# Idea Generation Through Empathy: Reimagining the 'Cognitive Walkthrough'

#### Abstract

Engineering and design students are often required to evaluate their products against user requirements, but frequently, these requirements are abstracted from the user or context of use rather than coming from actual user and context data. Abstraction of user requirements makes it difficult for students to empathize with the eventual user of the product or system they are designing. In previous research, Design Heuristics have been shown to encourage exploration of design solutions spaces at the initial stages of design processes. This study combines use of Design Heuristics in an engineering classroom context with a method designed to connect students with an understanding the context of the user, product use setting, and sociocultural milieu. We adapted an existing method, the cognitive walkthrough, for use in an engineering education context, renaming it the *empathic walkthrough*. In this study, this method was revised and extended to maximize empathy with the end user and context, using these insights to promote a more situated form of idea development using the Design Heuristics cards. We present several case studies of students using this method to expand their notion of situated use, demonstrating how this method may have utility for importation into engineering contexts. Our early testing has indicated that this method stimulates empathy on the part of the student for the design context within which they are working, resulting in a richer narrative that foregrounds problems that a user might encounter.

#### Introduction

Approaches to engineering education have historically included a significant focus on technical competencies<sup>1,2</sup>. While adoption of user-centered approaches that build on this technical foundation is growing, with more formal support for team and multidisciplinary communication and human-centered design methods, it is vital that this growth process continues and is adequately supported by the engineering education research community. In the past decade, human-centered approaches to engineering have grown substantially, with an increase in attention to building social competencies, such as role playing to encourage situated use in requirements engineering<sup>3</sup>, working in interdisciplinary teams with a variety of stakeholders<sup>2</sup>, and conducting user research through methods such as design ethnography<sup>4</sup>. There has also been a recent focus on conceptual and pedagogical framings that encourage students to take on the user's or stakeholder's perspective in the classroom experience<sup>6,7</sup>, developing students' empathy towards the population they are designing for—a key focus in human-centered design<sup>5</sup>. In fact, empathy has been noted as a primary characteristic of successful engineers<sup>7</sup>, yet there are limited examples of how to systematically encourage the development of empathy.

Scholars have begun focusing on understanding how concepts such as *care* and *empathy* are articulated or understood in engineering<sup>7,8</sup>, and they have suggested that engineering students should be learning interpersonal and social skills that relate to the outcomes of their work<sup>7</sup>. In particular, they recommend using perspective-taking as users to discover the complexity of the underlying socio-technical system of use<sup>6</sup>. This attention to *empathic communication* is underutilized in engineering education as a way of building core professional communication competencies. While the construct of empathy is complex, Levenson and Ruef's<sup>9</sup> definition

(quoted in Walther et al.<sup>6</sup>) includes three essential qualities: 1) the cognitive *knowing* of what another person is feeling, 2) the emotional *feeling* what another individual is feeling, and 3) the act of *responding* to another's experience with compassion. Our approach to developing empathy during an idea generation design task focused primarily on the *knowledge* of what the projected user is feeling, along with implications for how one feels emotionally and responds to that feeling.

The process of developing design requirements is an area that can alternately be viewed through technical and human-centered perspectives. Students are often asked to evaluate their products against user requirements, but frequently, these requirements are abstracted from the user or context of use. This makes it difficult for students to empathize with the eventual user of the product or system they are designing, or to understand the complexity of the socio-technical landscape that a user might face. Some methods have been imported from the broader design community, often drawing upon participatory design approaches to involve the user in a more dynamic and fluid way throughout the design process  $^{10,11}$ . These approaches also require a substantial commitment to user research that is challenging to integrate in many engineering courses because of access to the target user population and timelines associated with the course. Usability testing methods such as contextual inquiry<sup>12</sup>, mental models<sup>13</sup>, critical incident analysis<sup>14</sup>, and cognitive walkthroughs<sup>15,16</sup> have been developed to foreground situated, usercentered perspectives on design, and some of these approaches are already being used successfully in engineering design classrooms. We adapted a specific method-the *cognitive* walkthrough<sup>15,16</sup>—for use in an engineering education context. In this paper, we explain how this method was revised and extended to encourage engineering students' empathy with the end user and context, resulting in the proposed empathic walkthrough method. Insights generated from student empathy were then used to promote a more situated form of idea development using an established ideation method, Design Heuristics<sup>17,18</sup>

# Creating the Empathic Walkthrough

A range of participatory design and user research methods are documented in the design literature (e.g., <sup>19</sup>); however, many methods require direct access to the target user or population, or extensive "on-the-ground" research to generate implications for design. More rapid methods have been advocated, particularly in software engineering and human-computer interaction (HCI) to address these limitations of primary research<sup>12,19</sup>. One of these methods, the *cognitive walkthrough*, is commonly used to identify *how* a user interacts with a product or system, using observed barriers to serve as a generative source of data for further refinement. The cognitive walkthrough is particularly helpful for:

"evaluat[ing] a system's relative ease-of-use in situations where preparatory instruction, coaching, or training of the system is unlikely to occur. In these situations—when a person must actively engage with an interface to know what to do next, rather than relying on preexisting knowledge of the system—each step of the interaction with the system can be assessed as a step that either moves the individual closer to or further from his goal. Cognitive walkthroughs provide a systematic way to identify these distinct points during an interaction sequence, and then evaluate whether each step is more likely to fail or succeed in helping people make the next correct decision in the interaction." (<sup>19</sup>, p. 32)

The method<sup>20</sup> is focused on the user's ability to identify how to use interactive controls in order to achieve a desired effect through a series of questions. A later adaptation of this method<sup>15</sup> in the context of software engineering provided a more distilled set of steps and actions, with a particular focus on a team design process:

- 1. Define inputs to the walkthrough
- 2. Convene the walkthrough
- 3. Walkthrough the action sequences for each task
- 4. Record critical information
- 5. Revise the interface to fix the problems

In adapting this method, which was originally intended to raise issues of usability in functional products and systems, we focus on utilizing the framing of steps one through four in order to improve an idea generation phase in step five. Understanding how a user might interact with a given product or system (even in concept form)—taking into account unique characteristics of the user and their context of use—should afford a new perspective on the design space. This can be characterized by several key features: externalization of previously tacit design decisions<sup>21</sup>, identification of proximate assumptions about the user and/or context<sup>22</sup>, and the narrative engagement of the designer with their target user<sup>23</sup>. Each step of the existing cognitive walkthrough method will be summarized and mapped to the goal of generating empathy for the target user within the proposed empathic walkthrough method, using these insights to structure idea generation.

#### Inputs

The inputs into the cognitive walkthrough generally include user, context, and a specific design problem as operationalized through a finalized design. While the implementation of this method in software engineering and HCI has been largely focused on testing a product that is relatively far along in development, or is already "shipping," we will focus on an application of this method to early- or intermediate-stage concept development. The relevant inputs are listed below, with their equivalent in our version of the method (Table 1).

Cognitive Walkthrough Inputs	Empathic Walkthrough Inputs
Identification of users	Identification of users through previously provided personas, developed personas, or other secondary user research
Sample tasks for evaluation	Problem definition developed by the instructor, often included in the design brief
Description or implementation of interface	Concept sketch, including brief description of functionality, if available

Table 1. Comparison of inputs in the Cognitive Walkthrough and Empathic Walkthrough.

#### Convene and Walkthrough the Concept

The cognitive walkthrough is generally completed by pairing a user with an interactive product or system, and recording devices are used to capture their progress. We adapt this method for use earlier in the design process by pairing two engineering or design students and encouraging them to "position-take" or role-play for their defined user population. This process of role-playing forces the student to take on the perspective of the user, revealing tacit assumptions they have about the user they are designing for, and externalizing these assumptions by walking through the use of the product or system. While the cognitive walkthrough method is generally focused on walking through explicit "action sequences" that are defined by the design team, our adaptation focuses on the holistic interpretation of the design concept through the lens of the role-played user. Thus, the empathic walkthrough encourages the student to "talk through" the use of the product or system to generate their own action sequence, or what might be referred to as a "user story." User stories are a common form of human-centered requirements gathering and design<sup>24</sup>, and this approach is extended here to represent a broader narrative of use.

#### Record Critical Information and Generate Alternatives

The designer can observe user interactions with a product or system to identify usability obstacles. Where the traditional cognitive walkthrough focuses on obstacles in the context of action sequences, our conception of the empathic walkthrough method expands the identification of obstacles outward to refer to parts of the design that are confusing or strange, that don't appear to work correctly, or otherwise seem inappropriate for the user.

Following this identification of user obstacles, or *critical information*<sup>15</sup> about the design, the designer can then generate alternatives or additional concepts that address user concerns. In the empathic walkthrough method, we frame this stage as structured idea generation, with the types of concerns that arise serving as specific prompts (with embedded constraints) that can provoke the generation of additional ideas.

#### An Empathic Walkthrough

The empathic walkthrough method, as we have described, foregrounds issues of empathy by taking on the perspective and position of the target user or user population. Through the telling of "user stories," the designer is forced to imagine the use of a conceived product or system within a different context and set of user concerns. This empathy-driven retelling of the concept promotes the identification of obstacles or critical concerns. This framework addresses the desire for increased empathy pointed out by scholars in engineering contexts, including communication in an empathic framing, and perception of that empathy<sup>7</sup>.

# **Design Heuristics**

In previous research, the use of Design Heuristics has been demonstrated to facilitate the development of concepts during ideation in the initial phase of the design process. Design Heuristics—a tool based on award-winning products<sup>25,26</sup> and design activities of engineers and product designers<sup>27-30</sup>—has been empirically validated<sup>18,31-33</sup> and shown to support successful

ideation<sup>34,35</sup>. The Design Heuristics method involves the use of 77 cards, each with a heuristic name, a brief description and visualization of the heuristic, and two example products in which the heuristic is evident (Figure 1). While this method has previously been used primarily in early phase ideation, some recent efforts have addressed support for students who are in iteration or evaluation phases with more developed concepts<sup>29,36</sup>.



Figure 1. Sample Design Heuristics card (front and back).

Prior studies of Design Heuristics in an engineering classroom context (e.g., <sup>18</sup>) have not focused on the context of use. Studies of the Design Heuristics method have not yet explored the integration of the larger problem framing, or potential use cases and contexts within that framing. In our exploratory use of Design Heuristics with the empathic walkthrough, we focus on extending the student's understanding of the problem space by generating empathy with the end user and context. Through this empathic positioning, we expect that Design Heuristics can be used to lead to a richer space for additional idea generation.

# **Purpose of the Study**

The purpose of this study is to document the instructional qualities inherent in the exploratory empathic walkthrough we have proposed, noting how this more empathic framing relates to the ideation support provided by the Design Heuristics method. In particular, we address how the use of Design Heuristics might change when students are encouraged to think empathically through the felt user or contextual needs brought out in the empathic walkthrough process. In the data collected, we examined how participants generate credible user stories, externalize empathy, and make use of Design Heuristics in generating concepts.

# Method

# **Participants**

Participants in this study include eight engineering and industrial design students from a large Midwestern university, interacting in dyads. Participants included five males and three females, with all females appearing in the two industrial design dyads. Students were identified and selected to represent two programs focusing on design, with two undergraduate dyads and two graduate dyads. The undergraduate dyads included students in a junior-level industrial design course (n=2) and students in a sophomore-level mechanical engineering course. The graduate dyads included students in an engineering design studio (n=2) and an industrial design studio (n=2).

## Data Collection

Students agreed to participate in a one-hour data collection session, with 30 minutes devoted to each participant's concept. Each participant was asked to bring a previously defined concept for the project they were engaged in within their course, and all students had been previously required to complete some form of user or market research to inform their project. The entire exercise was audio and video recorded (Figure 2), and all sketches and notes the participants generated were retained and scanned for further analysis.

The empathic walkthrough method was conducted twice for each dyad, with each participant's concept serving as an encapsulated use of the method, approximately 30 minutes in duration. Dyad A was used as a pilot test of the procedure, and as such, only one cycle of the method was performed with these junior industrial design students.



Figure 2. Two participants interacting during the idea generation portion of the empathic walkthrough.

The participants were led through a three-part procedure (Figure 3), including: 1) walking through the user story, 2) listing and grouping concerns about the design, and 3) generating new concepts. The full protocol is provided in Appendix A.



Figure 3. Revised cognitive walkthrough process.

#### 1. Walking through the user story

After providing brief introductory information about the method, students were directed to use their knowledge of the user population in telling a "user story" about their partner's concept. In particular, they were asked to step through the actions the user would need to perform in relation to the design, taking into consideration that some interactions might include multiple steps over different points in times and/or locations. Students were encouraged to tell the narrative from the perspective of the target user, wherever possible, and that this narrative should be "credible"—providing enough detail to understand how the product would be used by a specific user in a specific context.

While one participant was walking through the user story of their partner's concept, the other participant was given Post-It notes to write down issues or questions that arose. These were explained to the participant as "parts of the concept that were confusing or strange, that somehow seemed inappropriate to the user, or didn't work correctly."

#### 2. Listing and grouping concerns

After the user story, the concerns that were noted were shared with the other participant, and any additional concerns were added onto new Post-It notes. The participants were then asked to sort these concerns as they applied to the five properties of a concept, identified above (i.e., form, function, temporal, use/user, and system). A brief definition of each property (Table 2) was provided on a sheet of paper for the participants to reference.

#### 3. Structured idea generation

The participants were then briefly introduced to the Design Heuristics cards (two groups had not used them previously, both engineering dyads), and were given five packets of three cards each (randomly selected), with each labeled packet tied to one of the five properties they used to sort their concerns in the previous stage (Table 2). The cards related to each property were used for all four dyads.

Property	Definition	Design Heuristics cards
Form	Form of the product	#32: Expand or collapse
		#38: Impose hierarchy on functions
		#55: Repurpose packaging
Function	Functions embedded in the product	#5: Adjust function through movement
		#16: Bend
		#50: Provide sensory feedback
Temporal	Use/function of the product over time	#13: Apply existing mechanism in new way
	Relation to sociocultural environment	#21: Change product lifetime
		#46: Mimic natural mechanisms
Use/User	Situated use of the product	#9: Allow user to customize
	User interactions with the product	#10: Allow user to rearrange
		#40: Incorporate user input
System	Context in which the product is used	#24: Contextualize
	Systems/services the product relies on	#28: Create service
		#29: Create system

**Table 2.** Properties and definitions of Design Heuristics cards used in the procedure.

Participants were then asked to generate as many concepts as they could using the Design Heuristics cards in whatever way they chose. They were encouraged to generate ideas by referencing a design concern and the related set of Design Heuristics cards for that property that concern was associated with, using the set of Design Heuristics as a potential set of strategies to create additional concepts.

# Findings

The concepts and related problem statement for each dyad was drawn from the engineering or industrial design course in which they were enrolled, including a wide variety of conceptual and product framings (Table 3). Dyad A (Junior, Industrial Design) was focused on creating kitchen products for millennials, addressing new kitchen practices surrounding this generation's interaction with the foods of the future. Dyad B (Sophomore, Mechanical Engineering) was tasked with "design[ing] a device that meets a basic need in a developing region, while improving or creating self-sustaining economic activity." Dyad C (Graduate, Mechanical and Aeronautical Engineering) was working on a project assigned by an airline manufacturer to resolve noise issues caused by galley and cart construction in a new aircraft. Dyad D (Graduate, Industrial Design) was rebranding an existing product that had fallen out of favor or had ceased production, with the intention of creating a newly viable product for a defined market using branding strategies and packaging designs.

Dyad Concept Classification Initiator		Concept Initiator	Initial Concept (Target Population)	# Generated Concepts	# Concepts using Design Heuristics
A.	Industrial	P1	Herb garden in fridge (millennial)	8 (P1=5; P2=3)	8
	Junior	P2			
B.	Mech.	Р3	Hand-cranked generator (rural India)	11 (P3=6; P4=5)	5
Engineering Sophomore	Engineering Sophomore	P4	Latrine shovel/toilet (nomadic areas of South Africa)	10 (P3=3; P4=7)	2
c.	C. Mech./ Aero.	P5	Latching galley curtain (flight attendant)	9 (P5=3; P6=6)	2
Engineering Graduate	Р6	Rubber stopper to reduce galley curtain noise (flight attendant)	6 (P5=2; P6=4)	2	
<b>D.</b> Industrial Design Graduate	Industrial	P7	Silly Putty as fire starter (20s male survivalist)	9 (P7=4; P8=5)	1
	Graduate	P8	Tetley tea "lilypods" (college-aged girl)	14 (P7=6; P8=8)	2

Table 3. Problem framings and concepts generated by dyad and concept initiator.

We present four short cases of participant's experience using the empathic walkthrough method and Design Heuristics to demonstrate the character of user stories, the types of critical information that was inspired by these stories, and the idea generation that resulted.

# *Dyad A: Creating an Herb Garden for the Millennial Generation (Undergraduate Industrial Design)*

Both students in this dyad were female, and were enrolled in a junior-level industrial design studio focused on creating concepts for a kitchen tool manufacturer with a focus on millennial audience. The activity was completed near the beginning of the semester, after a couple of weeks of user research and limited early concept generation. Students were assigned to teams, all of whom were addressing the same general problem statement; each participant in this activity was assigned to a different team. This dyad served as a pilot test for the study, and resulted in several minor modifications to the protocol for the other participants, including having each participant tell a user story for a concept they did *not* create.

#### User Story

P1 initially told the user story for her own concept, taking on the perspective of a persona they were provided in class—"Scarlett." This persona was used to supply many of the contextual details included in the user stories, including Scarlett's occupation, recent move, and love of the outdoors. The entire user story took around ten minutes to tell, with P2 taking over telling the user story after P1's initial attempt in the first several minutes, suggesting: "Maybe this would work better if we were analyzing one another's sketches." Both participants documented critical information as the other told their story, although the user story became increasingly interspersed with conversation about functionality in relation to their personas in the second half of this phase. The first five minutes of the user story exchange is included below:

[6:50]

P1: Alright, so the product I was thinking of was kind of like a container that could help nurture and grow plants in your refrigerator. Since I'm new to the city, I don't really know about where the markets and best local places are, so I think this would be a really great product for me. So that I can grow my own food, kind of get a good start to the city. And since I do like riding my bike to work, it's also you know a way to reduce emissions and is cost effective for me as well. Let's see, what else. I can also grow—since I can grow my own food, then you know, bring the foods I don't want to eat to the workplace, so I can share them with coworkers, because I like meeting new people and getting to know them, so that's good. [laughs] I don't know. Getting a start to meeting my coworkers. Yeah, OK, I think that's what I'd like to use that product.

Researcher: You did a really good job incorporating that persona. And it's a lot to ask someone to do—this happens a lot out in industry. If you think about that individual and some of the demands that are put on them, because you essentially said all very positive things about how that product worked. So maybe think about it more critically as well, like based on who he is and what kind of personality he has, why wouldn't it work in his refrigerator. Or, you know—

P2: Maybe this would work better if we were analyzing one another's sketches.

Researcher: That's another way we could do it as well.

P1: Alright, this actually might not work, because I like running around and exploring the city, too, and I think it would be good to you know bike around to the shops and see what they have to offer as well. [laughs]. Let's see—I can't. [pauses]

Researcher: Yeah, that's tricky. Do you [P2] want to try your hand at it?

P1: Yeah, you try it, [P2].

*Researcher: And actually if you want to take her through the same concept she just looked at—* 

P2: Yeah, let's do that! [...] OK. I'm going to start with the negative side, just because I noticed one thing. OK, so because I'm Scarlett and I like the outdoors, I'd rather have a naturally grown garden. So I'd like to get my hands actually dirty and work in the soil. I love being outdoors. Even if I am in a small apartment or something, I'd like to have an opportunity to get outdoors, and this would be a great opportunity for me to do that, whereas, if it's in my fridge, it's less likely for me to be outdoors. I also would love to have somewhere where I could be in an open environment. Be outside, be in the garden, if it was like a public garden, and I was growing food there—not excluding myself to just my refrigerator, my space. Also because I like taking photographs, it would be a lot prettier if it was in the garden [laughs].

*P1: Where do you live?* 

P2: I would say she would live in some apartment or small loft, maybe.

*P1: The only reason I ask is if there would be a space to be an outdoor garden. Because if there isn't, maybe that product in the fridge might be the—* 

P2: Best option—

P1: Right

*P2: Cut my loss and say I have a garden in my apartment. Maybe I should just have a garden in my refrigerator. That's a good point.* 

[11:58]

#### Critical Information

The two participants generated the critical information listed in Table 4 through the user story phase of the activity. Both participants collaboratively sorted these issues or concerns into the five properties, with the most issues appearing in the system property. P1 translated the comments made by P2 in her sketchbook, writing them on the whiteboard as they talked through and came to agreement on each item of critical information.

Table 4.	Critical	informa	tion g	generated	by	Dyad A	•
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Form	Function	Temporal	Use/User	System
<ul><li>Fridge space</li><li>Tray</li></ul>	<ul><li>Cost effective</li><li>Is it wasteful</li></ul>	• Space	Maintenance	<ul> <li>User</li> <li>Location w/in home</li> <li>Is there a platform for use</li> </ul>

## Idea Generation

The two participants in this dyad created a total of eight concepts during an approximately 19 minute period, all of which noted explicit use of Design Heuristics cards. Four concepts noted use of more than one heuristic, and two of these indicated use of cards spanning multiple properties. The participants worked collaboratively, with both generating sketches (P1=5; P2=3) as they systematically looked first at the Design Heuristics cards for the property under consideration, then the critical information they had generated previously. The participants created concepts to address critical information for every property except "temporal," where no heuristics were used, though related concepts were found in the "form" property. Many of the concepts drew directly on the critical information that came out of the combined user stories, including making efficient use of fridge space by stacking or hanging (n=3), customization of the planter to allow for different form factors (n=2), adding an indicator to alert the user to the moisture level (n=1), compartmentalizing to allow for easy transport and sharing (n=1), and adding reuse possibilities in lieu of disposal (n=1).





**Figure 4.** The top row contains concepts generated by P1, suggesting a flexible countertop planter (left) and indicator to note the moisture level of the soil (right). The bottom row contains concepts generated by P2, including a basket that can be moved up and down (left) and a hanging pouch for quick access (right).

Because the participants chose a central role for Design Heuristics in their idea generation process, each concept they generated links the critical information and one or more heuristics in a direct and explicit manner. For instance, P1's countertop planter concept (Figure 4, top left) addressed the issue of space and location within the home, drawing on heuristic #16 ("bend") and #10 ("allow user to rearrange") to create a flexible planter that could be reformed to match the contours or available space of a user's kitchen. Another example of this explicit use of Design Heuristics can be found in P2's adjustable basket (Figure 4, bottom left). This concept drew on heuristic #5 ("adjust function through movement") and #40 ("incorporate user input") to create a basket that could move up and down as the contents and available space in the user's refrigerator changed over time.

#### Dyad B: Portable Toilet for Nomadic Tribes in South Africa (Sophomore Engineering)

Two male undergraduate mechanical engineering students interacted in this dyad. Both were enrolled in a sophomore mechanical engineering design course. In this first such course in their curriculum, students worked in teams for the entire semester to address a very open problem framing: To create a device for a developing region that could aid in improving or creating localized economic activity. The participants in this dyad participated in the study at the beginning of the semester, as they were concluding a week of user research, and were beginning to create concepts as a team to address their chosen developing region and related challenge. Each participant was from a different team, but both had a general idea of their use context (e.g., rural India and undeveloped areas of South Africa) and the problem they were going to address (e.g., off-grid electrical generation, human waste). P4's concept was addressing the lack of infrastructure for human waste in South Africa, particularly in nomadic tribes where no permanent roads or dwellings exist. He proposed a modification of a standard shovel with an attached toilet seat, which could be used to dig a temporary latrine and facilitate safe disposal and covering of waste (Figure 5).



**Figure 5.** The initial latrine/toilet concept proposed by P4. The strap in the bottom left was added during the idea generation phase by P4 in response to one of the concerns P3 raised.

#### User Story

P3 told the user story, loosely taking on the perspective of a villager in South Africa. The entire user story took around three and a half minutes to tell, with a couple of interjections from P4, clarifying product functionality or the way he should be documenting critical information. The entire user story is included below:

*P4:* So, alright, so let's just say I'm living in South Africa. I—I work with my family, all that. I'm walking downtown to get some supplies, and have to use the restroom. Well there's one of these laying there because I don't want to have to carry this wherever I go, because—

#### P3: Issues of portability

P4: Yeah, but it's kind of heavy, so I don't like having to carry it from home to go to work, because I have to carry all this other stuff. So, I mean I wish there was a way to maybe loop it around my back or something. But, so for now, there's a few of these at a place and if you need to use the restroom, you go grab that. But one thing that kind of bugs me is that some people are gross.

P3: Oh my word.

P4: They—it gets kind of dirty and yeah, so that's one thing that bugs me [laughs]. I don't know if that's—I don't know. And so, I'm a pretty strong guy, so I can dig into the dirt pretty well, but sometimes the dirt is really dry and really compact, so like my dad, who's getting pretty old can't really dig down. So I kind of wish there was something you could jump on. Maybe there is? But like, kind of like a shovel, if you could jump on—

P3: I mean, it would just basically be a shovel. I was thinking that you're not going to redesign the spade, because it would be cheaper for someone that already produced the spade.

P4: Nice, I was just shooting out ideas. Let's see [laughs]. So, and another thing with my dad. He's pretty short, so some of these are a little high for him, like the seat is a little high. I don't know, like taller or shorter—maybe if it was adjustable. Eh, that's probably not necessary.

*P3: I'm putting them all on one—it's probably not a good idea. [referring to critical information Post-Its, looking towards me]* 

P4: Alright, I'm describing what's happening. So did my business, and I really need to get going. So I just leave it there, because I'm lazy. I don't know. I'm thinking—what I'm going at is, somewhere something you could use anywhere? Or is there some central place where these are located and kind of keep it there? It's kind of hard to describe. But it works really well, and cover it up—like the dirt.

#### Critical Information

P4 generated the critical information listed in Table 5 while P3 told the user story about the use of the portable latrine concept. Prior to sorting the critical information, P4 offers several suggestions about including a location for toilet paper, which included a short conversation on a more functional level. As part of this conversation, P3 offers a suggestion about providing sanitizer, sharing a story from the slide deck of another member of their class, saying: "They tried to incorporate hand sanitizers into other countries, but they don't know the idea of germs...so I was thinking, what if there was a hand sanitizer thing on there, but would they understand that?" As P4 read off the critical information, P3 sorted most of the notes into the five properties, with the most issues appearing in "form," and none in "temporal."

Form	Function	Temporal	Use/User	System
<ul> <li>Portability, is it heavy?</li> <li>Is it detachable?</li> <li>Toilet paper and sanitizer; strap on back</li> </ul>	• Durability	• N/A	<ul> <li>Adjustability – height</li> <li>Small operators in dry/hard ground</li> </ul>	• Stations to keep devices

Table 5. Critical information generated by Dyad B.

#### Idea Generation

The two participants in this dyad created a total of 10 concepts during an approximately 12 minute period working collaboratively, both generating sketches (P3=3; P4=7) as they discussed some of the critical information they had documented previously. P3 began the conversation, synthesizing some of the elements of critical information in his initial concepts. He also kept the Design Heuristics cards in front of him, looking through several of the packets before using a card on his second concept. Once P4 began to talk as he sketched his concepts, P3 generally remained silent, producing relatively few concepts over the remainder of the ideation period. While these participants did not go through the critical information one piece at a time, they did address properties of concerns in their concepts, which included an adjustable height seat (n=1), a way to hold the device in place while in use (n=3), ways to detach the toilet seat from the shovel for multipurpose use (n=4), and sanitizer available in the handle of the device (n=1).



**Figure 6.** P4 (left, center) and P3 (right) concepts. The left concept describes a way to detach the toilet seat; the center concept shows how P4 incorporated heuristic #38 ("impose hierarchy on functions") to alter his approach to detaching the seat. In the right concept, P3 uses heuristic #5 ("adjust function through movement") to allow the shovel to adjust in height.

In keeping with the critical information these participants generated, most of their concepts dealt directly with the form of the product; in particular, imagining how the device could quickly be transformed from a shovel to take on its new purpose, and thus not including the toilet seat on the device when the shovel was being used for digging. P3 appeared to use the critical information generated based on his user story most directly, creating concepts that addressed hard ground and adjustability for users of different heights (Figure 6, right). P4 focused more on the transformation of the device, including ways to detach or disable the toilet seat through a thumbscrew (Figure 6, left), pin and clip (Figure 6, center), or flange that could slip off of the shovel. While P4 began the process of addressing detachment by brainstorming the thumbscrew, he then iterated on this concept using heuristic #38 ("impose hierarchy on functions"), imagining how the concept could be altered:

*P4: "So I'd say, if there's a way—I would have it come back, and I would go past parallel, and then have something flip down. So it would be maxed out on the hinge, and* 

then you'd have a pin that would like hold it in place. And once it's down—who cares if it goes up or down a little bit..."

P3 demonstrated a different use of Design Heuristics, mapping his previously expressed concern about adjustability of the seat for users of different heights to heuristic #5 ("adjust function through movement") to develop a set of notches on which to fasten the seat. After these two uses of Design Heuristics, P4 tended to dominate the conversation, and the remainder of the time was spent iterating on previous concepts.

#### Dyad C: Building a Flight Attendant-Friendly Airline Curtain (Graduate Engineering)

Both students in this dyad were male, and were enrolled in a graduate studio focused on addressing noise concerns in a recent aircraft model. The activity was completed near the conclusion of the semester, after many weeks of ideation and concept refinement. Other teams in the class were engaged in specific noise sources such as the chiller or cart, but both participants were members of the team addressing noise in the galley on the aircraft. The class had visited the aircraft the week prior to completing this activity, and some of this information clearly impacted the user story the participants told. P5 noted that their team had been "working on different curtain designs to block the noise," explaining that the challenge was that "it's all metal on metal contact."

#### User Story

P6 told the user story, taking on the perspective of a flight attendant. The entire user story took around four minutes to tell, with no interruptions from P5, who was documenting critical information during the story. The entire user story is included below:

After entering the airplane, the catering is already done. So—hopefully the curtain is stored away so I can pass through the area, you know 20 to 50 times as the passengers are starting to boarding. And I have to look through to my other flight attendants that are working in other areas on the aircraft; we are talking huge distances like a few yards. After—during takeoff, I have to look at the galley to see what is going on in emergency, they have to be stored away. So they should not be visible, in any case. After having takeoff, I would really appreciate to have my privacy during working inside the galley, preparing food; the new galley design gives me the opportunity—there are not so many passengers hanging around where I am working, because it is more separated than before. Furthermore, the two—the Lycra curtain which were introduced now offers us the opportunity to reduce the noise incredibly. The passengers are not—the last rows of the passengers were always—we heard they were talking about, and now it's pretty quiet from there on. That's a good perspective of the curtain, of course, and I really appreciate it.

On the other hand, there are a few like—I don't like that I always have to pass two curtains to get to the galley. Just imagine how often I have to pass through—50 times a day—I guess even more per flight. And especially with the damn cart [steering with hands]—it's always stuck as a car, and it's not really fixed, so even with the magnetic fixation, it's—it doesn't offer me the flexibility that I would really like to have. On the

other hand it was always nice for me in the older aircraft without a curtain or with bad curtains that were like hanging around that I had to look through the galley. I was able to work and see what was going on. This is not so easy possible anymore. Some of—I say, safety issue. But I know it's nice to see who's walking around, like a big group of people—sometimes just feel uncomfortable instead of how it was before. Maybe it's not really useful, but I don't like the new curtain's shape—it's strange. And if you walk around pretty fast, it hurts on your skin and I don't know, it's kind of annoying somehow.

Well, different part which is bad on the new curtain—it separates you for the passenger area from the area where you are working. And the plane doesn't have ECS outcomes— ECS is environmental control system—outcomes, so that means as we have chiller in our area, our area gets colder and colder, and it's freezing cold so it's around 40. And the work environment is getting worse and worse, even if it's not as loud. Maybe more secure.

#### Critical Information

P5 generated the critical information listed in Table 6 while P6 told the user story of the flight attendant interacting with the galley curtain. Following the user story, both participants collaboratively sorted these issues or concerns into the five properties, with the most issues appearing in "function."

Form	Function	Temporal	Use/User	System
• Would a transparent curtain help w/ not knowing what's happening	<ul> <li>Is the curtain staying closed easily?</li> <li>Did the more open environment help keep the cold air dispersing to the cabin?</li> </ul>	• N/A	• How do they decide when the curtain is open/closed	• Is it loud when opening/ closing?

Table 6. Critical information generated by Dyad C.

#### Idea Generation

The two participants in this dyad created a total of nine concepts during an approximately 15 minute period. The participants worked collaboratively, with both generating sketches (P5=3; P6=6) as they systematically looked through the critical information they had generated and categorized previously. While the participants looked at the Design Heuristics cards in every property they addressed (skipping "temporal," since they had no critical information categorized), they only used two heuristics for the "function" property in a direct way when

generating concepts. This may be due to the technical problem context and "function" being the most relevant property to use for generating new solutions. Many of the concepts drew directly on the critical information, including adding a clear window within the curtain to provide a view outside (n=1); opening the curtain in the middle instead of from the edge (n=2), providing an external air source to prevent the galley from being colder than the cabin (n=2), and reconfiguring the curtain shape to allow flight attendants to pass through more easily (n=2).



**Figure 7.** Concepts generated by P6, first providing a staggered user path through two curtains, and then altering the shape of the cart to allow the curtain to part with a triangular-shaped cart, inspired by heuristic #5 ("adjust function through movement").

To address the constant in/out traffic to the galley pointed out by P6 in his user story—especially difficult when steering a cart around an inflexible curtain—P6 reimagined the shape of the cart while keeping the curtain the same (Figure 7, right). For that, he used heuristic #5 ("adjust function through movement") to alter the way the curtain reacted to the cart. The heuristic seemed to change the approach this participant had been using earlier when generating concepts, as with his staggered curtain concept (Figure 7, left), which was generated directly before the modified cart.

# Dyad D: Starting a Fire with Silly Putty (Graduate Industrial Design)

A male (P7) and a female (P8) graduate student interacted in this dyad. Both were enrolled in a graduate industrial design studio that was addressing a relatively open problem framing, which was to rebrand a product that had fallen out of favor or had even ceased being manufactured. The participants engaged in the activity at the beginning of the semester, and were just beginning to produce a large quantity of divergent concepts to address their chosen product as part of their course requirements. They had done varying amounts of user research, with P7's focus more vaguely on a male survivalist in their mid-20s. In contrast, P8 had recently completed an experience map, including journey moments for a teenage or early-college age female persona. P7's concept was addressing the relatively low profile of Silly Putty, and its limited appeal for those outside of a younger age bracket. He proposed a fire starter that included Silly Putty as a way of producing a sustained flame, along with magnesium and a flint (Figure 8).



Figure 8. The initial Silly Putty fire starter concept proposed by P7.

#### User Story

P8 told the user story, taking on the perspective of a mid-twenties male, which she named "Kevin." The entire user story took around seven minutes to tell, with several requests for more detailed information about product function and the mechanics of starting a fire from P7, who was documenting critical information during the story. The first several minutes of the user story is included below:

[6:10]

*P8:* So I'm looking at this and I see it has a handle on it, so I grab it from this [pointing at the sketch], and first looking at it without reading your notes, I feel like I have to push down on this little—

P7: Wait, where are you—

P8: This handle—is that wrong? [laughs]

*P7:* No. It's OK. That's actually the magnesium and flint. That's the striking part, so if you haven't used it, it's not really explained well.

P8: OK. Right, right. But—form wise, it's reading to me—form wise, I would definitely grab it by the handle, and just like do something with that thing that looks a little bit like a clicker or something. And so, OK, the "iconic egg shape"—so like the barrel of a gun. So you unscrew this, and see the putty on the inside, and that's \_\_\_\_, and the magnesium, so that's how you would start the fire?

P7: Mmmhmm.

P8: Would you start it—like I feel like maybe, cause you need this, you put putty in the cap, and then do it that way? And then you have a little fire in a cup. [singing] We didn't start the fire, it was always burning. OK, unscrew the watertight putty and strike it wide or store matches in it. That's a good question? That's a really good question. Because it's flint and magnesium, it would probably just be more feasible to use \_\_\_\_ and matches at the same time. Flint and magnesium—that would probably last longer than a couple of

matches that you're using, I guess, it's more analogue like cooler way to do this. And most people would have like lighters and matches on them to begin with, you would think, if you're like hiking and stuff. Or this is quick instead of having to gather leaves and sticks just because I'm assuming we're in the woods, and they are available.

Researcher: Kevin is in the woods right now [prompting her to speak in a more situated way]

P8: Kevin is in the woods right now. [laughing] There's like a bunch of sticks and leaves available. But instead of having to gather all of them, I would just take out my Silly Putty and set that on fire, and then create like a mass fire with all of that stuff. So yeah, formwise I want to grab it like that, but it's still very first stage, so honestly—and then, let's see. Once the putty is in that egg, in a cup, can I put that back on, like after it's all on fire?

*P7: It's sole—the putty is like a matrix that you'd scrape the magnesium into. And the putty replaces the need for tinder. Being like the—the cotton or part of the bark—* 

P8: You don't keep it in the cup—

P7: So the way the starter works is you grab it from the handle, and you have an actual piece of steel that's not glued in there along the—so you scratch off the magnesium with a piece of steel, and it flakes off, and you work it into the matrix—the Silly Putty matrix—and then you use the flint, and the magnesium has a high flash point, that will start the Silly Putty off. And it would allow it to burn longer at a higher temperature.

P8: So you probably wouldn't need to the entire Silly Putty, you—

P7: No, you would rip off a little piece

[09:27]

After this portion of the user story, the back-and-forth conversation continued between the two participants until P7 ended this portion of the method. While there were elements of storytelling, most were not from the perspective of the user (first-person), and P7 raised a number of questions about the use of the fire starter, which were then addressed by P8.

#### Critical Information

P8 generated the critical information listed in Table 7 while P7 told the user story about the survivalist, "Kevin," and his interactions with the Silly Putty fire starter. Following the user story, both participants collaboratively talked through the issues or concerns, with P8 sorting most of the Post-It notes himself into the five properties, with the most issues appearing in relation to the user and potential use cases.

Form	Function	Temporal	Use/User	System
• Affordances are not right; handle shape	• Use of the cup as a starter (improper use)	• Need to gather sticks and wood	• The novelty of using Silly Putty instead	<ul><li> How do I buy refills?</li><li> Is it one time</li></ul>

Table 7. Critical	information	generated b	y Dyad D.
			-1 -1

Form	Function	Temporal	Use/User	System
<ul> <li>Change the handle</li> <li>Does the form indicate proper use?</li> </ul>		<ul> <li>Consider the hiker-smoker</li> <li>What other types of outdoor activities can they be used in</li> </ul>	of fire • Use it as theatrical or group fires. Novelty for camping. • Use putty instead of tinder • Understand the need for flint/ vs. matches • Move Hipster method of starting a fire vs. matches • Need to light candles or cigarettes	use OR how many uses

# Idea Generation

The two participants in this dyad created a total of nine concepts during an approximately 12 minute period while working collaboratively, both generating sketches (P7=4; P8=5) as they loosely addressed the critical information they had documented previously. Their style was highly conversational, with the externalization of shared insights (often crossing multiple elements of critical information) stimulating the generation of drawn concepts. They both worked at different rates, with P8 sketching more rapidly early in the session, and P7 sketching more of her concepts near the end. Both participants had used Design Heuristics previously, but neither felt they needed the additional ideation support; the user story and critical information, along with their easy collaborative communication, stimulated enough ideas that they were never "stuck" and without ideas on how to generate another concept. Consequently, only one concept noted the use of Design Heuristics.

The categorization of critical information did seem to appear in many of the concepts they generated, including adding methods for younger and older users to open the fire starter device more easily (n=3); adding different forms for the handle to demonstrate the affordance of holding (n=4); or including storage within the device for materials (n=2).



**Figure 9.** Concepts generated by P7, first reimagining the form of the fire starter to include finger grips (left), and then altering the cap and striker using heuristic #38 ("impose hierarchy on functions") to more clearly identify the parts of the fire starter, "making the striker available only once the cap is unscrewed."

Although the critical information notes focused on the user/user, P7 found the issues of form particularly the lack of the appropriate affordance for the handle—to be of most concern, and thus both participants focused most of their idea generation within the form property. P7 first added finger grips to differentiate the handle portion of his original concept more clearly (Figure 9, left). Then, he broke apart this concept, using heuristic #38 ("impose hierarchy on functions" to make the striker visible only when the cap was unscrewed (Figure 9, right). After this single use of Design Heuristics, the participants' approach to generating concepts remained unchanged, and their conversation about issues of form and user accessibility continued to dominate their concepts.

#### Discussion

As detailed in these cases, the empathic walkthrough method appeared to aid students in externalizing credible user stories, leading to new ideas. While the approach to telling user stories ranged widely—from a stand-alone first person narrative to an dialogue shifting between first and third person—this component of the method appeared to generate effective insights into the use and contextual qualities of the concept being developed, and led to targeted areas for iteration. All participants explicitly mentioned the value of the procedure in thinking through their concepts in a detailed way, and even those who were most skeptical initially ended the session with new approaches to their problem that added value to their class project. While these cases represent a small yet diverse sample, the character of user stories (and the critical information and concepts generated) demonstrate the effectiveness of the empathic walkthrough method in concept generation.

Next, we will discuss the impact of introducing a situated concept on the perceived and actual use of Design Heuristics; then, we will explore how the empathic walkthrough encouraged the development of empathy, including how empathic positioning was used by the participants to scaffold idea generation.

## **Contextualized Use of Design Heuristics**

We found that in the empathic walkthrough method, Design Heuristics cards were not used as often to prompt ideas when compared to use of the cards unpaired with other methods. For concepts that were less developed, traditional free flow ideation seemed to be preferred, where the critical information the dyad generated provided a number of points from which to iterate on the concept, and the relatively short time allowed (less than 15 minutes) did not exhaust their ideas. In this time period, students often did not make use of the cards, relying on free flow ideation for the majority of the ideation period. However, they did use the cards when they became stuck on a particular piece of critical information they were struggling to implement in a concept. Some participants attempted to use the cards, but decided to rely on their own abilities to generate solutions once they did not see a place for immediate application. This practice is exemplified by P6, who first tried to use the cards in the "system" packet, but after looking them over briefly, said to his partner: "we'll have to do it our own way." This seems to be due to the fact that participants needed some time to absorb the new critical information provided by the empathic walkthrough before feeling the need for ideation support.

The use of Design Heuristics seemed to be unaffected by participants' previous experience with this method. Both industrial design dyads had experience using Design Heuristics in previous course settings, while neither engineering dyad had any previous exposure. Only the Junior Industrial Design dyad used Design Heuristics regularly and methodically for every piece of critical information uncovered. Overall, the use of Design Heuristics seemed most valuable at intermediate stages of concept development (e.g., Graduate Engineering), where the idea generation stage was more focused on extending concepts or elaborating on undeveloped ideas that had been generated over multiple weeks, rather than the more ad hoc approach taken by the remainder of the teams, who were just beginning to formulate concepts for their class project. This is consistent with our prior work that would suggest that students want to exhaust their naturally-occurring ideas before making use of a tool.<sup>37</sup> In all, most dyads focused on solving problems within the framing of their initial concept, rather than thinking divergently about other conceptual strategies to solve the larger class project problem, possibly reducing the need for additional creativity support tools. Participants who started with a concept framing generally iterated within it, but with an apparently renewed interest in solving problems that served as barriers for users of that concept.

The properties that participants used for sorting their critical information appeared to generate conversation about concerns or issues inscribed in the original concept, and effectively encouraged concept development. While the data do not provide sufficient evidence to prescriptively guide the use of specific Design Heuristics, the use of the cards by these participants is suggestive of the potential value of categorization to steer students towards appropriate heuristics. This could take place through guided pairings of issues/concerns and cards that would be helpful in targeted ways.

#### Scaffolding Ideation Through Empathy

One of the core goals of the empathic walkthrough was to foster an empathic connection between the student and their designed solution. The participants in this study demonstrated varying levels of empathy, often hampered by lack of user research or first-hand knowledge of how their concept might be perceived in an "authentic" context of use. Even with the uneven levels of empathy exhibited, however, we noted multiple instances where participants demonstrated two qualities from Levensen and Ruef's<sup>9</sup> definition: *cognitive knowledge* about what the projected user was feeling, and in several cases, articulating the *feeling* itself. For instance, P6's foregrounding of flight attendant concerns about privacy or ambient temperature were couched in the experience of how it might be to feel that way as a flight attendant. This moves beyond a statement of the cognitive knowledge that an area may be publically visible, or not share the ambient temperature of the aircraft. No participants appeared to include the third quality—*responding*—in their user story or subsequent idea generation. They appeared to view any alterations to the concept to address critical information identified as improvements to the *product*, not to the lived experience of their projected user.

Overall, the participants' articulation of the user experience appeared to encourage a less technical reading of the concept (with some lapses from first person voice to a third person designer role) along with attention to more detailed qualities of use than might have been possible otherwise. Even without formal training on how to tell a "user story," all participants were able to tell credible stories that revealed some valuable insights about how product use might occur. The specific narrative approach was sometimes mixed due to lack of contextual details on which to base their narrative, or discomfort in sustaining a narrative on their own beyond the most general details of the user experience. In this way, the user stories also revealed how little the students knew about their target user, even though many had already completed their formal user research phase and were not planning further research. While this exploratory study was not embedded in the classroom, the empathic walkthrough method seemed to quickly raise participant misconceptions about the user, along with areas where insufficient information was available. In situated classroom use, an instructor could employ the empathic walkthrough as a priming agent to encourage further, targeted user research, alongside more sophisticated user experience journey maps or other methods.

#### **Limitations and Future Work**

There are several limitations of our work. The user story construction and content was limited by each designer's incoming knowledge of the target population or use characteristics, often informed by user research, so the breadth or range of user stories that a designer might be able to generate is limited by this frame of reference. The process of constructing a story, however, may also be explored as a tool to demonstrate—both to the student and an instructor—where more user research is needed to address queries or unexpected scenarios that come up. Uncovering these needs for external validation or more information are, arguably, just as valuable as "accurate" user stories that fully reflect the user population.

Because of the sensitivity to the construction of user stories, and the possible need for a more experienced other to intervene or ask probing questions to stimulate a richer story, initial scalability for this method is somewhat low, especially whenAs a first-time participant inwhen the empathetic walkthrough is being used for the first time; students may not used to position-taking on behalf of a user in an explicit way, or may need external encouragement or targeted questioning to draw attention to edge cases or specific scenarios that are not "desire paths." However, after students develop fluency, using this method may be much more scalable, without the need for a more experienced other to provide moderation. This is similar to other models of

contextual inquiry where insights are gained from research, mapped onto existing designs, and then used as insights for iteration.

The study also did not provide an opportunity for students to exhaust the ideas generated through the empathic walkthrough, thus, we were limited in our exploration of how the Design Heuristics could partner with the empathic walkthrough to help students increase the diversity of ideas generated for consideration. We did find that student referred to the cards when they confronted a challenge in developing their concepts, but the short time period limited whether or not and how many concept development challenges students faced during the study. Our future work will continue to explore how design methods combined with Design Heuristics can support more thorough explorations of design solution spaces.

Finally, this study was exploratory proof of efficacy in addressing the issue of foregrounding empathy and human-centered principles in the design process, verifying that the empathic walkthrough method provides generative insights in a range of project and disciplinary configurations. Future work will be required to address whether the iterative concepts that result from this method are actually more appropriate for the target user or use context than concepts created without such foregrounding of empathy, and how this method might evolve or change when applied more broadly in a classroom setting. Possible future research could examine the prerequisite abilities or tools (e.g., user research) that must be included for this method to generate valuable design insights.

#### Conclusion

In this paper, we present several case studies of students using a modified cognitive walkthrough method to expand their notion of situated use, and its impact on ideation using Design Heuristics. The results demonstrate that this combined method, the *empathic walkthrough*, may be useful for engineering contexts because it stimulates empathy from students for the context of use, and strengthens existing human-centered approaches. We propose that further adoption of the empathic walkthrough, especially in combination with formal user research and discussions of human-centered approaches to design, can stimulate empathetic qualities in developing engineers, leading to more appropriate and more successful designs. We also propose that Design Heuristics cards can allow for further exploration of the solution space. The initial response provoked by this method may facilitate an internal dialogue to solve problems that arise from empathic considerations, and then allow for a new, divergent ideation stage with the use of Design Heuristics.

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## **Appendix A: Cognitive Walkthrough Protocol**

Today, I'm going to walk you through a design method that will hopefully allow you to iterate on some of your existing concepts by walking through them from a user's perspective. We are still in the process of developing this activity, so feel free to reflect on what is and is not working during the activity. We can also talk in more detail after the activity has concluded.

The activity includes three main steps, and I'll walk you through each of them one at a time. The whole sequence should take around 20 minutes.

## Step One: Tell a User Story (5-10 Minutes)

Pick one of your concepts to share with your partner. Using a persona and some of the normal tasks a user would need to perform using the product you are designing, tell your partner how you would use the product you have envisioned in a narrative form. Step through the actions the user would need to perform throughout that task, taking into consideration that some tasks might include multiple steps over different points in times and/or locations. Make sure to tell the narrative from the perspective of your persona.

While one of you tells the narrative, I want the other person to take notes on these post-its that include issues or questions which arise. These could be parts of the design that are confusing or strange to you, that don't appear to work correctly, or otherwise seem inappropriate for the user.

Your narrative doesn't have to be incredibly long, but it should be credible—a narrative that gives your partner enough detail to understand how the product would be used by a specific user in a specific context.

#### Step Two: Sort Issues (5 Minutes)

We have come up with five different properties of issues, which are described on this sheet. Try sorting the issues or concerns you have documented into these properties together, using the whiteboard or whatever is most comfortable for both of you. Note that some of the properties deal more with the form and function of the artifact in isolation, while others are related to the use of the artifact in a specific context.

#### Step Three: Ideate (10 Minutes)

For each property you used to sort the issues, I have a set of three Design Heuristics cards that I would like you to use to ideate new or refined concepts. On each card, there is a prompt and description of how you might use that prompt in creating new concepts; on the back, there are examples of how that prompt could look in an actual product.

Using these concept sheets, I want you to go through one issue at a time, generating as many concepts as you can using the Design Heuristics cards in whatever way you wish to come up with refined or new ideas. Put each concept on each sheet, along with a brief description of the functionality, how it changed from the previous concept (if applicable), and the card(s) you used (if applicable). Feel free to use cards from other properties, if you find them helpful.