to the overall experience the user may go through while interacting with a complex system. This shift requires designers to involve the users early on in the design process and to have a deep understanding of the users' needs through the interaction journey. However, designers are facing several challenges to achieve such an understanding.

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One challenge of interaction design lies in its own characteristics. Interaction design deals with digital materials that are *temporal* and *spatial* [19]. Our general senses to hand the physical objects are not adequate to describe digital artifacts [18]. Naturally, such abstract qualities, materials and design concepts become even more difficult for the users to understand, reflect upon and describe. The elements of an interactive system are directly or indirectly depending on other elements [1]. All parts of a system are *Dynamic* and *Interactive* [1]. Digital products, environments, systems, and services being designed are all interrelated rather than separate independent components. Such interrelationships generate *Complexity* by its nature. Interaction design also deals with issues such as tangibility, immersion, sound, and haptic [7]. Interaction is i*nvisible* and functioning behind the scenes [23]. Designing interactive artifacts is about designing a *Future*. It can be defined as "an act of choosing among or informing choices of future ways of being" [2]. These characteristics of interaction design are extremely difficult for the designers to address when communicating with users in early design stages, especially when a specific design language is lacking for describing the abstract and complex design concepts.

A complex interactive system can include more than one interface where the users have to interact with the system in order to achieve his/her goal. The different interfaces are usually installed in different locations and contexts. Each interface may only help the user to complete a single step of a journey. Thus, it is very difficult to build prototypes for such systems. Although building a prototype for a complex interactive system is possible, it will cost huge amounts of time and recourses. Therefore, such systems require designers to have a thorough understanding of the users' needs and to identify the design problem accurately early on in the design process. Gathering user requirements data is a crucial step to gain such understandings [22].

The commonly used requirements gathering techniques in interaction design practice are heavily dependent on natural language communication, either by talking (such as using interviews and focus groups) or by writing (such as using

written notes of direct observations) [22]. These techniques pay little attention to the multimodal aspect of language, communication and social interaction. Sense making processes in communication can be a combination of making use of writing, images, speech and embodied actions [28], sometimes even touch, feel and taste [14]. "It is now impossible to make sense of texts, even of their linguistic parts alone, without having a clear idea of what these other features might be contributing to the meaning of a text" [14].

Defining characteristics of interaction design, including aspects of temporality, spatiality, interactivity, complexity etc., are extremely difficult to address by means of natural language alone. Thus, the user requirements gathering methods purely based on natural language can hardly provide the designers with enough understanding of the users' needs, wishes and limitations. The dependence on natural language puts a problem to the documentation of user requirements. Written reports are the ones mostly used for communicating findings from user studies, but these tend to generalize and abstract conclusions, which leads to a loss of richness of the data [25].

New approaches are urgently needed to complement the disadvantages of conventional user requirements gathering methods. This paper proposes User Participatory Sketching as a complementary approach to user requirements gathering methods, applies the approach in an empirical study and investigates its potential benefits early on in the design process. The results from the case study showed that: (1) sketches can enhance the communication between the designers and the users by visualizing natural language and tangibilizing abstract conversation; (2) sketches can support contextualizing design concepts, which is particularly important in location-dependent interactive systems; (3) sketches may help designers to unveil the users' underlying needs, which may otherwise be neglected. The sketches created by the users may also facilitate design by providing recourses for idea exploration, documenting the users' requirements in a visual way and allowing for further interpretations.

SKETCHING

When talking about a sketch, it is usually referred to as a simple and rough drawing with a lack of details. Sketching has been a tool supporting various kinds of creative works. There has been a long tradition in the areas of architecture design, industrial design and graphic design to use sketching as an essential technique to "develop, explore, communicate and evaluate ideas" [29]. Sketching has different characteristics in various fields of design, but it has three basic purposes: to structure thoughts and to form ideas, to externalize ideas and to communicate with oneself, and to support the communication with others by offering something to reflect upon [18].

To Form Ideas

Sketching is a way to structure thoughts and to form ideas. Without such external representations, new possibilities and combinations of ideas can be difficult to see [18]. Sketching is a way of externalizing an idea quickly [15]. Sketches "facilitate memory by externalizing the basic design elements" [27]. This external representation allows designers to think about other properties of the elements, such as spatial arrangements and functions [27]. The finding of the feature of sketches to represent spatial information has its roots in human cognition – sketches have the attribute of representing three-dimensional visual experiences by using abbreviated two-dimensional lines. These lines can provoke visual experiences resembling that associated with the objects or scenes represented [5]. Thus, sketches can be used to depict spatial scenes and convey the conceptions of reality [30].

To Communicate with Oneself

The externalized ideas presented in sketches can become new design materials for the designers to reflect upon [18]. By observing how designers work, Schön defined the design process as a reflective conversation and characterized sketching as a recursive "seeing-drawing-seeing" loop [24], typical to design conversation. Goldschmidt emphasized the conversation attribute of the sketching activity [9]. The sketching process can be seen as a systematic dialectics between the "seeing as" and "seeing that" reasoning modalities. "Seeing as" is regarded as using figural or gestalt argumentation while "sketching-thinking". And "seeing that" refers to developing the non-figural argument and associating it with the design subject. Vague is the attribute of sketching, which allows the designers to "seeing that" [9]. Tversky pointed out sketches' importance in serving as a communication tool for communicating with oneself. "Like spoken and written language, sketches are a form of communication" [30]. On the one hand, sketches can be used for oneself to check the completeness and internal consistency of an idea. On the other hand, sketches also help oneself to see new relations and figures based on the existing ideas. Fällman viewed the concept of sketching as the "archetypal activity" of the design approach [4]. He emphasized the role sketching plays in the design process and how it helped designers to get involved in a "dialogue" which enabled the design problems and solutions to be worked out simultaneously. Here, sketching is regarded as "the way in which designers think", rather than merely as a design tool, technique or skill, which designers use to solve problems.

To Communicate with Others

Sketches can serve as a tool for the communication with others by offering something that all the collaborators can see and discuss [18]. Interaction design is a multi-discipline design area where design tasks often involve designers from different backgrounds. Collaboration and communication thus becomes crucial for the designers as a way to explore, reflect, validate and reshape ideas. Sketching is often used in collaborative design activities [3]. In design collaborations, sketches serve as shared design materials for communicating with others, since "expressing ideas in a visuo-spatial medium makes

comprehension and inference easier than in a more abstract medium such as language" [30].

Through an empirical study of collaborators designing an optimal emergency rescue route, Heiser et al. demonstrated sketches promoting collaboration by serving as a shared focus of attention to ensure the collaborators were considering the same thing; simplifying communication by conveying spatial temporal information through gestures depicted on the sketches instead of using cumbersome language; and allowing for the establishment and maintenance of a common ground between the designers [10]. Heiser et al. also pointed out that shared sketches didn't function alone; the gestures on the sketches were especially crucial [10]. Tholander et al. broadened this view by looking at how embodied actions (talk, gaze and gestures) in a design activity made the design representations – sketches – become meaningful [28]. Sketches can also support the communication between designers and non-designers. For example, by comparing user interface sketches, scenarios, and computer prototypes adopted in six stakeholder meetings, it was found that sketches gave the broadest discussion and facilitated the same extent of discussion as prototypes on the overarching concept of the design [11].

A Thought towards Change

The related research on sketches discussed above indicates the possible usage of sketches in facilitating the process of user requirements gathering. First of all, sketches are visual representations; they may complement to the user requirements gathering methods, which are solely based on natural languages, from a visual perspective, especially when the intended design concepts are too abstract to describe by words alone. Secondly, sketches can depict three-dimensional environments. Reading spatial information from the sketches may allow the users to think about the context in which the system will be situated early on in the design process. Further more, sketches can become shared design materials between the becoming users and the designers so that the becoming users can participate in the user requirements gathering in a collaborative way. The sketches created collaboratively may also offer the designers a rich visual documentation for further analyzing, interpreting and recreation of ideas. Thus sketches have the potential to become a complementary resource to the text-dominated requirements reports for the designers to work with. These potential benefits of sketches may help designers to cope with the problems of conventional user requirements gathering methods. Thus, User Participatory Sketching is proposed to adopt sketching in the user requirements gathering process.

USER PARTICIPATORY SKETCHING

The use of sketching in interaction design is often limited to interface sketches, storyboarding and paper-based prototypes [18]. In recent years, more and more researchers are exploring the role of sketching in interaction design [6,16,28]. Some of the studies also extend the use of sketching outside of the designers' world, and to introduce sketches to stakeholders and end users [11,29,31]. Inspired by the potential benefits of sketches and results from related studies, this paper proposes adding sketching as a complementary approach to support the conventional user requirements gathering methods.

User Participatory Sketching is proposed to bring sketching into the user requirement gathering process and allow the users to come to multimodal expressions making use of sketches, spoken and written language. It emphasizes the sketches' role in supporting the communication between the designers and the users when words are lacking for talking about abstract interaction design concepts, since sketches can "convey abstract ideas metaphorically, using elements and spatial relations on paper to express abstract elements and relations" [30].

As illustrated in Figure 1, sketches are shared design materials between the designers and the users: 1) the designers create the sketches as a way of bringing the users into a certain design situation and posing questions about the users' requirements; 2) the users read these sketches and then 3) create their own sketches, either by changing the designers' sketches or by creating completely new sketches; 4) the designers read the sketches created by the users and gain new knowledge of the users' requirements.

Figure1: Sketches are shared design materials

The User Participatory Sketching approach can be used together with other user requirements gathering methods, for example, interviews and focus groups. It is a dynamic and open-ended approach. It can also be modified to adjust to specific design situations. But the designers need to prepare the initial concept sketches before the participatory sketching session with the users. Below we describe our use of User Participatory Sketching before moving on to the case study.

The Designers' Sketches

The designers create the concept sketches that are deemed relevant to a current design stage and problems at hand. The contents of concept sketches should not be closely "defined concepts". Rather, these sketches should be more open-ended with the intent of asking questions. They can contain drawings of the artifacts or the places where the artifacts will be used. They can illustrate short stories of

certain situations. These sketches can also be abstract shapes that stimulate emotions and feelings. In short, the sketches are questions in the form of visual presentations, which the designers want the users to reflect upon. The sketches created by the designers are then photocopied.

There are three main reasons of using photocopies instead of real sketches. 1) By photocopying, the sketches can easily be reproduced, thus become plenty. All the users that participate in the requirements gathering session can sketch out their ideas directly on the designers' sketches. 2) The designers have more freedom to organize the users in the sketching session depending on the design situation. For example, the sketching session can include individual users or a group of users. 3) Printed sketches have the qualities of being cheap, disposable and unfinished. The users may further feel more comfortable to play around with the sketches and give their comments to the designers on the photocopied sketches.

The Users' Sketches

During the sketching session, the sketches created by the designers are sent out to the users, just like questionnaires. The users are asked to reflect on the sketches and to give their comments directly on the concept sketches. The users are also asked to create their own concept sketches of the artifacts on white paper. They can also discuss the design concepts with the designers, create as many sketches as they want and add text to explain the sketches. This open-ended approach allows the users to come to multimodal expressions making use of sketches, spoken and written language.

CASE STUDY

Project Context

The intended interactive system is a Destination Control System (DCS, abbreviated) for elevators. The DCS allows users to choose their destination floor before entering the elevator, and the system will assign the elevators to the users depending on their destination floor. By doing that, the DCS largely improves the efficiency of the elevators, minimizes the users' waiting and traveling time and, in turn, minimizes the energy consumption of the building where DCS is installed. Thus, the DCS benefits both the users and the environment.

However, since this system is new as compared to how elevators are usually used, it is not obvious or easy for the users to think about this new system and way of operating it. Designers are here facing the challenge of making such a system usable from a user's perspective. Due to limitations of conventional ethnographic approaches, the difficulties of building prototypes, as well as the dependency of the intended interactive system on the spatial environments, we proposed using the User Participatory Sketching approach in the very beginning of the design process. We wanted to use the DCS before the design concept was defined, in order to communicate with the users, understand their needs and anticipate the problems they might encounter while interacting with the DCS.

Method

The case study was conducted at a usability testing room in an office building located in the Shanghai city area in February of 2011. The testing room was equipped with 3 video cameras with online streaming functions. An experienced moderator guided the participants through the process. The researchers observed the whole study remotely via simultaneous video streaming. 23 users (12 women and 11 men, age between 19 - 64) participated in the study. The participants were divided into 3 groups with 7 or 8 participants in each group. All the participants were informed that the materials, sketches and video recordings in this study were used for research purpose only.

The goal of the study was to understand the users' needs both regarding general elevator usage and more specifically regarding requirements towards the DCS concept design. A questionnaire session was conducted in the beginning of the study to gather the participants' demographic data. Focus group was adopted as the main user requirements gathering method to collect the users' requirements about their general elevator usage, for example, issues of comfort, safety, efficiency of the elevators in the users' office or residential buildings. The proposed method User Participatory Sketching was added in the end of the focus group discussion session focusing on the DCS concepts. Analysis of data in this paper will focus on this latter session.

Procedure

In the User Participatory Sketching session, each user was provided with 7 sketches, containing the information of the DCS concepts and the simplified environment where the elevator would be located, in this case, inside office buildings.

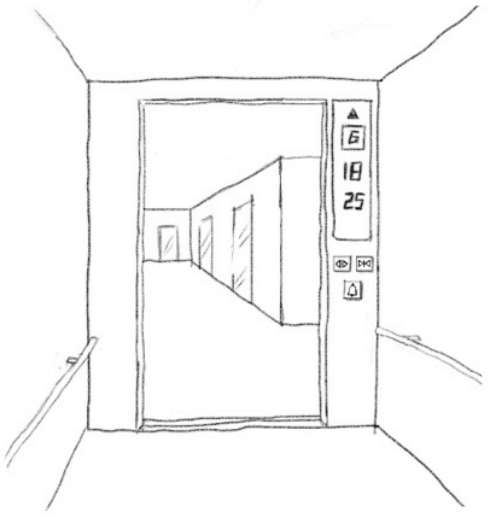


Figure 2. One of the sketches from the designers

The sketches also intended to indicate different solutions. The interfaces of the different elevator control panels look very different in different sketches. This was an intentional choice to prevent users from limiting their thoughts and sticking to one idea. The users were not given any verbal description about the functions of the intended system, but were asked to think about how they would call an elevator using such a system. After reflecting on the concepts verbally, the participants were asked to comment the concepts by sketching directly on the sketches provided to them, and then sketch their own ideal interface of the DCS control panel on plain white paper. They were told they were allowed to express their thoughts freely by text, drawings or a combination of both.

Data

The whole user requirements gathering session was video recorded. In total 3-hours of video was recorded for each group, from the point in time when the participants entered the meeting room until they left the room at the end of the study. In analyzing the use of the User Participatory Sketching approach we make use of three types of data: video recordings, users' comments on the designers' sketches and users' sketches of their own ideal interface of the intended system.

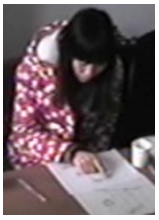
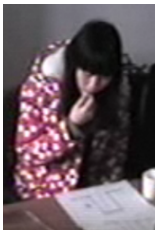
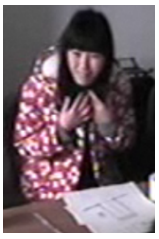
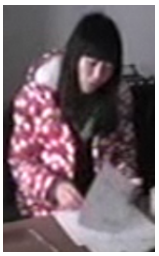
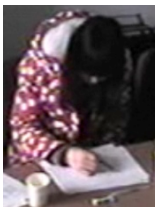
FINDINGS

The three different types of data highlighted different aspects of the User Participatory Sketching approach. The video recordings showed how the users interact with the designers' sketches. The sketches allowed the users to come to multimodal expressions including spoken/written language, gestures, facial expressions, and drawings. The users' comments on the designers' sketches contained more written text than drawings. These comments often concerned the spatial information depicted in the sketches by the designers. Comments were also given in a spatial way on the sketches via the use of pointing arrows, lines and text boxes. However, few comments described the participants' desired functions, wishes, or requirements. The participants' sketches of their ideal interfaces, on the other hand, more clearly showed the participants' own thoughts about the functions, symbols and logics of the layout arrangements. The findings from the three types of data are presented in the following text. A few examples are given in relation to each type of data, in order to illustrate the different roles of sketches in supporting the user requirements gathering.

Video Recordings

Interaction analysis [12] was used to analyze the video recordings, with a focus on both verbal and non-verbal interactions. An example is given below to illustrate how sketches acted as tangible representations to engage the users to reflect on the abstract design concepts.

The participant (P1) was presented with the designers' concept sketches and asked if she could complete a simple task to go to the 11th floor using such an elevator system.

Verbal action	Non-verbal action	
If I am going to floor 11, I will click the number "11". The number should blink until I choose the confirm button. The blinking number is here.	P1 points at the numbers and the screen on the operation panel out side the elevator car.	
Does it show where the elevator is, here? Mm, I think it should display the floor I am going to.	P1 points at the empty space on top of the elevator door.	
But I have a question. If I enter an elevator but realize I have chosen the wrong floor.	P1 puts her hand under her chin.	
Yes, there are no buttons (to choose the floor) inside (the elevator)!	P1 then finds the other sketch depicting the environment inside the elevator car and compares the two sketches.	
What shall I do?	P1 turns to the moderator with a slightly embarrassed expression.	
I think it is a problem. It should have some buttons there as well.	(The moderator encourages P1 to express her own opinion.) P1 finds the sketch that she thinks problematic and points at that sketch.	
	P2 draws her comments on the sketch.	

As shown in the example, by viewing the sketches, the participant went through the process of reading the sketches, interpreting the concepts, relating the concept to her previous experiences, reflecting on the concept and then giving feedback. Instead of clearly stating the word "screen", "buttons", "display" and so on, the participants quite often used the word "here", "there", "this" and "that", and, at the mean time, pointed at certain spots on the sketches. This finding was in line with the study conducted by Tholander et al. [28], in which during the process of a collaborative design task, the designers' talk was not very descriptive; rather, a lot of short and deictic utterances such as "here" and "there" were often used and combined with highly active pointing work [28].

Users' Comments

Users' comments on the designers' sketches were collected and analyzed. The users' comments consisted of a combination of short texts and simple drawings making use of e.g. arrows, lines, circles and rectangles. The written language and drawings taken together made the comments meaningful. There were 7 different sketches presented to every participant; each of the sketches depicted a touchpoint where the user might interact with the system. Thus, all the participants' comments on the same touchpoint were collected resulting in 7 sets of users' comments on each touchpoint. Users comments were analyzed and sorted into meaningful categories. Below the resulting categories of user comments are presented and discussed.

Dimension Sensitivity

Several participants mentioned the size of the destination indicators, such as the floor numbers, and whether those were large enough as compared to the indication panel inside the elevator car, showing their sensitivity towards information regarding dimensions on the sketches. For example, one participant wrote:*"(The display panel) looks nice; the size of the signs is big enough."* To compare the dimensions of different elements inside the elevator, the participants needed to be able to picture themselves in relation to the car and compare its size, their own size as compared to the car, the size of the control panel and all the other elements in the surrounding that were depicted on the sketch.

This sensitivity towards dimension was even more visible from the participants' comments on the sketch depicting a lobby area of a building, as shown in Figure 3. Some participants had different comments on the distances between the operation panels and the elevators. For example, one participant commented, *"the distance between the control panel and elevator door is too long; people may have to run after choosing the floor in order to catch their elevator."* Another participant sketched a similar comment on the sketch, stating *"dislike: the operating screen is too far away from the elevator."* But some participants liked the long distance since *"the spacious area will make it less crowded outside the elevator door"*.

The designer left some space between the elevators and the operation panels on the sketch in order to see if the users would understand and accept to make an elevator call on an operation panel remotely located from the elevator doors. However, some participants perceived this question from another angle; instead of focusing what was far away from the operation panels, they worried about what was close to the operation panels. For example, one participant commented, *"the distance between the operation panel and the access control is too short; people will block the entrance if they all need to choose the elevators."*

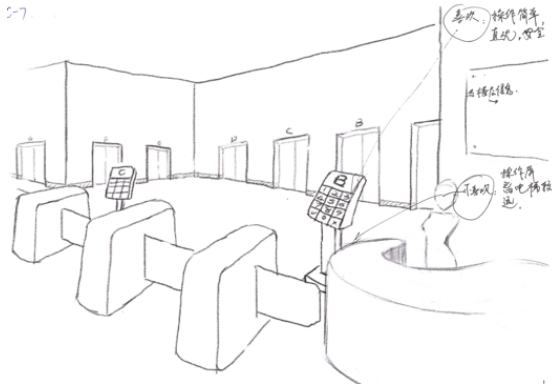


Figure 3: A User's Comments on the Dimension

The spatial information extracted from the sketches thus allowed the participants to relate the different elements in the environment and further to relate themselves inside that same environment. Sketches containing spatial information may thus support the users' dimension sensitivity towards the design concepts and allow the users to reflect and give requirements on such issues early on in the design process.

Mapping in Space

Interestingly, among the comments on the sketch shown in Figure 3, there was no one pointing at there are 7 elevators but only 2 operation panels to control the elevators. This "mismatch" between number of elevators and operation panels however became an issue while commenting the sketch of the hallway, as shown in Figure 4.

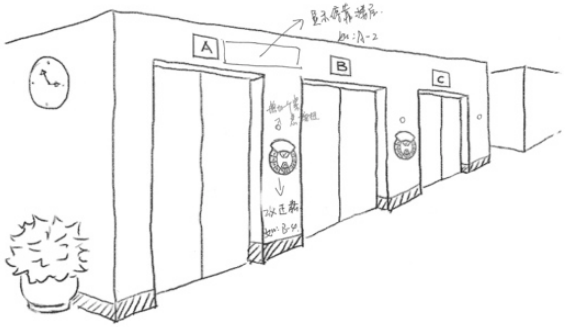


Figure 4: A User's Comments

Several participants commented that the number of operation panels didn´t match the number of the elevators. However, in the DCS, every operation panel would control all the elevators; there is thus no need to install the same amount of operation panels as there are elevators. Knowing the system by heart, the designer only put two operation panels on the sketch in Figure 4, the same as in Figure 3. The comments from the participants indicate that the two operation panels were "enough" for 7 elevators, but not "enough" for 3 elevators.

This feedback illustrates one of the potential problems the users might encounter while interacting with the DCS system; although participants seem to have understood an elevator call could be made by any operation panel, they might still tend to call an elevator using the operation panel closest to it and thereby relating specific elevators with specific control panels. This finding reflects one of the visual Gestalt principles, Law of Proximity, by Wertheimer, Köhler and Koffka [20]. Thus, in this example the users' requirements points at the importance of the designers to consider the users' "mental model" [20] to avoid such problems in the future use of the DCS. Without providing the users with the sketches, it might be difficult to early on in the design process gather such requirements.

Spatial Feedback

Not only did the participants read the spatial information the designers depicted on the sketches, they also gave their feedback to the designers in a "spatial" way. Some participants commented on the sketches by drawing and writing on the elements they had opinions about; some wrote their comments with the help of pointing arrows, lines, circles or squares. As shown in Figure 4, this participant commented that an indication panel should be needed on top of each elevator door. So he drew a little rectangle shape representing a screen and commented "Displaying destination floor, for example: A– 2 ".

Figure 5: Spatial feedback

Similarly, in Figure 5, the participant changed the signal shown on the screen from a single letter "B" to a whole sentence that says: *"Please go to B elevator."* The texts the participant added became part of the concept sketch. To clarify the purpose of adding the text, the participant right above the sketch wrote, "Without the explaining text, some people may not understand the meaning of the letter B." Both of these examples illustrate how the participants gave their comments in a "spatial" way. These spatial representations of the requirements in turn informed the designers what information the participants wanted to see and where they would like to see it.

Users' Sketches

The third part of the data was the sketches created by the participants to illustrate their own ideal interfaces of the operation panels. Since none of the participants was a trained drawer, the designers didn't expect all of them to express their thoughts by means of sketching. The participants were therefore told they were allowed to express their thoughts freely, by either writing or drawing. Unexpectedly, the participants had no hesitation to express their own ideas by drawing. There were in all 29 sketches created by 23 participants. This finding is in line with a study conducted by van der Lugt, "…non-designers can very well engage in sketching activity, provided that they are given the proper directions" [17]. All the participants chose to draw their ideas, with half of them combining their drawing with using simple text to emphasize the most important aspects of their ideal interfaces. Some of the participants even sketched more than one concept. The 29 sketches were collected and in a similar way to users comments, analyzed and sorted into meaningful categories. Basic shapes of sketches were rectangular, circular and irregular shapes. Below the resulting categories of user sketches are presented and discussed.

Functions

One of the most significant findings based on the analysis of the participants' sketches was that there seems to be a need of two sets of functions: to open/close elevator doors, and to choose up/down directions, as the example shown in Figure 6.

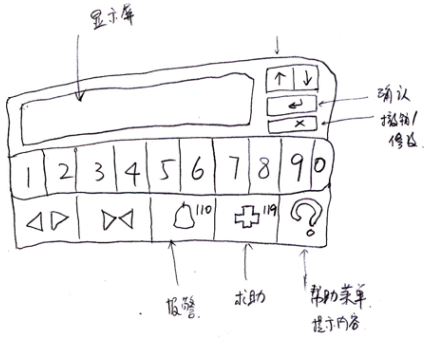


Figure 6. Users sketches of desired functions

6 of the users' sketches had "Open and Close" buttons, while 4 of them included "Up and down" buttons in the interfaces that were sketched. In the DCS, such functions are not needed, since the directions and waiting time of the elevators are assigned by the central system. The function of manually choosing up or down direction is a contradiction to the DCS principles.

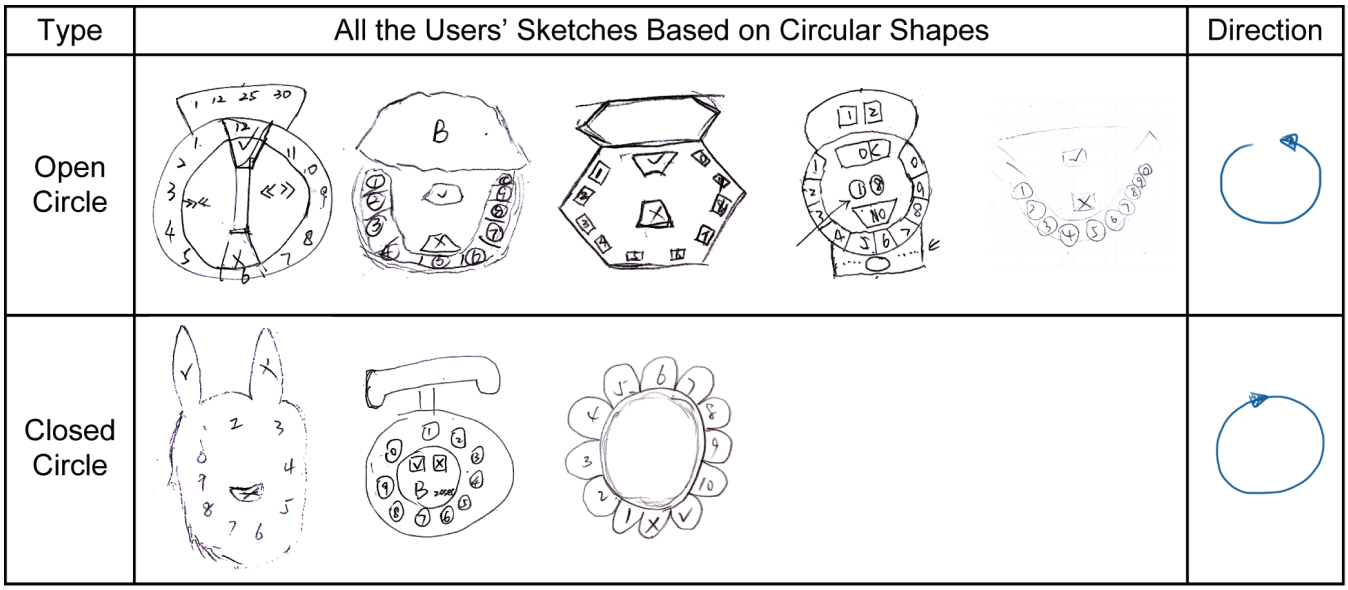


Figure 7: The Users' Sketches that are based on Circular Shapes

The designers again knew the functions of the DCS by heart. It therefore became difficult for them to realize and picture that although the users might understand how the DCS is meant to work, it might still take some time for the users to change the way they think about how to operate an elevator. Without asking the participants to create their own ideal sketches, the requirements of having these functions would not have been easily identified. Some other functions were shown in users' sketches as well, such as the need for audio assistance and alarms.

Symbols

The provided concept sketches used the symbol "⌫" to illustrate the function of "Delete/Cancel" on the elevator control panel, but only 2 out of 29 user sketches kept that symbol in their own design. Rather, 20 of them used the symbol "□" to represent the "Delete" function. This result shows that certain symbols might be more acceptable than other. Information expressed in symbol systems is deeply rooted in culture. This shows it is important for an international design team to take the users' culture into account. The example further shows that while sketching, the participants made their own choices rather than sticking to the designers´ sketches. They made their own choices reflecting their understandings and thoughts, their culture, habits and requirements. It could be hypothesized this would not have been easily identified by solely using language-based requirements gathering methods. The users' own sketches may thus help designers to understand users' requirements that could go unnoticed using conventional requirements gathering methods.

Layout

15 sketches from the rectangle category had a layout similar to that of a conventional mobile phone keypad. The number buttons on 5 rectangle sketches were located following a kind of "linear sequence". Only 1 sketch didn´t illustrate the number buttons at all. It seems the mobile interface was easier to accept for most of the users. All 8 round shape sketches organized the number buttons in a linear manner, with 3 of them in a clockwise order and 5 of them in an anticlockwise order. While taking a closer look at the users' choices, a pattern seemed to emerge. When sketching a closed circle, the number buttons were seen as the numbers on a regular clock; the buttons followed a clockwise direction, regardless of where the number sequence starts. On the other hand, when sketching an open circle, then the number sequence was viewed as a linear line and follows the "left-right" coordination. While represented along a circle, the numbers appeared as in an anticlockwise order. See Figure 7.

Implications

The findings from the analysis of the video recording highlighted the supportive role of sketches in transforming the intangible communication into a tangible design material with the help of multimodal expressions, including written/spoken language, gestures, facial expressions and sketches. It is argued that adopting sketches as a communicable material in the meetings with users can help designers to make intangible concepts, topics and communication more tangible, thus supporting gathering the users' requirements.

The results from analyzing the users' comments showed that the designers' sketches with the spatial information captured the interaction touchpoints and their contexts of use. Thus, the sketches helped the designers to contextualize the design concepts and allowed the users to situate interaction moments into the context. On the other hand, the users were able to read the sketches and interpret the functions of the system. Most of the requirements gathered were related to the spatial information and environments. The comments were often given by a combination of written language and drawings, which directly showed what the users wanted and where they

wanted it. It is thus argued that adopting sketches as a tool to communicate with the users early on in the design process can be especially beneficial when the intended system requires the consideration of the environment, the surroundings and the context of use.

By analyzing the users' sketches, the user requirements of desired functions, symbols and layout started to unveil. These sketches, to some extent, reflected the users' thoughts and facilitated the discovery of the users' requirements. This finding emphasizes the role of sketches to "serve as an external display to facilitate inference and discovery, to go from the intended to the unintended, to go from the seen to the unseen" [30].

These three types of data highlighted three different aspects of sketching that might benefit the user requirements gathering process:

(1) Sketches can enhance the communication between the designers and the users by encouraging multimodal expressions and tangibilizing abstract conversation;

(2) It can support contextualizing the design concepts, which is particularly important in location-dependent interactive systems;

(3) It can help the designers to unveil the users' underlying thoughts, which may otherwise be invisible.

DISCUSSION

There are of course different approaches proposed in the interaction design field to include sketching as a means to communicate with users, stakeholders and other designers. In an influential approach proposed by Tohidi, Buxton and Baecker [29], users' sketching is involved in the evaluation of alternative design concepts. In their study, users were exposed to different sets of paper prototypes of an interactive artifact and then required to create their own sketches. By doing that, the designers got the users' reflective feedback, which would not be obtained only by using conventional user testing techniques, such as questionnaires, interviews and think-aloud protocols. The other example selected is one of the most recent studies to include sketching in the early interaction design stage, which is proposed by Wyche, Tech and Grinter [31]. In this study, the researchers used sketching to translate findings from fieldwork and then presented these sketches to participants who became motivated and inspired by the ideas depicted in the drawings. The findings suggested sketching could be used to uncover value differences between users and designers, highlight promising design ideas, and validate qualitative research findings [31].

Although these approaches admittedly share features with the User Participatory Sketching approach, we here wish to point at some important differences. The User Participatory Sketching is introduced early on in the design process, namely in processes of inquiry. The other approaches however rather seem to be crucial to processes of evaluation and ideation. Further, one crucial difference is the role of sketching in the approaches. In the User Participatory Sketching approach sketching is adopted as a way of posing questions to the users early on in the design process rather than generating new ideas. The role of sketching here is to gather user requirements, whereas in the other approaches the role of sketching is closely tied to evaluation and ideation.

The User Participatory Sketching approach intends to involve the users in the requirement gathering by communicating with the users via sketches. This approach may complement traditional user requirement gathering techniques in the following aspects: First of all, sketching derives from design methods rather than ethnography. To designers, sketching a visual representation is a way of thinking and reflecting [24]. Adding the sketching elements in the user requirements gathering process may help the designers to get richer design materials to reflect upon. Secondly, sketches help to externalize the abstract thoughts, which can be rather ambiguous to express purely by use of natural languages. Thus, including sketching in the user requirements gathering phase may support the communication between the designers and the users when words are lacking. Further more, involving the users in the sketching activities can change the users' role from a "reactive" state to a "reflective" state [29]. The user's expertise is appreciated and respected; the *Doctor designer* and *patient user* relationship can shift to a *student designer* and *master user* relationship [13]. Last but not least, sketching is also a time saving and inexpensive technique to use in the user requirements gathering phase. The time for the sketching process is flexible and can be varied depending on particular circumstances. And the materials for sketching are easily obtained.

Besides the three aspects discussed above, the user participatory sketches potentially have some other functions that may support the design process. Sketches provide rich resources for idea exploration and users' sketches may help designers to think "outside the box". Sketches further have the function of visually documenting the users' needs which can count as essential for the designers' creative work [8], and help designers generate new ideas [26].

CONCLUSIONS AND FUTURE RESEARCH

User Participatory Sketching in the case study showed a way to complement conventional user requirements gathering methods. Based on the results of the case study, it is argued that the proposed approach can support the user requirements gathering activities in the aspects of: (1) tangibilizing communication; (2) contextualizing design concepts; and (3) unveiling underlying thoughts.

After the case study, this approach had been adopted in different design projects and became one important step in the design process in KONE Corporation. Further studies on transforming the users requirements to the design solutions are needed. It is also planned to involve users and stakeholders in the design process and to develop a set of

systematic guidelines to support the collaboration by means of participatory sketching.

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