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The Development of a Care Assistive Device Based on Design Thinking: An Examination of Interview Methods by Visualizing Ideas Using Sketches

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ABSTRACT

In the design thinking process, interviews are essential to incorporating user perspectives. Typically, the initial interviews aim for empathy, while subsequent ones during the user test phase validate prototypes. However, this often means that direct user input is not integrated during the ideation and prototype creation stages, potentially leading to a disconnect between developers and users. This study aims to promote user participation throughout the design thinking process and align perceptions between developers and users. We conducted a case study where interviews were held during the ideation phase, and hand-drawn sketches were used for visualizing ideas, thereby incorporating direct user feedback on prototype concepts. The case study focused on the development of a device to prevent falls among elderly residents in a care facility. The results suggest that using hand-drawn sketches for idea visualization during ideation interviews contributes to aligning developer and user understandings, enhancing the development process.

Keywords: Visualization, Sketch, Design thinking, Interview, Care assistive device

INTRODUCTION

In the evolving landscape of engineering and design, the concept of design thinking has emerged as a cornerstone of innovation and user-centric development. This paper delves into the challenges and potential enhancements of the design thinking process, particularly focusing on the integration of visualization techniques to streamline the design cycle and improve user engagement.

At the heart of design thinking's five steps (Brown, 2008) lies empathy-based problem definition, which is integral to user-aligned development. However, a significant limitation in the current design thinking model is the delayed incorporation of direct user feedback. This feedback often only emerges during the user testing phase, after substantial resources have been allocated to prototype development. Consequently, this can necessitate significant pivots, despite the substantial investment in the prototyping phase. While iterative processes are essential to design thinking, the time-intensive nature of current practices poses a challenge that demands attention.

To address this challenge, it is necessary consider whether the design thinking process can be expedited. The potential of visualization in this context has been recognized, as indicated in prior research: the effectiveness of freehand sketches in participatory design, highlighting their role in facilitating communication and idea generation (Al-Kodmany, 1999; Shimizu, 2017). Similarly, recent research not only highlights the advantages of incorporating visualization into the design process but also proposes a framework for its effective integration. These insights suggest a substantial opportunity to improve the efficiency and effectiveness of design thinking by utilizing visualization techniques (Bresciani, 2019). Despite the recognized potential of visualization, comprehensive studies detailing its integration throughout the design thinking process are scarce. This paper aims to bridge this gap by presenting a case study about developing an assistive technology (AT) device designed to support decision-making in refraining from engaging in hazardous activities autonomously that implies visualization techniques from the ideation phase to the user testing stage. By doing so, it seeks to propose a refined methodology for design thinking, one that harnesses the power of visualization to define challenges for designers and users more accurately, generate more creative and relevant ideas, and test these ideas more effectively with users.

CURRENT SITUATION

The First Development

In Japan, there exists a public social insurance system called nursing care system, which provides financial assistance to individuals who need caregiving. Enrollment is mandatory for those aged 40 and above, and principally, people aged 65 or older are eligible to receive services under this scheme. Elderly health services facilities, or "kaigo roken" facilities, are designed to support the independence of elderly individuals requiring care, primarily through rehabilitation. They play a crucial role in facilitating the return of residents to their homes or in providing support for at-home care. Being public facilities, they are characterized by the applicability of long-term care insurance, which covers a portion of the care costs (Ministry of Health, Labour and Welfare, 2021).

The growing challenge of understaffing in modern geriatric care, driven by an aging global population, is a pressing concern. Addressing this issue necessitates innovative solutions, particularly in the realm of assistive technology development. This paper discusses our research team's approach to developing assistive devices for elderly care, following the principles of design thinking—a methodology that focuses on user-centered, iterative design processes.

This prototype is being developed as a research project under the guidance of instructors, with multiple students collaborating as a team. Additionally, this project is conducted in collaboration with a certain "kaigo roken" facility in Japan, hereinafter referred to as "elderly health services facility Z," integrating practical insights from the field into our development process.

Our initial step involved conducting comprehensive interviews with staff at elderly health services facility Z. These interviews aimed to pinpoint specific user scenarios and understand the unique needs and challenges faced by both caregivers and the elderly users. Such insights are pivotal in shaping the development of assistive devices that are not only technologically sound but also align closely with real-world caregiving environments.

The assistive device under development is a wheelchair-oriented system designed to support elderly individuals. It enables them to make safe, personalized decisions about their activities, considering their risk-taking capabilities. Furthermore, it assists caregivers in providing timely support. The system incorporates a mat sensor fitted to the wheelchair to detect movements indicating the user's intent to stand up. It then uses a microphone and speaker-based dialogue system to infer the user's intentions, providing appropriate feedback. If the intended action is within the elderly person's capabilities, the system offers safety reminders; if not, it triggers a notification to the caregivers.

Despite the promising design, the first user test (prototype 1) revealed a significant issue: the elderly users had difficulty recognizing and interacting with the dialogue system, leading to ineffective feedback communication. Consequently, this necessitated a redesign of the feedback system in the second version of the assistive device.

Consequently, prototype 1 was not user-friendly, necessitating a significant update with a return to the ideation stage. The development team, aiming to gain fresh insights into user behaviours, conducted participant observation (Fujinaga *et al.*, 2013) at elderly health services facility Z using prototype 1.5—a version operating solely on the system, excluding user feedback. This version included an enhanced mat sensor and excluded the dialogue system. Based on these observations, the development team, including myself, interviewed Mr. K, the administrative head of elderly health services facility Z. During the interview, the team collaborated with Mr. K to design the feedback system, striving to more accurately reflect the caregiving environment using ideas generated by the team members (Takizawa *et al.*, 2023).

This outlines the trajectory for an extensive discussion on the design thinking process applied in the development of assistive devices for elderly care. Subsequent sections of the paper will delve into a detailed analysis of the challenges encountered, solutions proposed, and the results achieved.

Participant Observation and Ideation

To conceptualize feedback ideas for the second prototype, we conducted participant observation to study the living conditions of users. The observation was carried out over two days by members of the development team at the elderly users health services facility Z. On the first day, observations were made from post-breakfast until pre-lunch, and on the second day, from pre-lunch to post-lunch. It is important to note that the residential section of elderly health services facility Z is organized in a unit-based system, where the elderly residents are grouped into six different units. Our participant observations were conducted on the floors of two such groups, with permission

granted by the facility's management, and focused on the behaviours and interactions of both residents and staff.

The insights gained from the participatory observations are as follows.

- Installing feedback devices like smartphones on wheelchair handrails is difficult.
- The residents of the facility did not abruptly stand up from their wheelchairs; instead, they typically moved toward a destination, such as a restroom, before standing up.
- Facility users seated in chairs tend to move after standing up. The transition from sitting to standing is often instantaneous, while the time from standing to starting to walk is comparatively longer.
- Some facility users have higher than expected ADL (Activities of Daily Living) scores and are capable of brisk walking, whereas others tend to take in their surroundings.
- Around meal times, staff members are constantly busy with tasks like serving meals, collecting dishes, assisting with medication, encouraging toothbrushing, aiding in toilet use, and helping users move to their rooms. With each user exhibiting different behaviors, risk assessment is not straightforward.
- Daytime activity levels of facility users are not very high. While more active behavior, like walking in corridors, is desirable for health reasons, it poses a risk of accidents when users act alone, making it difficult to balance accident prevention with encouraging activity.

Based on these insights, the development team members formulated ideas for prototype 2. The conceived ideas, utilized in Interview 1, pivoted from being wheelchair-centric to a format that involves installation within the facility.

METHODOLOGY

Visualization

The visualization methods used in the interviews consisted of three types, as detailed in Table 1.

Table 1. Visualization methods used for interview (created by the first author).

Name	Creation Timing	Content
Design drawing	Before interview	Ideas conceived by the development team members, represented in drawings
Additive sketch	During Interview	Modified proposals reflecting opinions on design drawings, represented in drawings
Free sketch	During Interview	Drawings of new ideas not captured in design drawings or additive sketches

Prior to the interviews, seven types of design drawings related to feedback ideas were prepared under the following conditions (Figure 1). It should

be noted that the wheelchair representations were simplified and partially differed from the actual structure.

Anticipating that presenting a single design drawing might not effectively convey the point to the interviewees and might not elicit precise responses, multiple design drawings were created, each incorporating different ideas. These focused on specific discussion points, such as "method of installation (wall-mounted or placed on a base)" and "device design (physical 3D object or digital 2D display)." Notably, the figures including backgrounds replicate the scenario of the floors at elderly health services facility Z.

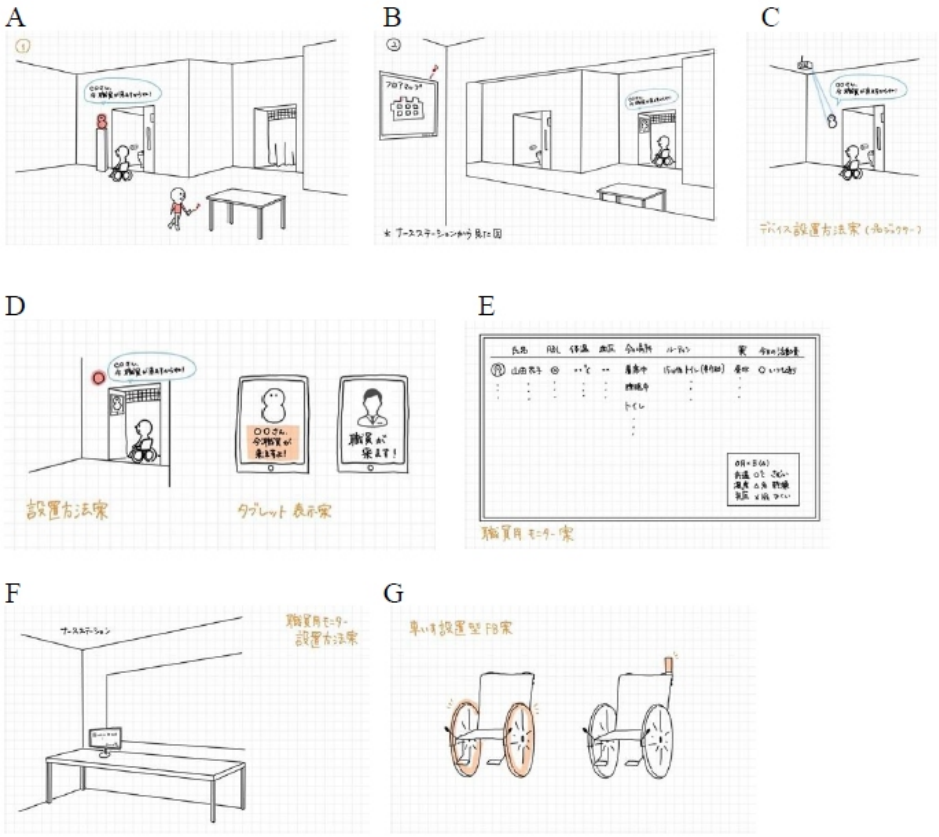

Figure 1: Design drawings (created by the first author).

Tools Used:

- iPad Air (Model released in September 2020)
- Apple Pencil (2nd Generation)

Application:

- GoodNotes5 (*Goodnotes | Notes Reimagined | Note-Taking App*, 2019)

Creator:

- The author

Interview 1 – After Ideation

The interview was conducted by four members from the development team, their instructor: the last author, and Mr. K, the administrative head of elderly health services facility Z. The author was responsible for idea visualization. Prior to the interview, the author prepared design drawings and, in real time, created additive sketches and free sketches. Three other students were assigned distinct roles: one as the main interviewer, another as the sub-interviewer, and the third as the video recorder. The instructor also contributed as a sub-interviewer. The content of the interview is detailed in Table 2 below.

Table 2. Interview 1 content (created by the first author).

Topics	• Sharing results from user tests and participant observations and soliciting opinions • Opinions on feedback (FB) ideas for prototype 2 (gathering feedback on design drawings from interviewees and incorporating it into new ideas through additive and free sketches)
Interview Method	Semi-structured interview
Date and Time	June 19, 2023 (Monday), 14:30 to 16:00
Location	Elderly health services facility Z (reception room)
Participants	Mr. K, Administrative Head of elderly health services facility Z (interviewee) 4 students (main interviewer, sub-interviewer, idea visualizer, video recorder) 1 instructor (sub-interviewer)
Recording Methods	• Minutes recorded on a PC • Video recording of the interview • Audio recording of the interview • Screen recording of the iPad

During the interview, visualized ideas were displayed on a large screen, and the process involved appropriately zooming in and out, as illustrated in Figure 2.

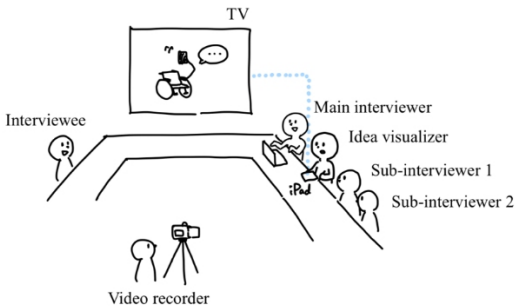

Figure 2: Illustration of the interview session (created by the first author).

Interview 2 – After Prototyping

Following Interview 1, a preliminary prototype was created, and a second interview was conducted with Mr. K. This interview served as a precursor to the user test, aiming to verify the extent to which the visualizations used in Interview 1 successfully incorporated Mr. K's feedback into the prototype. The content of the interview is detailed in Table 3 below.

Table 3. Interview 2 content (created by the first author).

Topics	• Confirmation of the agreements made during the first interview • Opinions on the prototype developed based on Interview 1
Interview Method	Semi-structured interview
Date and Time	December 14, 2023 (Thursday), 10:00 a.m. to 11:00 a.m.
Location	Elderly health services facility Z (reception room)
Participants	Mr. K, Administrative Head of elderly health services facility Z (interviewee) 4 students (main interviewer, 2 sub-interviewers, video recorder) 1 instructor (sub-interviewer)
Recording Methods	• Minutes recorded on a PC • Video recording of the interview • Audio recording of the interview

This study has been approved by the Research Ethics Committee for Human Subjects at Tokyo Institute of Technology (Approval Number: No. 2022044).

RESULT

Visualization and Interview 1 – After Ideation

During Interview 1, Mr. K provided numerous opinions on the ideas proposed by the development team's students, leading to a dynamic discussion. Initially considering a wheelchair-mounted device, we pivoted to a facility-installed format. Presenting the design drawings to Mr. K garnered a very positive response. However, Mr. K offered detailed suggestions for improvements rather than only affirmation, which the visualizer sketched in real time. This process triggered further questions from the interviewer students and clarifications from Mr. K, deepening the discussion. Below are excerpts from the discussion transcript, showing how sketches facilitated deeper dialogue (Table 4).

Table 4. Discussion transcript example.

162	Main interviewer	Yes, indeed. Then it would be simple, not a character. Another big problem with this is that even if it is placed outside, the amount of light from the smartphone screen is quite limited, so no one will notice it no matter how many lights are on at the edge of the room. So, it would be necessary to prepare another light, so a round light would speak to the user in a way that is slightly linked to the sound, and in a color that is easy to recognize. I wonder if it would be better to install a new light attached to the wall, rather than, say, something new like a foundation, such as a tripod, or something like that, or, say, a new light attached to the wall.
163	Interviewee	It is definitely better to put it on a wall, you know, because it becomes an obstacle.
164	Main interviewer	But, if it's simple…
165	Sub-interviewer 2	Mounting it on the wall.
166	Main interviewer	Then, it would be…
167	Idea visualizer	It looks like it would be high.
168	Main interviewer	How about the height? For example, how high is the height of the handrail of a person's room?
169	Sub-interviewer 2	It's about the same as that one, isn't it?
170	Main interviewer	It's about the same height as that one. From the perspective of a wheelchair user, the handrail would be right in front of you.
171	Interviewee	Yes, it is about in the middle.
172	Main interviewer	Yes, yes, yes. It has a very long torso.
173	Idea visualizer	It's a little long in the torso.
174	Main interviewer	For a person who is standing...
175	Interviewee	For a person who is standing, the railing, for example, is, you know, really a lamp. Well, it depends on how thin it is, but it's at the top of the railing. If a power source is required, it may be difficult to put it there. If the lamp is placed there, it will be close to both standing and sitting people.
176	Main interviewer	Certainly, certainly, certainly. The handrail is a vertical one like this, so it's a little bit....
177	Sub-interviewer 2	I'll take a picture later.
178	Main interviewer	Just take your time. It's about the size of a handrail, and if you put something on it, it's going to be very small. Yes, yes, yes. I think it's an image, but since you wrote it down, I think it's a good thing that it's more concrete. That's great. That's great. What do you think is shining in the image you have now, Mr. K?
179	Interviewee	I think the top one is fine. I think it should be at the top of the list. Yes, that's right. Yes, that's right.

Below are some of the additive and free sketches created during Interview 1. These were developed to support the discussions between Mr. K and the students, and were drawn in real time in response to the conversation.

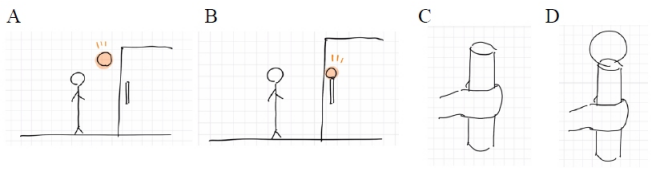

Figure 3: Additive sketches and free sketches drawn in interview 1 (created by the first author).

The main interviewer, in utterance 162, inquired whether to mount a round light on the wall or place it on a pedestal. Considering the differing eye levels of walking and wheelchair-using facility residents, a sketch (Figure 3A) was created during utterances 163 to 174. This led to a spontaneous proposal from Mr. K (utterance 175). Subsequent modifications, as shown in Figure 3B, led to the realization that handrails are a common focus point for all residents, resulting in agreement on the installation location. To form a more concrete agreement on light placement on the handrails, a free sketch (Figure 3C) was created. The main interviewer then questioned Mr. K about the size and installation image of the light on the handrails and hands (utterance 178). Based on the response, Figure 3D was created, leading to a consensus on installing a fist-sized light on the handrails.

Interview 2 – After Prototyping

In Interview 2, we sought Mr. K's assessment of the prototype compared to what was envisioned in Interview 1. Although still rudimentary, we created a facility-installed light prototype, as discussed in the previous section's dialogue. This prototype was functional and could be operated in real time. After the demonstration, we asked Mr. K to compare it with his initial imagination from Interview 1. He responded, "This is exactly right, and I would like to use it as soon as it's completed."

CONCLUSION

This study presented a design thinking process that incorporates sketches into interviews. In the design thinking process, empathizing with users during interviews typically leads to incorporating their direct feedback only at the user test stage, after creating a prototype. This approach has been challenging due to the excessive resources required for prototype development. However, as illustrated in the case presented in this paper, conducting user interviews during the ideation stage and introducing sketches allows for early verification of the solution's direction and a more detailed reflection of user feedback before creating a prototype. This method proves to be an effective approach for implementing the design thinking process more rapidly and efficiently, with potential for further practical applications in the future.

LIMITATION

The primary challenge of this methodology lies in its reliance on human resources. In this study, the author executed the sketches by hand, but it is conceivable that if someone else had conducted the sketches, different results might have been obtained. Additionally, some teams may not have individuals capable of sketching. In the future, further refinement and practice of methodologies that address these human resource challenges are anticipated.

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REFERENCES

Al-Kodmany, K. (1999) 'Using visualization techniques for enhancing public participation in planning and design: process, implementation, and evaluation', *Landscape and Urban Planning*, 45(1), pp. 37–45. Available at: https://doi.org/10.1016/S0169-2046(99)00024-9.

Bresciani, S. (2019) 'Visual design thinking: a collaborative dimensions framework to profile visualisations', *Design Studies*, 63, pp. 92–124. Available at: https://doi.org/10.1016/j.destud.2019.04.001.

Brown, T. (2008) 'Design Thinking', *Harvard business review*, 86(6), pp. 84–92.

Fujinaga, T. *et al.* (eds) (2013) *[Dictionary of Modern Psychology] Saishin shinrigaku jiten (in Japanese)*. Shohan. Tōkyō-to Chiyoda-ku: Heibonsha.

Goodnotes | Notes Reimagined | Note-Taking App (2019). Available at: https://www.goodnotes.com/ (Accessed: 5 August 2023).

Ministry of Health, Labour and Welfare (2021) *The outline of a nursing care system*. Available at: https://www.mhlw.go.jp/stf/seisakunitsuite/bunya/hukushi_kaigo/kaigo_koureisha/gaiyo/index.html (Accessed: 25 January 2024).

Shimizu, J. (2017) *[Graphic Recorder: a graphic recording textbook for visualising discussions] Graphic Recorder: Giron wo kashika suru gurafikku reko-dingu no kyoukasho (in Japanese)*. BNN, Inc.

Takizawa, N., Yanagase, R. and Saijo, M. (2023) '[Investigation of a direct support system for accident risk management for older people in collaboration with nursing homes] Kaigo shisetsu to kyoudou de okonau koureisha jiko risuku kanri no chokujiteki shien shisutemu no kentou (in Japanese)', in. *LIFE2023*, Kashiwazaki.