A Value Sensitive Action-Reflection Model: Evolving a Co-Design Space with Stakeholder and Designer Prompts

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ABSTRACT

We introduce a design method for evolving a co-design space to support stakeholders untrained in design. Specifically, the purpose of the method is to expand and shape a co-design space so that stakeholders, acting as designers, focus not only on the form and function of a tool being envisioned but also on the social context of its use and values that lie with individuals, groups, and societies. The method introduces value sensitive stakeholder prompts and designer prompts into a co-design process, creating a particular kind of reflection-on-action cycle. The prompts provide a means for bringing empirical data on values and theoretical perspective into the co-design process. We present the method in terms of a general model, the Value Sensitive Action-Reflection Model; place the model within discourse on co-design spaces; and illustrate the model with a discussion of its application in a lo-fi prototyping activity around safety for homeless young people. We conclude with reflections on the model and method.

Author Keywords

Co-design; creativity; design method; Envisioning Cards; homeless young people; mobile technologies; prototyping; reflection-on-action; safety; security; Value Sensitive Action-Reflection Model; value scenarios; value sensitive design

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous.

INTRODUCTION

Tools are not only about acting in the world – they also reflect back the conditions, perceived needs, and values of the people and societies who make, own, and use them. From this perspective, the form and function of tools can tell us a good deal about what is important to the tools' owners and users, including what they care about, what activities they wish to do, what problems they wish to solve, with whom they wish to communicate, with whom they wish to sustain friendship and build community, from whom they wish to remain hidden, and who or what they want to keep safe. As such, the form and function of tools provide a view onto people's values and the intersection of those values with technology.

Analyses grounded in existing tool use provide one such lens, albeit constrained by a range of pragmatic dimensions that include people's resources, infrastructure, and socio-political context. Consider the case of cookies and web browser security and privacy, a complex interaction design problem. A retrospective analysis between the years of 1995-1998 of early web browsers and their cookie settings shows substantial development of technical features to provide users with transparency about and control of cookie settings [15]. Such technical development in response to public outcry about privacy could give the impression that people were interested in managing cookies when they were being set. But such analyses of the deployed technical mechanisms would miss the possibility that what people really cared about was managing cookies at the time of use. That particular technical implementation would have required a major redesign of underlying web protocols.

To understand what is important to people in their lives, it is often helpful to complement analyses of what people do with existing tools with their visions for how tools *could be different*. Therein lies the design turn. By engaging with stakeholders around perceived needs and values in the co-design of yet-to-be-built tools researchers and designers are offered a window into the kind of relationship between technology and values that people and societies might wish to experience. Given this kind of value sensitive envisioning goal for co-design, how might researchers and designers construct a co-design space that would foreground consideration of human values?

In this paper we introduce a Value Sensitive Action-Reflection Model to support such value sensitive envisioning. The model builds from the work of Schön [22,23] and more recent work on co-design spaces [3,5,9,19,20,21], as well as from work in value sensitive design [11,12]. At the outset of this work, the goal was to advance our understanding for how mobile phones might help keep homeless young people safe in their communities. However, in the course of conducting that

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research, we encountered the need to extend existing co-design methodology. Accordingly, we take this opportunity to report on our methodological innovation. In this paper we strike a balance between introducing the Value Sensitive Action-Reflection Model, our key contribution, and reporting on our co-design study. The reporting of the co-design study helps us examine the model; at the same time, the model helps to provide rationale for the methodological choices made in the study.

BACKGROUND

Spaces for Co-design

Co-design, sometimes called co-creation, emerged in the late 1990s, building on the tradition of participatory design (PD) and user-centered design (UCD). The term co-design, in its broad sense, refers to any act of joint creativity in which designers, end-users untrained in design, and perhaps other stakeholders work together in design processes [21]. Over the past decade co-design has been widely accepted as a valid user study methodology in the fields of product design, service design, interaction design and HCI [16].

More recently, Sanders and colleagues have theorized the concept of *co-design spaces* [19]. In brief, their work foregrounds the importance of scaffolding the co-design space in order to improve the creativity of stakeholders who are less experienced in design. Ideally this scaffolding – that is the materials, structure, and activities of the co-design space – should encourage stakeholders to explore many possible solutions, feel confident to put forward ideas, and eagerly aim for new, creative ideas. Furthermore, Sanders et al. show how common methods – Futures Workshops and design tools for creative exploration – can be understood as co-design spaces [20,21].

We see an important connection between Sanders et al.'s conception of co-design spaces and Schön's foundational analysis of design [22,23]. Here, two points are particularly germane. First, in addition to exploring design as a conversation with materials, as a form of reflection-*in*-action, Schön emphasizes the importance of reflection-*on*-action. He shows how focused comments by teachers can prompt students of architecture to pause and reflect on the current state of a design and then take new action. Accordingly, we ask: how might researchers or designers prompt stakeholders to reflect on action without undermining exploration and creative thinking? Second, Schön also emphasizes that the designer engages in different kinds of "seeing," that is, the designer makes appreciations related to different kinds of object domains (e.g., cost, form, structure, etc.). Accordingly, we ask: how might stakeholders participating in a co-design process be prompted to consider object domains of particular salience to a design project? In the present study the object domain concerns the aspects of society and values along with features of mobile phones; hence, we turn to value sensitive design to address in part both questions.

Value Sensitive Design

In the 1990s value sensitive design emerged with the aim to offer a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process [11]. In the design research reported here, we bring two methods developed within value sensitive design into a space of co-design, prompting stakeholders to reflect on the technical and value aspects of their design ideas.

Value Scenarios. Value scenarios, an extension to traditional use and problem scenarios [6], consist of stories that emphasize the social and value considerations of new technologies, especially long-term and potentially negative impacts [17]. In prior work value scenarios have been written by designers for use as an analytic tool to explore values related to good parenting and mobile applications for monitoring teenagers [8]; in other work value scenarios have been written by stakeholders and thereby used as an empirical tool to elicit safety-oriented stories about mobile phone use for homeless young people [24].

Envisioning Cards. The Envisioning Cards [10,12] consist of a deck of 28 themed cards that are intended to raise awareness of long-term and systemic effects of proposed technologies. Each card presents a title and an evocative image related to one of four envisioning criteria – stakeholders, time, values, and pervasiveness [17]. On the flip side, the card offers a theme describing that card's key concept and a focused design activity related to the theme. The cards are intended to be used for various design processes: ideation, co-design, heuristic evaluation, critique, and more. Prior use includes ideation and goal setting with health enterprise systems in Eastern Africa, heuristic value analysis of security in cloud computing, and surfacing value tensions in persuasive profiling [10].

Socio-technical Context: Homelessness, Youth, Safety

As part of a larger movement with the HCI community to engage a more diverse community of users [2], recently studies have examined the use and design of technology by homeless people [14,18], including homeless adults in urban settings who were found to use mobile phones to tap into social networks for basic needs and homeless mothers living in an emergency shelter who were found to benefit from information sharing on public displays.

The socio-technical context for this work entails that of homeless young people, mobile technologies, and safety. In the United States, at any given time during the year it is estimated that 3 million people are both young, up to the age of 30, and homeless [26]. Extensive research reveals that homeless young people are a heterogeneous mix of ages, genders, races and ethnicities [26]. Life can be very difficult when a good deal of time is spent securing basic needs, such as safety, food, and shelter, often while managing physical and mental health problems. At the same time, despite the extraordinary conditions of living on the streets, homeless young people seek ordinary

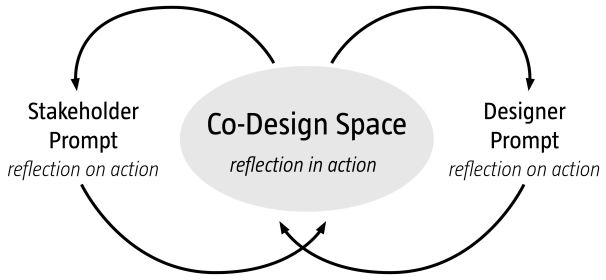

Figure 1. Value Sensitive Action-Reflection Model.

experiences with technology such as music players, social network sites, and mobile phones [25].

SPACES FOR CO-DESIGN: A VALUE SENSITIVE ACTION-REFLECTION MODEL

To bring forward values in what can be an essentially technology-centric co-design process, we developed a Value Sensitive Action-Reflection Model. The model draws in spirit on Schön's attention to reflection-on-action and extends the work of Sanders and colleagues on the construction of co-design spaces.

While co-design can be approached in many ways, co-design spaces at their core typically include creative toolkits (e.g., maketools [20]), designed assignments (e.g., design games [5]), and in-situ ideation and communication among stakeholders to co-create solutions. Traditionally, although co-design has focused on end-user needs and desires, less emphasis has been placed on values and societal concerns.

To the traditional co-design core, the model presented here blends methods from value sensitive design to structure engagement with consideration of values. Specifically as shown in Figure 1, the model begins with the familiar core materials and activities of a co-design space that afford somewhat free-form design in response to an initial design challenge. With initial design ideas in hand, and herein lies the model's innovation, we add two types of structured interventions. One type, known as a *stakeholder prompt*, entails material that by and large originates with the stakeholders and provides a good deal of direct access to stakeholder perspectives. A variety of materials can function as stakeholder prompts such as stakeholder generated value scenarios [17], value sketches [24], or responses to cultural probes [13]. The second type of intervention, known as *a designer prompt*, entails materials that originate largely from a designer or researcher perspective. Similarly, a variety of designer generated materials can function as designer prompts such as Envisioning Cards [12], personas [7] or pastiche scenarios [4]. The model is meant to be fairly general; in its current form, these two types of interventions can be invoked multiple times and used in any order including the use of only stakeholder or only designer prompts. The novelty of our approach is not in the prompts per se but in the constellation of (1) the combination of both stakeholder-led as well as designer-led prompts; and (2) a lens on human values.

METHODS

Researcher Stance

The present research is part of a long-term engagement with a community of homeless young people in Seattle, Washington in which value sensitive design theory and method has been applied in a number of research and design projects. Collectively, the authors have substantial experience working with this community – as volunteer instructors in educational programs, as consultants on IT projects with our principle collaborating organization, and as researchers – and substantial methodological experience with co-design, value scenarios, and the Envisioning Cards.

Participants

Between June-August 2011, sixteen participants worked in pairs, yielding eight co-design groups, six with homeless young people (8 men, 4 women; ages 19-27, M=23), one with police officers (1 man, 1 woman; ages 39, M=39), and one with service providers (2 women; ages 30 and 51, M=41). To create a comfortable co-design environment, separate sessions were held for each of the three population types. All study participants were offered $25.00 gift cards.

Procedures

Participants were oriented to the study and the co-design materials were introduced. These materials included broken-off pieces of cell phones (e.g., screens, keyboards, casings) and craft materials (e.g., cardboard, colored paper, glue, tape, colored modeling clay). Additionally, we included a 11×17 inch spec. sheet that provided a 9×9 inch space for sketching a mobile phone, and prompted participants to name their prototype phone, to list its key functions and features, to specify its look and feel (e.g., color, cost, battery life), and to answer three design questions (e.g., How might the features of the phone help to keep a homeless youth or young adult safe?). Participants were encouraged to be forward looking and assume any idea could be pursued in the co-design process.

Once these materials were introduced, participants were given the following instruction:

> *Homeless youth and young adults may face special challenges in keeping safe from harm. Please make a prototype of a cell phone that might help keep a homeless youth or young adult safe. There are no right answers.*

In the first of three stages, participants were instructed to complete their spec. sheet and develop an initial prototype.

In the second stage, with their initial prototypes in hand and applying the Value Sensitive Action-Reflection Model (see Figure 2), participants were prompted to iterate the design twice, first with a stakeholder prompt and then with a designer prompt. Each of the prompts was intended to promote a cycle of reflection-on-action that expanded the co-design space from the designed artifact to the broader socio-technical context of use.

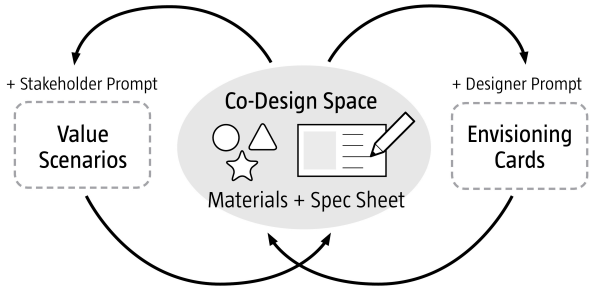

Figure 2. Model applied in the mobile phone study.

Stakeholder Prompt – The Value Scenario

Prior work had elicited 19 value scenarios from homeless young people about how they might use mobile phones to keep safe [24]. A sample of 11 scenarios was selected by the researchers and repurposed on cards as stakeholder prompts. The scenario cards convey situations where safety is at stake, how mobile phones can be used to keep safe, and specific features of mobile phones. For example:

> *Once upon a time a young man went down the alley, he noticed five guys following him, he immediately calls his cousin who lived in a building along the same alley. The upper light turns on and the said cousin appears and calls out, in turn the five guys walk away.*

Participants were instructed to select one value scenario card and to consider their prototypes in light of the situation described in the scenario (see Results for text of participant selected scenarios). Then, they completed a second spec. sheet to record any changes that they would make to their prototypes or to explain why no changes were needed.

Designer Prompt – The Envisioning Card

For the second prompt, participants selected an Envisioning Card from a set of six preselected cards. The six cards were selected by the researchers from the full set of 28 themed cards [12] for their relevance to mobility and sharing. The six cards were: CHANGING HANDS, CONSIDER CHILDREN, CROSSING NATIONAL BOUNDARIES, ONE PERSON MULTIPLE ROLES, SUSTAINED FRIENDSHIPS, and VALUE TENSIONS. As one illustrative example, the CHANGING HANDS card has the following prompt (theme and design activity):

> *A single product can change hands once, twice, or more times during its lifecycle. It may be passed among family members (e.g., coming of age gift) or across town (e.g., consignment). How might use of the system change as the technology changes hands?*
>
> *Design a scenario of your product changing hands. Imagine a specific challenge an individual might face when wanting to shift ownership. What features might make this process smoother?*

Similar to the stakeholder prompt, participants were instructed to complete a third spec. sheet to record any changes or explanations for why changes were not needed.

In the third and final stage, participants gave 3-5 minute demonstrations of their prototypes in use.

The co-design sessions varied in length from 88-168 minutes (M=114 min.). Audio recordings were made of each session and photographs were periodically taken. At the end of each session, the research team collected the physical prototypes and the three spec. sheets.

RESULTS

Participants' co-design ideas were reflected through a diversity of representations including physical prototypes, sketches, textual information written on the spec. sheets, and oral exposition of their designs and design changes that accompanied a demonstration of their devices. Because in this paper we are concerned primarily with the effect of the value sensitive prompts on shaping the co-design space, our reporting and analysis of results will emphasize the changes (if any) that were stimulated by those prompts. That said, participants produced a wide range of rich, creative designs in response to the initial design challenge that, in turn, served as the starting point for the structured design prompts. Thus we first present some results from the overall designs to provide a context for applying the design prompts before turning to examine the specific effects of those prompts. We save a more complete reporting of the co-design outcomes for another paper.

Recall, too, that we did not set out to develop or assess a new model for shaping a co-design space. Rather the model came about as we sought to explore ways to scaffold stakeholders' engagement with safety for homeless young people and other relevant values when envisioning new designs for mobile technology.

Overall Designs

The presentation of our data for the overall designs borrows in concept and form from Agee's and Evans's seminal work *Let Us Now Praise Famous Men* [1]. In reporting their work, Agee and Evans first present an uncaptioned series of striking black and white photographs that record three tenant families in the deep south of the United States during the 1930s and their physical surroundings; followed by words recording, again, people and place, and this time stories of interactions. The prologue of uncaptioned images throws the reader into the visual context of the research with minimal interpretation; the words follow as one way in to understanding those images and their implications.

In a similar vein, to allow the reader to form his or her own impressions of the data, we selected four of the eight designs (three by groups of homeless young people and the fourth by police officers). Photographs of the physical prototypes and sketches of the participants' devices are shown on the next page (Figures 3-6). Building on the gallery of photographs, we next provide holistic written accounts that explain these four devices in terms of what participants chose to recount about them. With this reporting style, we seek to position readers to form their own impressions of the data prior to presenting brief analyses of all eight designs and our interpretation as researchers.

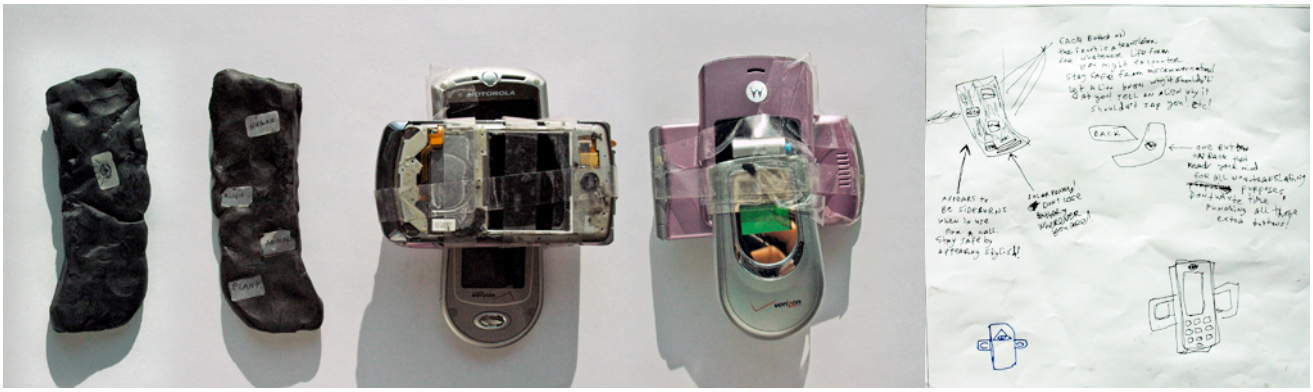

Figure 3. Brittany Futureproof (Homeless Young People).

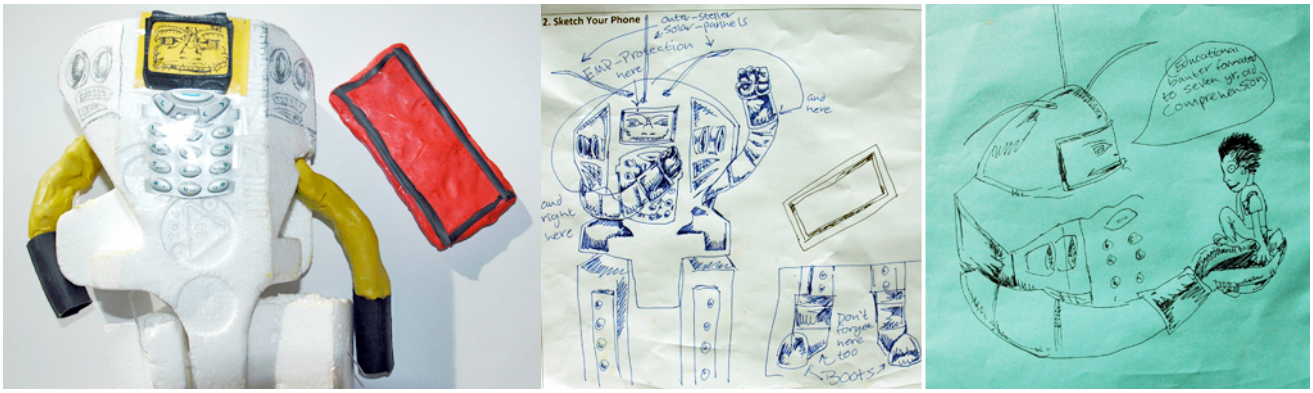

Figure 4. Failed Delusions (Homeless Young People).

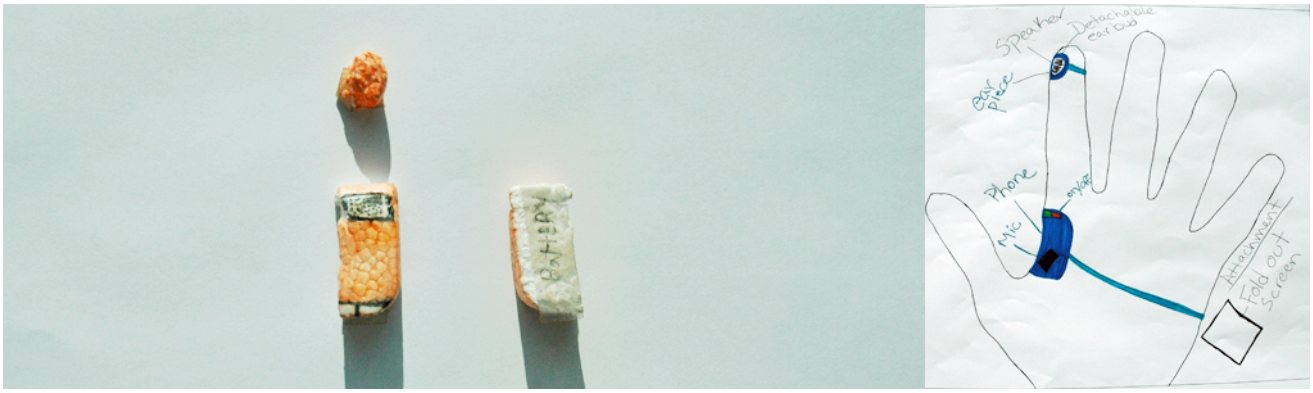

Figure 5. Hassle Free (Homeless Young People).

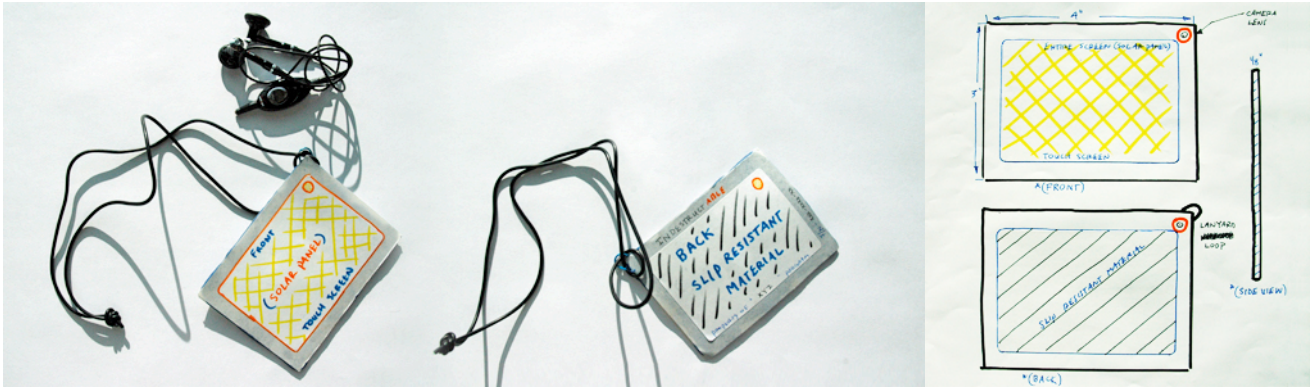

Figure 6. INDESTRUCTABLE (Police Officers).

Holistic Written Accounts of Four Designs

We now present brief holistic written accounts of these four designs, staying close to the language participants used on their spec. sheets and to describe their designs in the audio recordings. These accounts come from an in-depth process of considering each prototype. Specifically, we carefully inspected the spec. sheets, sketches, prototypes and photographs of the prototyping process and listened to the audio recordings of each co-design session. The researchers repeatedly discussed these. Then, iteratively and synthetically, narratives were written, reviewed, and edited for concise reporting. As appropriate, we include fairly lengthy verbatim quotations from the participants.

Brittany Futureproof (Homeless Young People, Figure 3). Brittany Futureproof comes with a swivel screen and a set of advanced technology such as telepathy and alien-plants-animal translation:

> There is actually near infinity number of buttons [on the front] you press the buttons for whatever species of life form you might encounter…. It just translates between you two so that if there's any conflict, you know, say you meet an alien and it's about to zap you and you just press the alien button and then it translates. [It] just mediates.

Beside this important communication feature that helps to mediate social interactions, Brittany Futureproof includes several other safety features. One is a button on the back of the phone that when pressed can read someone's mind in order to give the user an indication of whether she is in danger. This mind-reading function allows for a quick assessment of the situation (no wasting time with translations and pushing several buttons). Another safety feature is making the phone look like "stylish" side-burns:

> It's in the shape of the sideburns. So, if you're using it, it'll blend in.

Failed Delusions (Homeless Young People, Figure 4). This robot can fly to the location of a phone call and has built-in EMP (electro-magnetic pulse) disruption protectors. Among its features:

> It warns of impending law enforcement in the areas and lists the officers' possible offenses. There is also a snitch radar, too, on it. Just in case anybody that works for the police officer, they are immediately, you know their information is immediately broadcasted to everybody in the neighborhood.

Failed Delusions can also "extrapolate" air molecules and reconstruct them into food. It uses solar panels to provide energy and therefore, offers indefinite talk and stand-by times. The phone can easily be shared with other homeless youth, although it is closely tied to its owner:

> It takes a sample of your DNA as well as having a scent detector. So, you can control it pretty much by what you say, because it only has recognition towards you [and] it recognizes other people as being a friend if you consider them to be a friend. It can't get lost, 'cause it's a giant robot. It will find you and fly back to you.… You have like a symbiotic relationship to it to a certain degree.

Hassle Free (Homeless Young People, Figure 5). Hassle Free is a new type of phone that is hands-free and wearable made out of light materials. It is strapped to the user's hand and consists of three components: (1) the basic phone component located between the thumb and index finger including an on/off switch and a microphone; (2) the smaller ear piece attached to the tip of the index finger including a speaker and detachable ear bud; and (3) a fold out screen that can be attached to the outside of the user's hand. Hassle Free will keep its homeless user safe as:

> You don't have to dig into your pocket if you have to dial 911…. Or there might be like a system like if you were to fall it would register that you hit the ground or impacted it or maybe someone pushed you down, you got hit by a car or whatever. As soon as the impact is registered it asks you 'Are you okay?' If you don't respond or if you respond 'No, I'm not ok' some sort of help would be brought your way immediately.

INDESTRUCTABLE (Police Officers, Figure 6). This phone is lightweight, waterproof, and durable, with such safety features as theft prevention, quick access to 911, and built-in camera for making connections with service providers. Input is handled via the touchscreen or voice recognition and it comes with headphones. Worn on the body, the phone is a tool for reaching out to others:

> It's pliable. I can stick it to my shoes, you know, or around your ankle or something on your shoe if I were to go around running. The counselor version 101 is gonna have the camera and, you know, whatever, so next time you come into [a clinic] and you set [the phone] on the charger it's going to automatically update your apps or, give you the new phone numbers to all the shelters or give you the new whatever.

Characterizations of the Eight Mobile Phone Designs

To complement the more impressionistic treatment of the photographs and written accounts above, we next provide some analytic detail on all eight mobile phone designs. We conducted an in-depth examination of the technical features that participants chose to represent in their sketches and prototypes. We also attended to the overall structure of the representation and the form of the mobile phone.

As shown in Table 1, technical features included many familiar ones such as screen type or camera; as well as more unusual ones such as energy sources (e.g., solar and lunar), emergency functions (e.g., rape whistle, taser), and enhanced communication (e.g., real-time translation). In terms of overall representational structure, some participants embedded their technical solutions in a narrative or storyline (e.g., the Failed Delusions group situated their robotic phone in a sense of place and personal relationship with the homeless young person) while others represented their design solutions through technical features only (e.g., the Hassle Free group provided only technical details for their hands-only phone). In terms of the form of the mobile phone, many were used including typical flip and bar phones (e.g., Brittany Futureproof) as well as robots (e.g., Failed Delusions) and wearables (e.g., Hassle Free).

1. Screen Type (e.g., touch, display, foldout)	13. Buttons
2. Camera	13.1. Lock / Unlock
3. Audio (e.g., ear buds, remote control, mic)	13.2. On / Off
4. Accessory (e.g., bracelet, phone cover)	13.3. Send / End
5. Energy Source (e.g., battery, solar panel, lunar panel, universal charger)	13.4. Ring of Arrow Keys
6. LED	13.5. Keypads
7. Can Opener	13.6. Talk
8. Emergency (e.g., rape whistle, pepper spray)	13.7. Enhanced Communication (e.g., mind-reading, real-time translation)
9. Robot	13.8. Calendar
10. Slip Resistant Pad	13.9. Contact List (e.g., key service providers, friends)
11. EMP Protection	13.10. Transportation (e.g., vehicle, map)
12. Product Identifier	13.11. Other services
	13.12. Unspecified

Table 1. Coding categories for technical features.

The Effects of the Prompts

We now turn to a methodological view of the data. Recall the model presented in Figure 2 in which reflection-on-action was prompted with stakeholder prompts (i.e., value scenarios) and designer prompts (i.e., Envisioning Cards). These prompts, in short, were intended to trigger the generation of new ideas related to mobile phones and the socio-technical context of safety, youth, and homelessness. To examine the impact of the stakeholder and designer prompts, we analyzed each group's spec. sheets and prototypes before and after each prompt was administered.

As shown in Table 2, the prompts led to the addition of 21 new features in total. Participants chose to represent their changes on the spec. sheets and on the sketches; no changes were made to the physical prototypes. Notably, the majority of new features arose from the design work of the police officers and service providers, and fewer from the design work of the homeless young people (on average 6.5 and 1.3 new features, respectively).

A qualitative analysis of the impact of the prompts shows by and large a coherent relationship between the prompt's content and the proposed change. Moreover, when participants offered no changes in response to the prompts, they typically provided reasonable explanations for why their current designs sufficed. In the material that follows we report in detail on both types of prompts.

Stakeholder Prompt: Value Scenarios

Recall that the value scenarios were generated by other homeless young people in prior research. Across the eight co-design groups, seven unique scenarios were selected, with the service providers choosing two scenarios and one group of homeless young people declining to use a prompt.

The INDESTRUCTABLE (police officer) group selected this scenario:

> *I think it would be useful if you get hurt at night time or need to go to the Hospital and yeah or it could be useful for contacting friends and family. yup!!*

Mobile Phone	Value Scenarios	Envisioning Cards	Total
Hortical	2	1	3
Failed Delusions	1	1	2
Brittany Futureproof	1	1	2
Hassle Free	--	1	1
BOB	0	0	0
The Motorola Stupid Martian	0	0	0
INDESTRUCTABLE (Police Officers)	4	4	8
Squatters Phone (Serv. Providers)	3	2	5
Total	**11**	**10**	**21**

Table 2. Number of new features by prompt.

In response to the scenario, they added several new features: "Touch activated power-up feature;" "Panic button activation;" "Resources icon;" and "Dial-A-Icon (which sets up a speed dial to contact resources for help)."

The Squatters Phone (service provider) group selected two value scenarios:

> *I don't think cell phones keep people safe because if you call the cops for seeing a crime you might get beat up later for snitching.*
>
> *I would use devices in my cell phone to record law enforcement, when they choose to harass me.*

In response to the first value scenario they added: "untraceable way to report crime," and "contacting specific cop who's known to be safe." For the second, they added: "a built-in contact to report complaints/anti-harassment."

Turning to the homeless young people, the Brittany Futureproof (BF) group selected this scenario:

> *I was lost in the mountains, with no means of any gear all I had was my Phone which was used to call for an evacuation.*

In response to the scenario, the group proposed an innovative energy source, lunar panels, in addition to the solar panels in their initial design. Interestingly, the participants did not admit to the change at first; rather, they presented the new feature as if it was part of their initial design. Later they said that the lunar panels were actually a change made in response to the prompt:

> BF: If you're in the mountains, um, there is no outlets to plug your phone to charge it…and our phone has solar panels so uh, it would just, we also have the lunar panels actually. We forgot to tell you. [It] charges off the moonlight, too.
>
> Facilitator: So you, what changes did you decide to make that you wrote on your spec. sheet?
>
> BF: Actually, we uh, we didn't forget to tell you about the lunar panels. That was the change we made.
>
> Facilitator: So you've added…lunar panels to the phone?

The Hortical group selected this scenario:

> *Once upon a time there was three little Pigs, One lived in a house, one lived on the streets, and the last one lived in a squat. One day a big bad wolf was looking for squatter, the big bad wolf was out to get all little pigs. The first little pig called the second pig, and he found the third pig through word of mouth. Thank cell phone.*

In response to the value scenario, the new sketch depicted a wolf and three pigs, the phone's pepper spray was changed to wolf mace, and the beacon "beep" to a "pig squeak."

The Failed Delusions group selected this scenario:

> *I would use devices in my cell phone to record law enforcement, when they choose to harass me.*

Instead of changing the phone functions and features, this group responded with a policy, namely that persons in any form of military or law enforcement role would be prohibited from purchasing their device.

The BOB and the Motorola Stupid Martian groups each selected a value scenario and did not make any changes. Instead of exploring new ideas, both groups used their value scenario as an evaluation tool to highlight key features and functions of their initial designs.

The BOB group selected this scenario:

> *I feel when hitching rides, with a cell phone you can be kept safe. If you're walking down the road with your thumb out and a cell phone to your ear a "weirdo" is less likely to pick you up.*

Not making any changes, the BOB group wrote on their spec. sheet: "Our phone turns into a house-boat-car so hitching is pointless. And we're cool."

The Motorola Stupid Martian group selected this scenario:

> *Keep in touch with friends and family and take pic's for the party when ppl getting mess up.*

On their spec. sheet they wrote: "[Our] phone has two cameras and can download apps without WIFI."

The Hassle Free group declined to select a value scenario, giving the following explanation that surfaces critical aspects of the social conditions for and fundamental concerns of homeless young people:

> Simplicity is the best. It keeps everything cost effective. That way I can actually have this phone, not just be talking about it or hearing about it … You start adding things to phones it starts to cost you and you start to pay for more services, and you don't have it. If it's still cheap everybody can have one. Everybody can be safe. It's all about price. If you price something too expensive, we can't be safe because we won't have any offers of this.

Designer Prompt: Envisioning Cards

Having completed one iteration in response to a stakeholder prompt, participants were instructed to select an Envisioning Card from a set of six and to iterate again. Across all groups, four cards were chosen. We now briefly summarize responses to the cards.

The Squatters Phone (service provider) group selected the SUSTAINED FRIENDSHIP card. While the theme addresses the issue of a technology effecting people's friendships and family relationships, this group generated new ideas around ways to strengthen relations between homeless young people and the service providers. They added a contacts back-up system "so [that] the service providers can always be contacted." Additionally, they suggested an optional rollover program for the "funders/friends" to help homeless young people by donating extra minutes.

The INDESTRUCTABLE (police officer) group selected the CROSSING NATIONAL BOUNDARIES card. While other groups focused on their card's theme, this group focused on the design activity:

> *Choose three countries across the globe and envision challenges for your system if it was deployed in each of those countries. Label any common concerns across the identified challenges.*

For this design activity, they considered the use of their phone in three countries (India, Finland and Mexico) and added four features reflecting diverse socio-technical aspects including cultural dress code, appropriate size of the phone, charging methods, and software modifications.

Turning again to the homeless young people, the Hortical group selected the CHANGING HANDS card. The theme addresses the issue of a technology changing owners during the device's life cycle. Shifting the intent of the card, this group considered short-term borrowing and added a pin-code to their phone to protect it from unauthorized use.

The Brittany Futureproof group also selected the CHANGING HANDS card. Moreover, they also used this card to consider short-term borrowing, adding a button to deactivate the mind-reading function when sharing.

The Failed Delusions group chose the CONSIDER CHILDREN card. In response to the prompt, they considered how their robot phone would interact with children and decided to add an educational program to their design. In order to illustrate their upgrade they created a new sketch on the spec. sheet, showing a child in the robot's hand, reflecting how the robot would talk to a seven-year old.

The Hassle Free group selected the CROSSING NATIONAL BOUNDARIES card and decided to add linguistic software to their phone to help with translation to other languages. Note that the group had declined to select a Stakeholder prompt.

The same two groups – BOB and The Motorola Stupid Martian – did not make any changes to their designs. As with the Stakeholder prompt, they used the designer prompt as an evaluation tool in order to highlight the phone's existing functionality. The BOB group selected the CHANGING HANDS card and determined no changes were needed. They wrote on the spec. sheet that the phone is DNA sensitive and the phone is free so "get your own one" instead of sharing. The Motorola Stupid Martian group selected the SUSTAINED FRIENDSHIP card and wrote on their spec. sheet: "We have all the equipment to keep in contact with friends and family."

DISCUSSION

Co-design Spaces: Engaged Stakeholders and Meaning

The issue of engagement is important and complex. Of many meaningful forms of assessment, counting the

number of new features is one; another is characterizing the complexity and nuance of storytelling related to the artifacts. In terms of the sheer number of new features, Table 2 shows that the police officers and service providers can be seen as more engaged than the young people. At the same time, in terms of complexity and nuance of story, homeless young people can be seen to be quite engaged; for example, assessing arguments for not including new features, expressive depth of the sketches, and so on. Consider the prototypes and accompanying narratives holistically. While sometimes fantastical, they reveal a certain pragmatic intelligence and a good deal of creativity. Furthermore, the co-design activity brought forward vital needs, including, for example, the need to be heard and understood, the need to monitor the environment, the need to dispatch information through social networks, and the need for food, transportation, education, and safety.

We believe, on balance, that the co-design method was engaging because it enabled homeless young people to express intimate concerns about their lives in a relatively playful and comfortable manner. Moreover, speculating, the fantastical aspects of the prototypes may have provided a degree of "distance" between the person and the entrenched issues of homelessness, related to basic needs, human dignity, and social justice. Accordingly, it may be the case that our method – with its creative and reflective aspects – is particularly well suited to surfacing the needs and values of participants in intimate or vulnerable situations.

Reflections on Our Use of the Model

We now consider in greater detail how the stakeholder and designer prompts functioned in the co-design space. One question is: in what ways did the prompts expand the co-design space? First, the model prompted participants to generate new ideas. The use of the prompts not only resulted in an increased number of ideas (see Table 2) but, more importantly, it led to divergent thinking. The prompts drew attention to the particular socio-technical setting of use (i.e., value scenarios) and more generally the social and contextual issues that are easily overlooked (i.e., Envisioning Cards). In addition to generating technical possibilities – form and function – participants explored various problem solving strategies such as service design (e.g., rollover minutes by the Squatters Phone) and policy making (e.g., sales restrictions by the Failed Delusions).

Furthermore, the model expanded the co-design space by prompting participants to evaluate and elaborate their initial ideas. In several cases where no changes were made, the selection and interpretation of the prompt provided a clue for understanding participants' perspectives. Using the prompt, participants constructed rationales for their initial design choices and reaffirmed the most critical values and concerns. Evaluation sometimes led to elaboration of underdeveloped ideas. For example, the BOB group evaluated its DNA sensitive feature in response to the CHANGING HANDS card and elaborated on the obsolescence procedure of a person's biological record: "[when the phone becomes obsolete] it goes back to the factory, melted-down and gets made into a new one."

A second, related question is: how, if at all, did participants appropriate and employ the prompts? Both the value scenarios and envisioning cards proved flexible and suggestive; participants were able to derive meanings from the prompts that were applicable to their participation situations. For example, rather than following what is inscribed, the service providers selected the SUSTAINED FRIENDSHIP card and applied it to the relationship between themselves, homeless young people, and funders. Showing the multiple uses, the Envisioning Cards in particular provoked variety of access. Many participants focused on the theme, while the INDESTRUCTABLE group engaged the design activity, and the Motorola Stupid Martians group focused on the image and the title only: "I totally didn't read the back of that card." In all cases, the prompts allowed interpretive flexibility and multiple uses to evoke relevant concerns from across multiple stakeholders with diverse backgrounds and experiences.

Open Questions

As with the first use of any new method, there are limitations and open questions. Our case is no exception. In particular, the Value Sensitive Action-Reflection Model presented here has only been used once and only with value scenarios and Envisioning Cards for stakeholder and designer prompts respectively.

To begin discussion of the model we raise four open questions and offer some initial responses: (1) *What purposes can the Value Sensitive Action-Reflection Model serve?* Our short answer: many. Depending on the context and co-design goals, the model could be used to stimulate values assessment, envision futures, move toward realizable designs, as well as other aims; (2) *How do you generate effective stakeholder prompts?* Field data collected from stakeholders about their concerns and perspectives can be a rich source for stakeholder prompts. These data can take the form of stakeholder generated scenarios (as in the case reported here), concept maps, anticipated barriers to use from Futures Workshops, metaphors for system design, and so forth; (3) *How do you generate effective designer prompts*? Best practices, design toolkits, and representations from practicing designers and design researchers can provide innovative material for designer prompts. To be effective with individuals untrained in design, the material will likely need to be packaged in a simple format with straightforward directions for use; and (4) *What data should you collect from the co-design activities and for what purposes?* Recall that the stakeholder and designer prompts are structured interventions to elicit perspectives on value and societal concerns. Collecting data to assess change (before and after use) in response to the prompts provides one systematic type of evidence. Of course, there can be a wide variety of

data sources including but not limited to drawings, physical prototypes, use cases, stories, and other representations; and how to characterize change across such a wide range of representations can be challenging.

These four questions merely begin the conversation about how to employ, elaborate, and assess meaningful use of the Value Sensitive Action-Reflection Model.

CONCLUSION

In order to position stakeholders to articulate visions of yet-to-be-built tools and to explore how possible tools relate to the values of individuals, groups, and societies we have sought to develop an appropriate method. On reflection, we recognized that the method we developed for one particular study could be generalized and we have sought to do so through the Value Sensitive Action-Reflection Model.

The data and analyses reported in this paper have shown how imagined tools – by their form, function, and narrative – reflect back on the values and needs of their designers; and, how stakeholder and designer prompts can be used to evolve a co-design space. In addition, we have placed our particular method and general model in the ongoing discourse on how designers and researchers might structure and expand spaces for co-design [3,9,16,19]. The model and methodological detail reported in this paper clarify one particular point of view on co-design. We hope that readers will borrow and appropriate and, in turn, report on their methodological innovations.

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