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A Survey of Value Sensitive Design Methods

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To Nan and to Jeff
To Karen
To Charline and Marion

Contents

Abstract

Value sensitive design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and systematic manner throughout the design process. In this article we provide a survey of 14 value sensitive design methods: (1) direct and indirect stakeholder analysis; (2) value source analysis; (3) co-evolution of technology and social structure; (4) value scenario; (5) value sketch; (6) value-oriented semi- structured interview; (7) scalable information dimensions; (8) value-oriented coding manual; (9) value-oriented mock-up, prototype, or field deployment; (10) ethnographically informed inquiry regarding values and technology; (11) model of informed consent online; (12) value dams and flows; (13) value sensitive action-reflection model; and (14) Envisioning Cards ™. Each of these methods is honed to the investigation of values in technology, serving such purposes as stakeholder identification and legitimation, value representation and elicitation, and values analysis. While presented individually, the methods are intended to be integrated in a robust value sensitive design process. The survey article begins with a brief summary of value sensitive design methodology and theoretical constructs. We next provide an overview of the 14 methods. Then, we turn to a broader discussion of value sensitive design practice, focussing on some methodological strategies and heuristics to support skillful value sensitive design practice. Following the broad discussion of practice, we illustrate one method in action—value scenarios—providing details on its range of purposes and contexts. We conclude with reflections on core characteristics of value sensitive design methodology, and heuristics for innovation.

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1

Introduction

Value sensitive design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and systematic manner throughout the design process (Friedman et al., 2006a; Davis and Nathan, 2014). Under development since the mid 1990s, value sensitive design has been applied to a wide range of projects, including browser privacy and informed consent, implantable medical devices, and information systems for transitional justice. Throughout, methods for research and design have been developed. Often, familiar methods from the social sciences, human-computer interaction, security, and other disciplines have been adopted or adapted; at other times, new methods have been invented. While a substantial value sensitive design literature exists, no survey of these methods has yet been written. This article seeks to fill a portion of this gap by bringing together a collection of 14 value sensitive design methods, along with strategies and heuristics for skillful practice.

The core concern of value sensitive design is to address human values in the technical design process. Given this point of view, designers, researchers and engineers are likely to face questions of these kinds:

How can I explore the technical and policy design space from the perspective of human values? How can I identify stakeholders and legitimate this choice? How do I elicit stakeholder views and values? How do I resolve value tensions among stakeholders? How do I translate stakeholder values into technical design decisions?

Over the years a number of other approaches that are oriented to similar concerns have been developed (Davis and Nathan, 2014; Snyder et al., 2016; Huldtgren, 2015), including Values in Design (Nissenbaum, 2001), Values for Design (van den Hoven et al., 2015), and Worth-Centred Design (Cockton, 2009). According to van den Hoven (2015), these approaches and value sensitive design share at least four key claims: values can be expressed and embedded in technology, technologies have real and sometimes non-obvious impacts on those who are directly and indirectly affected, explicit thinking about the values that are imparted in technical design is morally significant, and value considerations should be surfaced early in the technical design process. Across a broad range of values, stakeholders, and technologies, value sensitive design is arguably the most widely used and extensively explored of these approaches.

One of the key contributions of value sensitive design is the identification and development of a set of targeted methods for engaging values in the context of technology. Over the past twenty years, a wide variety of methods have been used in the service of value sensitive design. A good many of these have come from the social sciences, including anthropology, sociology, and moral and social psychology (e.g., semi-structured interviews); and from design approaches such as participatory design (e.g., Future Workshops). Despite the strength of methods from these established fields, on occasion value sensitive design researchers found themselves facing a design challenge without a clear path for going forward. In those instances, the general strategy was to adapt existing methods when possible, or when needed to invent new methods that were particularly suited to engaging values in the technical context. The 14 methods surveyed in this article fit in this category.

1.1 On Method and Practice

The *Oxford English Dictionary* [2011] defines "method" as follows:

> *Method (n).* A special form of procedure or characteristic set of procedures employed (more or less systematically) in an intellectual discipline or field of study as a mode of investigation and inquiry, or of teaching and exposition.

This definition foregrounds several qualities of method in value sensitive design. First, value sensitive design methods in their descriptive forms provide guidance on how to engage in a particular kind of research or design inquiry. Thus, methods help designers focus their attention on critical elements of the design situation, positioning designers to obtain design insights. In their descriptive forms, methods and their outcomes can be scrutinized and compared with other methods. But methods also unfold as human activity. As such, the execution of a method may correspond more or less closely to its descriptive form. Thus, the use of a method always involves a kind of skillful performance that is learned. An expert will likely use a method differently than a novice.

A second quality of value sensitive design methods is that they are informed by the theoretical constructs of value sensitive design. Thus, to use a method well requires being faithful to value sensitive design theory. Here "being faithful" does not refer to some kind of easily recognized conformance; instead, it refers to a genuine engagement with theory. Thus, for example, a theoretical commitment in value sensitive design is to identify and legitimate the direct and indirect stakeholders in a design project. Accordingly, to do so, many different empirical and analytic methods might be employed, depending on the design situation. As methods are employed, new knowledge is generated that, in turn, informs theory—precipitating clarifications, extensions, revisions, adaptations, and even new dimensions. In so doing, theory and method engage in an ongoing dialog, each a tool to shape and reshape the other.

A third quality concerns the practical use of methods within value sensitive design. Value sensitive design methods are intended to be integrated with other methods and processes in technical design. Relatedly,

value sensitive design methods are intended to be open to adaption and evolution so that their use is responsive to the elements of the design situation.

In summary, the methods codify and operationalize how researchers, designers, and engineers can proceed to engage values in technical design.

1.2 Summary of Key Theoretical Constructs

Method positions researchers and designers to act in ways responsive to the considerations foregrounded by theory. For value sensitive design, as with many other theoretically informed approaches, method arises from theoretical constructs and, in turn, the use of method drives the development of theory. Thus, to position designers and researchers to employ value sensitive design methods, we begin with a brief summary of the key theoretical constructs of value sensitive design. A fuller explication of each construct, including nuances and limitations, can be found in Friedman and Hendry (forthcoming).

Tools and Technology. While the boundary between tools and technology is not a sharp one, as a heuristic, one might think of *tools* in their simpler sense as human-scale physical artifacts that augment human activity and *technology* as extending our ideas about tools to include the application of scientific knowledge to solve practical problems, including the specific methods, materials, and devices employed. *Infrastructure*—the basic physical and organizational structures and facilities needed for the operation of a society or enterprise—also needs consideration. Taken together, tools, technology, and infrastructure comprise what some might term a technological system. When speaking of one—tool, technology, or infrastructure—it is nearly impossible not to speak of the others. In value sensitive design, the term technology is used as a shorthand to refer to all three and their interdependencies.

At its core, value sensitive design is not tied to any specific technology. Accordingly, designers, researchers, and engineers working with diverse technologies can employ value sensitive design theory and methods.

Human Values. The current working definition of "value" within value sensitive design is:

> *what is important to people in their lives, with a focus on ethics and morality.*

Moreover, within lived life, human values do not exist in isolation, with, for example, privacy over here and security or community over there. Rather, in the complexity of human relations, values sit in a delicate balance with each other. This framing positions designers and researchers to emphasize moral and ethical values, but to do so within the complexity of social life, and with recognition for how culture and context implicate people's understanding and experience of benefits as well as harms and injustice.

Interactional Stance. Value sensitive design takes an interactional stance on technology and human values. Unlike approaches based primarily on technological determinism or on social determinism, interactional theories such as value sensitive design posit that human beings acting as individuals, organizations, or societies shape the tools and technologies they design and implement; in turn, those tools and technologies shape human experience and society.

The Tripartite Methodology: Conceptual, Empirical, and Technical Investigations. To address the value implications of socio-technical design robustly, value sensitive design employs an *iterative* methodology that *integrates* conceptual, empirical, and technical investigations. Conceptual investigations comprise analytic, theoretical, or philosophically informed explorations of the central issues and constructs under investigation. Empirical investigations examine the human context in which the technology is situated and, as appropriate, may draw upon the entire range of quantitative and qualitative methods used in social science research. Technical investigations focus on the technology as the unit of analysis, typically involving retrospective analysis of existing technology or proactive design of new technology.

Stakeholders: Whose values? Value sensitive design asks designers to seek out a robust set of stakeholder groups and to legitimate those who likely are most strongly affected—that is, to provide an analytic or empirical rationale for their inclusion in a design process. Equally

important can be the rationale provided for why certain groups or individuals are not engaged. Value sensitive design also asks designers to be transparent about explicitly supported project values and their own individual values (i.e., designer values). In any stakeholder analysis, a central distinction concerns stakeholders who directly interact with a system, the *direct stakeholders*, and those who, although they never or rarely interact with the system as end-users, are nevertheless affected by the system, the *indirect stakeholders*.

Value Tensions. Human values do not exist in isolation. Rather, much like the threads in a spider web, values are situated in a delicate balance. Touching one value implicates others. Moreover, people's values can align or come into tension at various levels of human experience—within an individual; among individuals; between an individual and a group; among groups, institutions, nations, and societies; and any number of other combinations. Adding yet another layer of complexity, the balance among the values of a person, group, or society may change over time, and value tensions may shift accordingly. While how to achieve balance among competing values is not obvious, value sensitive design frames a design process that engages constructively with the tensions.

Co-evolving Technology and Social Structure. The interactional stance of value sensitive design implies that the design space for technological innovation encompasses not only the technical design space but also the corresponding socio-structural one. Moreover, engaging both technical and socio-structural design spaces with the tools and methods of value sensitive design provides a more comprehensive design space—one with the possibility for solutions that might not be conceived of (or even possible) if approached from a technical or socio-structural perspective alone.

Multi-lifespan Design. Multi-lifespan design begins from the observation that certain categories of problems, such as healing from widespread or cyclical violence (e.g., genocide) or some environmental issues (e.g., regeneration of old growth forests) are unlikely to be solved within a single human lifespan. Correspondingly, technology developed and deployed in the service of such solutions as they unfold will

need to be robust and adaptive over time. Situated within value sensitive design, multi-lifespan design provides specific design knowledge and methods honed to a longer-term timeframe. Such work opens up new opportunities for preserving knowledge, supporting social structures and processes, remembering and forgetting, and re-envisioning infrastructure to support inclusivity and access.

Progress, not Perfection. The motto "progress, not perfection" is relevant to all aspects of value sensitive design practice. This motto encapsulates an overarching perspective and strategy for navigating the at times daunting challenges of addressing values in technical work, reminding designers that achieving progress is a worthy goal even though perfection remains ever elusive. Value sensitive design moves designers toward the conceptualizations needed to identify shortcomings in current design processes and to seek remedies that promote human well-being. It moves designers toward the language needed to discuss the often immense social consequences of technical innovation with the public at large. And, it moves designers toward considering human values as a design criterion—along with traditional criteria of reliability, efficiency, and correctness—by which systems may be judged poor and designers negligent. As with the traditional criteria for evaluating technical systems, we need not require perfection, but commitment to practice. And through practice, progress.

1.3 Bounding the Article

The central contribution of this survey article is to provide an overview of 14 methods in value sensitive design and to provide a broader discussion of value sensitive design practice. Specifically, we focus on methods that have been invented for the investigation of values in technology (e.g., value dams and flows, envisioning cards) or methods that have undergone substantial adaptation or development (e.g., value-oriented semi-structured interviews, value sketches).

The collection of methods surveyed here, while representative, is not complete. The value sensitive design literature is large and experiencing rapid growth. For example, a Google Scholar search in October 2017 on the phrase "value sensitive design" returned over 3,500 works. A similar Google Scholar search on "value sensitive design" by year for 2015 and for 2016 returned over 400 new works for each year; the pattern seems to be continuing for 2017. Methodological development and innovation is rich within this body of work. Methods engage, for example, transcultural and cross-cultural design (Abokhodair and Vieweg, 2016; Pereira and Baranauskas, 2015; Burmeister, 2013; Alsheikh et al., 2011); health informatics (Burmeister, 2016; Fitzpatrick et al., 2015; Novitzky et al., 2015; Pakrasi et al., 2015; Schikhof et al., 2010; Teipel et al., 2016); care robots in health settings (van Wynsberghe, 2013, 2015; Felzmann et al., 2016); empowerment and marginalization in crowd-work (Deng et al., 2016); appropriation within action research (Weibert et al., 2017); embedding ethical and moral considerations throughout the software development lifecycle (Spiekermann, 2015; Harbers et al., 2015); responsible innovation and value sensitive design (van den Hoven, 2013); and other developments (e.g., Walldius and Lantz, 2013; Shilton, 2012; van de Poel, 2013; Solomon, 2014). We leave an analysis of this broader value sensitive design literature to other scholars.

The remainder of this article is organized as follows. In Chapter 2 we begin by introducing the collection of methods, organizing them by purpose, and citing the original publications. Then, in Chapter 3 we provide some methodological strategies and heuristics to support skillful value sensitive design practice. In Chapter 4 we illustrate one method in action, providing details on that method's use for a range of purposes and contexts. Finally, we conclude in Chapter 5 with reflections on core characteristics of value sensitive design methods, and heuristics for methodological innovation.

2

The Fourteen Methods

We turn now to the collection of 14 value sensitive design methods. Given the breadth of methods that have been employed in value sensitive design work, our first task was to develop selection criteria for the ones to be presented here. We employed the following criteria. First, as noted above, we wanted methods that have either been invented, or undergone substantial adaptation or development, for the investigation of values in technology, rather than ones that have been adopted with minimal modification. Second, each method should be relatively self-contained. Third, we wanted to present methods that cover a broad range of values and application areas. Finally, we gave preference to methods that have been used and refined in multiple projects.

In limiting this survey to a collection of 14 methods, it is important to note that value sensitive design projects, as well as other design projects that have engaged values, have employed many other methods from design, the social sciences, and other disciplines. We recognize that broader selection criteria would lead to a large set of methods. Even so, as a collection, the methods reveal a good deal of innovation. Moreover, as new projects are pursued, the need for new methods arises.

We first present an overview of the 14 methods in Table 2.1, highlighting the main purpose and key citations for each method. We then describe each more fully. Details on the development and application of each method can be found in the cited work, which is presented in suggested reading order. Though these methods are presented in a stand-alone fashion for descriptive purposes, it is important to note that they are intended to be integrated into a robust value sensitive design process, one that employs the tripartite methodology.

Table 2.1: Summary of 14 value sensitive design methods.

Method	Overview and Key Citations
1. Direct and Indirect Stakeholder Analysis *Purpose:* Stakeholder identification and legitimation.	Identification of individuals, groups, organizations, institutions, and societies that might reasonably be affected by the technology under investigation and in what ways. Two overarching stakeholder categories: (1) those who interact directly with the technology, *direct stakeholders*; and (2) those indirectly affected by the technology, *indirect stakeholders*. See: Friedman et al. (2006b); Nathan et al. (2008); Czeskis et al. (2010); and Watkins et al. (2013).
2. Value Source Analysis *Purpose:* Identify value sources.	Distinguish among the explicitly supported project values, designers' personal values, and values held by other direct and indirect stakeholders. See: Borning et al. (2005).
3. Co-evolution of Technology and Social Structure *Purpose:* Expand design space.	Expanding the design space to include social structures integrated with technology may yield new solutions not possible when considering the technology alone. As appropriate, engage with the design of both technology and social structure as part of the solution space. Social structures may include policy, law, regulations, organizational practices, social norms, and others. See: Friedman et al. (2006c); and Miller et al. (2007).

4. Value Scenario *Purpose:* Values representation and elicitation.	Narratives, comprising stories of use, intended to surface human and technical aspects of technology and context. Value scenarios emphasize implications for direct and indirect stakeholders, related key values, widespread use, indirect impacts, longer-term use, and similar systemic effects. See: Nathan et al. (2007); Nathan et al. (2008); Czeskis et al. (2010); Woelfer et al. (2011); and Yoo et al. (2013a).
5. Value Sketch *Purpose:* Values representation and elicitation.	Sketching activities as a way to tap into stakeholders' non-verbal understandings, views, and values about a technology. See: Friedman et al. (2002b); and Woelfer et al. (2011).
6. Value-oriented Semi-structured Interview *Purpose:* Values elicitation.	Semi-structured interview questions as a way to tap into stakeholders' understandings, views and values about a technology. Questions typically emphasize stakeholders' evaluative judgments (e.g., all right or not all right) about a technology as well as rationale (e.g., why?). Additional considerations introduced by the stakeholder are pursued. See: Friedman (1997); Kahn et al. (2006); Borning et al. (2005); Freier (2008); and Czeskis et al. (2010).
7. Scalable Information Dimensions *Purpose:* Values elicitation.	Sets of questions constructed to tease apart the impact of pervasiveness, proximity, granularity of information, and other scalable dimensions. Can be used in interview or survey formats. See: Friedman (1997); Friedman et al. (2006b); and Munson et al. (2011).
8. Value-oriented Coding Manual *Purpose:* Values analysis.	Hierarchically structured categories for coding qualitative responses to the value representation and elicitation methods. Coding categories are generated from the data and a conceptualization of the domain. Each category contains a label, definition, and typically up to three sample responses from empirical data. Can be applied to oral, written, and visual responses. See: Kahn et al. (2003); and Friedman et al. (2005a).

9. Value-oriented Mock-up, Prototype or Field Deployment *Purpose:* Values representation and elicitation.	Development, analysis, and co-design of mock-ups, prototypes and field deployments to scaffold the investigation of value implications of technologies that are yet to be built or widely adopted. Mock-ups, prototypes or field deployments emphasize implications for direct and indirect stakeholders, value tensions, and technology situated in human contexts. See: Freier (2008); Woelfer and Hendry (2009); Denning et al. (2010); Czeskis et al. (2010); and Yoo et al. (2013a).
10. Ethnographically Informed Inquiry regarding Values and Technology *Purpose:* Values, technology and social structure framework and analysis.	Framework and approach for data collection and analysis to uncover the complex relationships among values, technology and social structure as those relationships unfold. Typically involves in-depth engagement in situated contexts over longer periods of time. See: Nathan (2012).
11. Model for Informed Consent Online *Purpose:* Design principles and values analysis.	Model with corresponding design principles for considering informed consent in online contexts. The construct of *informed* encompasses disclosure and comprehension; that of *consent* encompasses voluntariness, competence, and agreement. Furthermore, implementations of informed consent must not pose an undue burden to stakeholders. See: Friedman et al. (2000); Millett et al. (2001); Friedman et al. (2002a); Friedman et al. (2005b); and Friedman et al. (2006c).
12. Value Dams and Flows *Purpose:* Values analysis.	Analytic method to reduce the solution space and resolve value tensions among design choices. First, design options that even a small percentage of stakeholders strongly object to are removed from the design space—the *value dams*. Then of the remaining design options, those that a good percentage of stakeholders find appealing are foregrounded in the design—the *value flows*. Can be applied to the design of both technology and social structures. See: Miller et al. (2007); Czeskis et al. (2010); and Denning et al. (2010).
13. Value Sensitive Action-Reflection Model *Purpose:* Values representation and elicitation.	Reflective process for introducing value sensitive prompts into a co-design activity. Prompts can be designer or stakeholder generated. See: Yoo et al. (2013a).

14. Envisioning Cards™ *Purpose:* Versatile value sensitive design toolkit for industry, research, and educational practice.	Versatile value sensitive envisioning toolkit. Comprised of a set of 32 cards, the Envisioning Cards™ build on four criteria—stakeholders, time, values, and pervasiveness. Each card contains on one side a title and an evocative image related to the card theme; on the flip side, the envisioning criterion, card theme, and a focused design activity. Envisioning Cards™ can be used for ideation, co-design, heuristic critique, evaluation, and other purposes. See: Friedman et al. (2011); Kaptein et al. (2011); Friedman and Hendry (2012); and Yoo et al. (2013a).

2.1 Direct and Indirect Stakeholder Analysis

In the information field, stakeholder analyses are commonly employed by organizations to clarify project scope by systematically identifying individuals and groups that might reasonably be affected by the technology under investigation (Bødker et al., 2004; Mitchell et al., 1997). In value sensitive design, stakeholder analysis is broadened to include not only individuals and groups but also institutions and societies. The emphasis is placed on identifying and legitimating stakeholders, including enumerating the ways in which stakeholders might be affected, along with documenting potential benefits, harms, and tensions. To focus the analysis, two overarching stakeholder categories are employed: (1) *direct stakeholders*, those who interact directly with the technology; and (2) *indirect stakeholders*, those who do not directly interact with the technology but may nonetheless be affected. Depending on the technology, it may be possible to readily identify most, if not all, of the direct stakeholders. Indirect effects can be widespread and diffuse; accordingly, one challenge is to identify those indirect stakeholders who might be significantly impacted, either positively or negatively, by the technology.

2.1.1 Foundational Studies

- *Privacy in public.* Stakeholder analyses employed to shape the design of a research study on privacy in public, with an emphasis on indirect stakeholders (known as "The Watcher and the Watched") (Friedman et al., 2006b).

- *Reflections on direct and indirect stakeholders.* Discussion and reflection on the conceptual categories of direct and indirect stakeholders as well as limitations (Nathan et al., 2008).

- *Shifting between direct and indirect stakeholder roles—parent-teen mobile phone safety applications.* To surface differing stakeholder perspectives about a parent-teen mobile phone application for monitoring teens, study participants first take on the role of a direct stakeholder (e.g., parent of a teen who uses the application) and then switch to that of an indirect stakeholder (e.g., parent of a teen whose friend's parent uses the application) (Czeskis et al., 2010).

- *Bus drivers as indirect stakeholders—Mobile application to support public transit riders.* Stakeholder analyses used to surface bus drivers as key indirect stakeholders in a mobile phone application for transit riders (Watkins et al., 2013).

2.2 Value Source Analysis

As discussed in Section 1.2 in the summary of theoretical constructs, clarity and transparency about the source of values that implicate a system design can be critical. *Explicitly supported project values* refer to an agreed upon set of values to guide system development throughout the design process and can also serve as evaluation criteria. Typically these project values are subject to a principled analysis negotiated through public processes, and/or tied to funding sources. In contrast, *designer values* refer to the personal or professional values each designer brings to his or her own research and design work. There may or may not be a strong alignment between a designer's personal values and those

identified to be explicitly supported by the system. One would hope that the explicitly supported project values will also be shared by the designer, but often there will be relevant designer values that are not explicitly supported project values. Teasing apart these sets is a useful heuristic for reminding designers that every relevant value that they hold does not necessarily need to be explicitly supported by that particular project. Even so, when the divergence between designer and project values is significant, then additional methods to manage those differences may be warranted. Thirdly and building on the stakeholder analyses (see above), *stakeholder values* refer to the values of different stakeholder groups that need to be taken into account. Here, too, there may be a divergence among the values held by different stakeholder groups. This method involves systematically identifying and distinguishing among the values to be explicitly supported by the project, the values held personally by designers, and the values held by direct and indirect stakeholders. Surfacing such differences or tensions among the values from these different sources can point to important places to seek to balance or resolve these differences. For example, in the development of a large-scale simulation for land use and transportation (Borning et al., 2005), the designers' values tended toward supporting the environment while the project's explicitly supported project value of representativeness pointed toward an even-handed treatment of environmental values alongside of others such as economic development. To ensure the project's explicitly supported values were adequately addressed, specific periodic design reviews were put in place.

2.2.1 Foundational Study

- *Urban simulation for land use and transportation modeling.* Distinguished among those values explicitly supported as part of the project's goals and objectives, designers' personal values, and the often strongly held conflicting values of stakeholders in the design of a large-scale computer simulation for land use and transportation planning (Borning et al., 2005).

2.3 Co-evolution of Technology and Social Structure

Most technical design considers the technology in relative isolation, with a static view on policy, law, and other social structures. Expanding the design space to include not only technology but also the design of social structures may yield new solutions not possible when considering either alone. As appropriate, the design process engages reciprocally with and, in this sense, co-evolves technology and social structure. Social structures are viewed broadly and may include policy, law, regulations, organizational practices, social norms, and others. For example, in the design of a knowledge base and code repository system in a large software organization (Miller et al., 2007), a two-pronged design approach was employed to achieve a successful balance among the values of reputation, privacy and awareness: one prong emphasized technical features of the knowledge-base system, such as opportunities for anonymous posts and feedback on frequency of use, while a second prong emphasized managerial policies for the system, including how, if at all, contributors would be rewarded during annual performance reviews. Importantly, the technical features and managerial policies worked in consort to address concerns about reputation for both contributors and question askers.

2.3.1 Foundational Studies

- *Managerial policy and technology—knowledge-based system.* Working with a large software corporation, developed a knowledge-based and software repository groupware system in tandem with organizational policies for incentivizing employees' contributions to the system (Miller et al., 2007).

- *Software license and technology—privacy in an open source location aware system.* Working with an industry partner, developed a legal addendum to an open source license that preserves user privacy attributes for a mobile phone location-aware system (Friedman et al., 2006c).

2.4 Value Scenario

Scenarios have long been used effectively in user-centered design to focus on and communicate about discrete features of a technology and the immediate context of use (Carroll, 1999, 2000). Value scenarios extend this tradition to surface additional important humanistic and societal considerations of technology and context. Specifically, the narratives are intended to emphasize (a) implications for direct and indirect stakeholders, (b) key values, (c) widespread use, (d) indirect impacts, (e) longer-term use, and (f) systemic effects. In any given application, some elements may be emphasized more than others. Depending on the context of use, a value scenario can act both as a values representation and as a values elicitation method. For example, and as explicated in greater detail in Chapter 4, Czeskis et al. (2010) in their role as researchers wrote value scenarios around parenting technologies for teens as a means to explore a design space prior to conducting research with stakeholders. In contrast, Woelfer et al. (2011) asked research participants who were homeless young people to write value scenarios about mobile phones and safety as a means to elicit what the youth considered important in their lives.

2.4.1 Foundational Studies

- *Elements of a value scenario.* Value scenarios as a designer tool that build upon but are distinct from traditional scenario-based design; includes two exemplar value scenarios, one about avoiding crime when navigating a city and the another about social robots (Nathan et al., 2007).

- *Designer-generated value scenarios as a conceptualization tool—parent-teen mobile phone safety applications.* Value scenarios employed to situate a proposed new technology for parenting teens and explore a design space prior to developing a user study (Czeskis et al., 2010).

- *Stakeholder-generated value scenarios as an envisioning tool—homeless young people and safety.* Value scenarios employed with

stakeholders to envision situations in which homeless young people could use a mobile phone to improve their safety (Woelfer et al., 2011);

- *Value scenarios repurposed as design prompts—co-design and mobile phone safety.* Previously written value scenarios employed to prompt reflection in a co-design activity focused on using mobile phones to improve safety for homeless young people (Yoo et al., 2013a).

2.5 Value Sketch

Sketches, collage, and other visual expressions provide a means to tap into non-verbal understandings (Crilly et al., 2006; Lynch, 1960). With value sketches, the emphasis is on understandings, views, and values about a technology. Through drawings, participants can "show" rather than "tell" what is important to them in relation to a particular technology in a particular context. Value sketches can also be helpful in understanding how a technology is situated in place or in explicating how particular values are implicated by technical functioning. For example, the value sketches in Figure 2.1 show users' understandings of a "secure connection" on the web which they use to make decisions about what information to submit electronically (reprinted from Friedman, Hurley, Howe, Felten, and Nissenbaum, 2002b). Similar to value scenarios, value sketches can act as both a values representation and a values elicitation method.

2.5.1 Foundational Studies

- *Sketching processes—web browser security.* Study participants drew sketches to express their understandings of a secure web browser connection and to situate a discussion about security and privacy in web-based interactions (Friedman et al., 2002b).

- *Sketching experience of place—homeless young people and safety.* As part of a larger study on mobile phones and safety, to surface perceptions of where and when homeless young people might feel

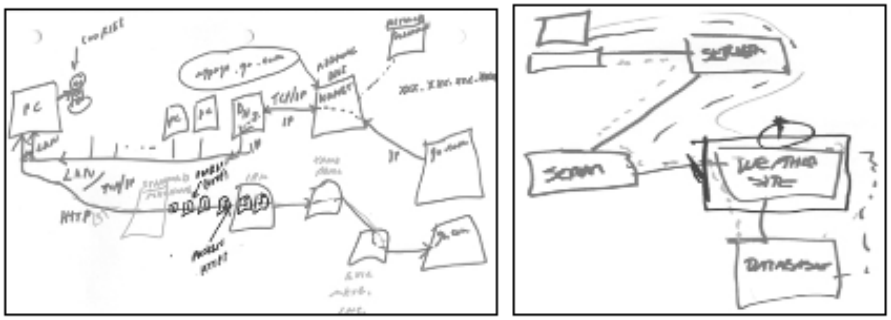

Figure 2.1: The drawing on the left shows a conception of a secure connection in terms of encryption while the information is in "transit". The drawing on the right shows a conception of a secure connection in terms of a secure boundary [box] around a specific "place" on the web.

unsafe as well as to situate value scenarios grounded in place, study participants sketched their perceptions of safe and unsafe areas for homeless young people on a local map (Woelfer et al., 2011).

2.6 Value-oriented Semi-structured Interview

Semi-structured interviews provide a means to tap into stakeholders' understandings, views and values (Kahn, 1999; Piaget, 1929/1960). Interview questions can be honed to elicit information about values and value tensions in relation to technology. Typical questions emphasize stakeholders' evaluative judgments about a technology (e.g., "Is it all right or not all right that technology X has feature Y or behavior Z?) as well as rationale (e.g., "Why or why not?). Value tensions can be explored in a variety of ways. One entails introducing alternative resolutions of the tension and inquiring which resolution (if any) resonates with the stakeholder's perspective (e.g., "Some people like X about the system for Y reason. Other people like A about the system for B reason. Are your views more similar to one person or the other? Why?"). The semi-structured nature of the interview provides an opportunity to pursue topics in depth as well to engage new considerations the stakeholder introduces into the conversation.

2.6.1 Foundational Studies

- *United States adolescents—online privacy and electronic property.* Interviews employed to elicit adolescents' views and values of privacy and property as they apply to electronic information—reading others' computer files and copying software (Friedman, 1997).

- *United States urban planners - urban simulation for land use and transportation modeling.* Interviews employed to elicit urban planners' and modelers' reflections on the relationship between values and policies important to land use and the technical features in the large scale UrbanSim simulation (Borning et al., 2005).

- *United States preschool children—robotic dogs.* Interviews employed to elicit preschool children's conceptions as well as social and moral judgments about a robotic dog (Kahn et al., 2006).

- *United States children—personified agent.* Interviews employed to elicit children's conceptions of self-reflective personified agents (e.g., avatars) as warranting moral consideration (Freier, 2008).

- *Swedish and United States adults—privacy in public.* Interviews employed to elicit adults' reflections on the use of web cameras in a public plaza, particularly on their conceptions of privacy in public; first conducted in the United States (Friedman et al., 2006b) and then in a comparative study in Sweden (Friedman et al., 2008b).

- *United States adolescents and their parents—mobile phones for safety.* Interviews employed to elicit teenagers' and their parents' views and values on mobile technologies to support parental awareness and notification of teenager activities and location (Czeskis et al., 2010).

2.7 Scalable Information Dimensions

Assessments of the importance of a value or the severity of a harm may depend on a number of scalable dimensions, such as granularity of information, proximity, and pervasiveness. This value elicitation method takes such scalable dimensions into account by structuring questions to explicitly tease apart their impact (e.g., "For public records, ... how comfortable would you be with searching public records by state? By city? By zip code? By neighborhood name? By home address? By last name only? By first and last name?" (Munson et al., 2011)). Assessment of scale can be used in a wide range of formats, including interviews, surveys, value scenarios, and value sketches.

2.7.1 Foundational Studies

- *Pervasiveness—copying commercial software.* Investigated the effect of fewer or greater number of copies on adolescents' views and values on copying commercial software for personal use, to give to friends, and to sell to others (Friedman, 1997).

- *Pervasiveness and proximity—privacy in public.* Investigated the impact of pervasiveness of and proximity to a technology on participants' views and values about web cameras in a public plaza (Friedman et al., 2006b).

- *Location—public records online.* Investigated the impact of granularity of location information on participants' views and values about online public records for real estate sales and for political campaign contributions (Munson et al., 2011)).

2.8 Value-oriented Coding Manual

Coding manuals provide one systematic means for coding and then analyzing qualitative responses to value representation and elicitation methods, such as the value scenario (e.g., narrative), value sketches (e.g., visual), and semi-structured interview (e.g., discourse) methods described above. Typically, the coding categories are generated from

the data and a conceptualization of the domain. Each category contains a label, definition, and as a rule of thumb up to three sample responses from the data. Depending on the research or design project, the coding schemes may capture technical as well as values and other social aspects of the data. For example, a coding manual for a project on privacy in public (Friedman et al., 2005a) included categories about technology as well as about values such as privacy and property. A few examples follow:

> Technology. An appeal based on existing technologies (e.g., "Anybody could put a camera out here and film people.") or on technological augmentations of the physical world, time or biology (e.g., "not only are your actions viewable to anyone here? They'd be viewable to anyone there.").
>
> Privacy. An appeal based on a claim, an entitlement, or a right of an individual to determine what information about him or herself is communicated to others including private content (e.g., "because it's your personal thoughts and feelings"), legitimate use (e.g., "there's absolutely no reason for anybody to need to know"); maintain anonymity (e.g., "it's perfectly fine if we're not capturing people, individual people"); and control (it depends on how closely you guard it").
>
> Property. An appeal based on a concept of tangible property (e.g., "They could have a right to do that since it's university property.") and intangible property (e.g., "My image, if I'm being looked at is a different, I feel a different property right").

2.8.1 Foundational Studies

- *Interview data—privacy in public.* Coding manual (36 pages) for analyzing direct and indirect stakeholder views, values and tensions around privacy in relation to web cameras in a public plaza (Friedman et al., 2005a).
- *Chatroom data—robotic dogs.* Coding manual (61 pages) for analyzing robotic dog owners' online chatroom discourse from the

perspective of social robots, moral judgments, and human experience (Kahn et al., 2003).

- *Discussion forum data—Telegarden.* Coding manual (49 pages) for analyzing online discussion forum data from Telegarden participants with an emphasis on human experience of technologically mediated nature (Kahn et al., 2005).

- *Sketch data—web browser security.* Coding manual (10 pages) for analyzing study participants' sketches and dialog explaining security for web browsers (Friedman et al., 2002b).

2.9 Value-oriented Mock-up, Prototype, or Field Deployment

Mock-ups, prototypes, and field deployments can be employed to scaffold the investigation of value implications of technologies that have yet to be built or widely adopted. To do so, these established methods are adapted to emphasize implications for direct and indirect stakeholders, value tensions, and technology situated in human contexts. With these and other potential adaptations, these methods can be introduced into development, analysis, and co-design processes to aid with values representation and elicitation. For example, in a project investigating early-stage security concepts for implantable medical devices such as pace makers, low-fidelity prototypes of potential security solutions were shown to patients as a means to elicit their views and values on living with the different security concepts (Denning et al., 2010).

2.9.1 Foundational Studies

- *Mock-ups—security for health and parenting applications.* Lo-fi mock-ups employed in one study to convey to patients with implantable cardiac devices a diverse set of potential security solutions for their devices, as shown in Figure 2.2 (Denning et al., 2010), and in another study to convey to parents and teens a

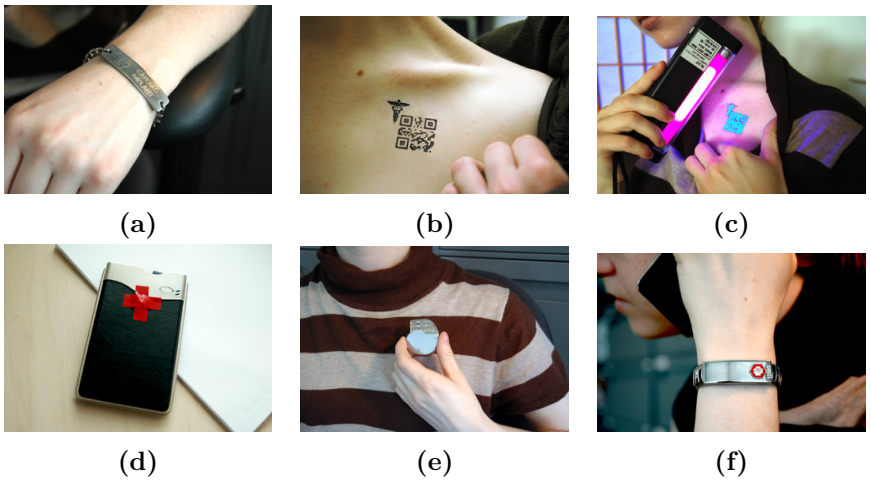

Figure 2.2: Physical mockups that were presented to participants during the implantable medical device project. These mockups were intended both to make system designs more concrete for participants and to provide an easy visual way to recall and refer to systems. The mockups were intentionally rough to suggest unpolished, flexible system designs. Six of the eight mockups are shown here. Mockups represent, in clockwise order from the top-left: (a) a medical alert bracelet with a device password imprinted on it; (b) a tattoo of a device password encoded in a 2D barcode format; (c) the same password tattoo in ink visible only under ultraviolet light; (d) computationally-active security wristbands; (e) example pacemakers and implantable cardiac defibrillators, to indicate that security solutions could be built directly into implantable medical devices; and (f) a restricted-access external device to be used by medical personnel in order to activate wireless capabilities on an implantable medical device. Photo credit: Nell Carden Grey.

range of technical features to balance security, privacy and notification considerations in a parent-teen mobile phone security application (Czeskis et al., 2010).

- *Video prototypes—information systems for homeless young people.* Three short videos (1:30–3:30 minutes) of physical prototypes for presenting paper brochures, each emphasizing a different value (respect, autonomy, and trust), were used to elicit stakeholder views on a design space (Woelfer and Hendry, 2009).

- *Paper prototypes—co-design for mobile phone safety.* In a co-design activity, participants employed paper and clay prototypes

to express their ideas for using mobile phones to improve safety for homeless young people (Yoo et al., 2013a).

- *Wizard of Oz prototype—personified agent.* Children interact with a personified agent implemented by "Wizard of Oz" techniques in the context of a tic-tac-toe game to elicit the children's views on personified agents as potentially warranting moral personhood (Freier, 2008).

- *Working prototype—household indicators for urban simulation.* Design, development, and evaluation of working prototype for a user interface and system to explore the impact of region-wide land use and transportation policies on an resident's household (Davis, 2008).

- *Field deployment—privacy in public.* Field deployment of webcams in a public place with images seen on large displays in university faculty and staff offices as part of a longer-term study (Friedman et al., 2008a) and as part of a controlled experiment (Friedman et al., 2006b).

2.10 Ethnographically Informed Inquiry regarding Values and Technology

Ethnographically informed research focused at the intersection of technology and human activity (Nardi and O'Day, 1999; Orlikowski, 2000) can be employed to probe the complex relationships among values, technology and social structure, particularly as those relationships unfold over time. Such work makes a particular commitment to identifying and clarifying values and value tensions; the endeavor is dynamic, involving in-depth engagement in situated contexts over longer durations. The emphasis might be on a particular community or social structure as that community and its members appropriate and adapt to existing technologies, as well as how community members in the course of those processes shape those technologies. Points of interest often occur at the boundaries, where strongly held individual or community values may come into tension with behaviors or experiences facilitated by

the technology. For example, in the ethnographically informed study of an emerging ecovillage (Nathan, 2012), digital information technologies such as email at times conflicted with community values around equitable access to information for those less technologically savvy or living on limited incomes with limited access to the Internet.

2.10.1 Foundational Study

- *Environmental sustainability, information technology, and intentional communities.* Ethnographic exploration of two eco-villages, one well-established and the other in early phases of development, to gain insight into the tensions among commitments to environmental sustainability and other core values with the use and dependence on information technology (Nathan, 2012).

2.11 Model for Informed Consent Online

One mechanism for protecting human values is to provide stakeholders with an opportunity to agree to the use of a technology that impacts their lives in important ways. The Model for Informed Consent Online provides design principles and a value analysis method for considering informed consent in online contexts. The construct of "informed" encompasses disclosure and comprehension; that of "consent" voluntariness, competence, and agreement. Furthermore, implementations of informed consent must not pose an undue burden to stakeholders. Among other applications, this model is relevant for much of the current work on usable security and privacy, pointing toward the importance of "informing through interaction" and the need for just-in-time management of privacy and security options with low burdens of use.

2.11.1 Foundational Studies

- *Elements of model.* Description of the model for informed consent online, including eight design principles for guiding implementation (Friedman et al., 2000).

- *Evaluation criteria for existing technology—cookies and web browser security; and machine-generated ads in gmail.* Informed consent model employed to surface limitations in the handling of cookies in then state-of-the-art web browsers (circa 1995–1999), despite industry efforts to do otherwise (Millett et al., 2001); and to counter challenges of misrepresentation when Google first introduced machine-generated ads in its email application gmail (Friedman et al., 2005b).

- *Design criteria for guiding new technical features—cookies and web browser security.* Informed consent model used to design and develop two technical features—ready-to-hand information and just-in-time cookie management—to address some of the limitations in state-of-the art web browsers' handling of cookies; implemented and deployed as a Mozilla plug-in (Friedman et al., 2002a).

- *Design criteria for guiding law and policy—privacy protections for location aware applications.* Informed consent online model employed in conjunction with a traditional security threat analysis model to surface elements for a privacy license for an open source location aware application (Friedman et al., 2006c).

2.12 Value Dams and Flows

At key junctures in a design process, there is often a need to reduce the solution space and resolve value tensions among design choices. Value Dams and Flows provide one analytic method for doing so. First, design options that even a small percentage of stakeholders strongly object to—the *value dams*—are removed from the design space. How to identify a suitable threshold percentage for determining value dams is an open research question; current research has used a heuristic on the order of 7-10%. Then, of the remaining design options, those that a good percentage of stakeholders find appealing—the *value flows*—are foregrounded in the design. This method, as with other methods, can be applied to the design of both technology and social structures. For

example, in the design of a software knowledge and code repository for a large software organization, the value dams and flows method was used to refine feature selection in the technical system as well as organizational policy for regulating use of the system (Miller et al., 2007).

2.12.1 Foundational Studies

- *Balancing privacy, anonymity, and reputation—industry groupware system.* Value dams and flows method employed to identify a set of technical features and organizational policies that positively balanced concerns for privacy, anonymity and reputation (Miller et al., 2007).

- *Discerning objectionable and acceptable solutions—security for implantable cardiac devices.* Value dams and flows method employed to eliminate technical security approaches that patients with implantable cardiac devices found objectionable (Denning et al., 2010).

- *Deciding not to collect data—parent-teen mobile phone safety application.* Value dams and flows employed to identify the conditions under which certain data about teens should not be collected and communicated to their parents (Czeskis et al., 2010).

2.13 Value Sensitive Action-Reflection Model

In co-design and similar types of activities, a common challenge is to position stakeholders to generate creative ideas or to reflect on their ideas (Sanders and Westerlund, 2011). The Value Sensitive Action-Reflection Model addresses this challenge with a structured, reflective, and iterative process in which value sensitive prompts are introduced (Figure 2.3). The prompts, which can be either created by designers or by stakeholders, are intended to lead participants to reconsider their

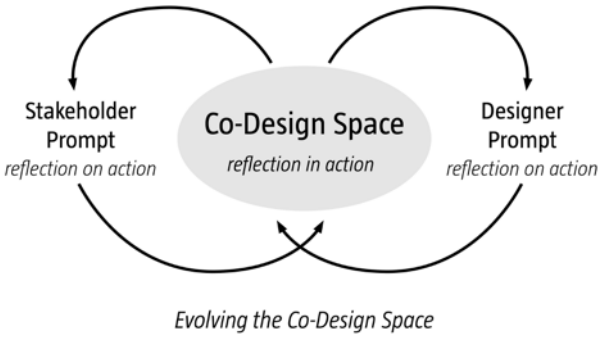

Figure 2.3: Value sensitive action-reflection model. Stakeholder and designer prompts are introduced to expand the co-design space and to prompt co-designers to reflect on their involving design.

designs from a values perspective at various points in the co-design activity. For example, co-design participants might be given a value scenario and instructed to "revise your current design solution, if needed, to account for the scenario."

2.13.1 Foundational Study

- *Designer and stakeholder prompts—co-design and mobile phone safety.* A stakeholder prompt (e.g., stakeholder generated value scenario) and a designer prompt (e.g., an Envisioning Card^{TM}) were used to stimulate iterative design in a co-design process with homeless young people, service providers and police officers (Yoo et al., 2013a).

2.14 Envisioning Cards^{TM}

The Envisioning Cards^{TM} (Friedman et al., 2011) are a practical and versatile toolkit to bring value sensitive design theory and method into industry and educational practice. Comprising a set of 32 cards, the cards build on four criteria: stakeholders, time, values, and pervasiveness. As shown in Figure 2.4, each card contains on one side a title

Figure 2.4: Sample Envisioning Card™: Changing Hands from the stakeholders category.

and an evocative image related to the card theme (e.g., Indirect Stakeholders [stakeholders], Reappropriation [time], Perceptions of a Value [values], Political Realities [pervasiveness]). On the flip side, there is the envisioning criterion, title, card theme, and a focused design activity. Envisioning Cards™ can be used for ideation, co-design, heuristic critique, evaluation, and other purposes.

2.14.1 Foundational Studies

- *The Envisioning Cards™.* The Envisioning Card toolkit (Friedman et al., 2011), www.envisioningcards.com.
- *Ideation—co-design and mobile phone safety.* Envisioning Cards™ employed to scaffold non-designers' active participation in a co-design process, including focused iterative design (Friedman and Hendry, 2012; Yoo et al., 2013a).
- *Value implications—persuasion profiling.* Envisioning Cards™ employed in a professional workshop setting to anticipate the uses, benefits, and harms of persuasion profiling (Kaptein et al., 2011; Friedman and Hendry, 2012).
- *Heuristic value analysis—cloud computing.* Envisioning Cards™ employed as an analytic heuristic tool to surface critical issues for potential cloud computing solutions (Friedman and Hendry, 2012).

3

Strategies and Heuristics for Skillful Practice

Applying value sensitive design can seem daunting. After all, there is much to consider. Which methods? When in the design process? In what sequence? How to get started? How to talk with stakeholders and technologists about values in technical systems? How to balance values in tension? As with any complex practice, no simple algorithm or checklist will suffice to guide effective practice. That said, a set of methodological strategies and heuristics gleaned from existing value sensitive design projects point the way. Toward that aim, in this chapter we provide some practical suggestions for skillful practice.

3.1 Getting Started

Any of these core aspects—a value, technology, policy, or context of use—readily motivates value sensitive design. We suggest starting with the aspect that is most central to your work and interests. Woelfer, Hendry and their colleagues, for example, began with a population (homeless young people) and a value (safety) of central interest, and moved from there to implications for mobile phone design (Woelfer et al., 2011). In the case of computer security, Denning, Kohno and

their colleagues began with a technology (implantable cardiac devices) and a situated context of use (cardiac patients in their lived lives) (Denning et al., 2010); upon consideration of those two, values issues quickly came to the fore.

3.2 Clarify Explicitly Supported Project Values and Designer Stance

At the onset of the project, spend some time reflecting on and identifying the explicitly supported project values. As noted above, these values may be subject to a principled analysis negotiated through public processes, and/or tied to funding sources. With the explicitly supported project values in hand, then turn to articulate the researcher or designer stance. That is, as suggested by Borning and Muller (2012), make visible the background and perspectives of the individuals who are carrying out the work. For example, in their work in Rwanda with the Voices from the Rwanda Tribunal project, Yoo et al. (2013b) write about themselves:

> Our project originated with researchers at universities in the United States and Canada; and was developed further with Rwandan practitioners specializing in peace-building and healing communities. As with the collection of the testbed interviews, this work is independent of the Rwandan government, the ICTR, and the United Nations. The United States and Canadian members of our team are comprised of HCI researchers and designers; law, human rights, and conflict resolution scholars and practitioners; technologists; and videographers. In addition to domain area expertise, these team members bring familiarity with a multi-lifespan information system design framing and the Voices from the Rwanda Tribunal project. Several of these project team members have worked previously in Rwanda and elsewhere in Central and East Africa. The Rwandan members of our team are comprised of counselors and interpreters experienced in post-conflict healing. They bring expertise in

> working with survivors and perpetrators of widespread violence and recovery from trauma, particularly in the Rwandan context. Our Rwandan partner organization is Healing and Rebuilding Our Communities [HROC], a Quaker based organization. HROC regularly runs workshops in Rwanda, Burundi, and elsewhere in the Great Lakes Region that bring together perpetrators and survivors to rebuild their communities. The research reported here while situated with respect to community, place, participant composition, and receptiveness within the HROC workshop structure was independent of the HROC regular trauma healing and reconciliation workshops. (p. 2529)

3.3 Identify Direct and Indirect Stakeholders

Direct and indirect stakeholders can be identified using both conceptual and empirical methods. Typically, it is helpful to conduct an initial conceptual investigation that systematically identifies direct and indirect stakeholders; then confirm and/or revise those results based on empirical inquiry.

Many considerations go into a robust stakeholder analysis. To briefly discuss three, first, as stakeholder groups and subgroups are identified, it is helpful to develop clear definitions, recognizing that an individual may be a member of multiple groups. Addressing difficult edge cases for placing individuals within a stakeholder group often improves the analysis. For example, in the UrbanSim project, an individual who works as an urban planner and lives in the area is both a direct stakeholder (i.e., through his or her direct use of the simulation to evaluate proposed transportation plans) and an indirect stakeholder (i.e., by virtue of living in the community for which the transportation plans will be implemented). Second, because technologies often have far reaching effects, it is at times difficult to discern the most germane indirect stakeholder groups. As a heuristic, generate as many indirect stakeholder groups as possible and then give priority to indirect stakeholders who are strongly affected, particularly if

there is a moral issue involved, or to large groups that are somewhat affected. Third, among the many important challenges for meaningful involvement of stakeholders, one stems from differences in power relations (Floyd et al., 1989; Muller, 2003). For example, in organizational settings there might be low-level employees who are either direct or indirect stakeholders and who have little control over the design or use of a system (e.g., workers on an assembly line). Opportunities for participation will need to be carefully constructed so as to provide real possibilities to contribute ideas and concerns in as risk-free a manner as possible. In such instances, explicitly supported project values can go some distance toward legitimating the inclusion of and accounting for the perspectives of less powerful stakeholders.

3.4 Identify Benefits and Harms for Stakeholders

Having identified the key stakeholders in a particular design context, systematically identify the potential benefits and harms for each group. Given an interactional stance on technology and human activity, a broad perspective on benefits and harms at individual, societal, and environmental levels can be helpful. Both conceptual and empirical investigations can be employed here. Moreover, when conducting empirical investigations, attend to issues of technical, cognitive, and physical competency of stakeholders. In such cases, care must be taken to ensure that stakeholders' interests are represented in the design process either by representatives from the affected groups themselves or, if this is not possible, by advocates.

3.5 Identify and Elicit Potential Values

As the methods above suggest, there are numerous ways to identify values that are potentially relevant for a given technical design. Some of these methods involve conceptual investigations that draw on analytic strategies or philosophical arguments; others involve empirical investigations involving values discovery and elicitation from direct and indirect stakeholders. One analytic strategy entails mapping benefits and harms onto corresponding values. Specifically, with a list of benefits and

harms in hand, researchers and designers are in a strong position to recognize corresponding values. At times the mapping is immediate. For example, a harm that is characterized as invasion of privacy maps onto the value of privacy. Other times the mapping is less direct if not multifaceted. For example, with human-robot interaction, companionship may be one benefit; such a benefit potentially implicates not only the value of psychological welfare, but also those of accountability, identity and moral personhood. In some cases, the corresponding values will be obvious, but not always. Table 2.1 in the theory section provides a list of human values with ethical import often implicated in system design. As discussed within that section there are pros and cons to providing an explicit list of values that are frequently implicated in system design (cf Borning and Muller, 2012). On the one hand, such a list may help to orient researchers and designers more quickly to values of import and help to legitimate accounting for human values in the design process—particularly in settings for which such investigations are atypical. On the other hand, at best such lists are incomplete and at worst such lists can be (inappropriately) misused to reify the consideration of a certain set of values over others that might be equally important. Empirically based values representation and elicitation methods provide a complement to conceptual means of identifying values. Here any number of the methods—stakeholder generated value scenarios, value sketches, value-oriented semi-structured interview, value sensitive action-reflection model—can be used individually or in combination.

3.6 Develop Working Definitions of Key Values

As key values are identified from conceptual or empirical sources, develop careful working definitions for each. Here it is helpful to turn to the relevant literature. In particular, the philosophical literature can help provide criteria for what constitutes a particular value and, thereby, guide how to assess it empirically. For example, the existing literature helped provide criteria for the model of informed consent online described above. The adjective "working" is important here: generally

the working definition should be a few sentences—a book-length discussion of a value will be more difficult to use in providing useful guidance in the value sensitive design process.

3.7 Identify Potential Value Tensions

Values rarely exist in isolation. Rather, they often sit together in a delicate balance and, at times, come into conflict. Moreover, the tension among two or more values in one culture might be experienced quite differently in another. Once key values have been identified and carefully defined, a next step might entail examining potential conflicts or tensions among the key values. For the purposes of design, value tensions usually should not be conceived of as "either/or" situations but rather as constraints on the design space. Admittedly, at times designs that support one value directly hinder support for another. In those instances, a good deal of discussion among the stakeholders may be warranted to identify the space of workable solutions. Typical value tensions found in the literature are accountability vs. privacy (Miller et al., 2007), trust vs. safety (Czeskis et al., 2010)), environmental sustainability vs. economic development (Borning et al., 2005), privacy vs. access (Munson et al., 2011), and control vs. autonomy (Kaptein et al., 2011).

3.8 Heuristics for Interviewing Stakeholders

As part of an empirical investigation, it can be useful to interview direct and indirect stakeholders, to better understand their judgments about a context of use, an existing technology, or a proposed design. A semi-structured interview often offers a good balance between addressing the questions of interest and gathering new and unexpected insights. In these interviews, the following two heuristics can prove useful.

First, in probing stakeholders' reasons for their judgments, the simple question "Why?" can go a good distance. For example, seniors evaluating a ubiquitous computing video surveillance system might respond negatively to the system. When asked "Why?" a response might be: "I don't mind my family knowing that other people are visiting me,

so they don't worry that I'm alone—I just don't want them to know who is visiting." The researcher can probe again: "Why don't you want them to know?" An answer might be: "I might have a new friend I don't want them to know about. It's not their business." Here the first "why" question elicits information about a value tension (the family's desire to know about the senior's well-being, which the senior also values; and the senior's desire to control some information); the second "why" question elicits further information about the value of privacy for the senior.

Second, ask about values not only directly, but indirectly, based on formal criteria specified in the conceptual investigation. For example, suppose that you want to conduct an empirical investigation of people's reasoning and values about "X" (say, trust, privacy, or informed consent), and that you decided to employ an interview methodology. One option is to ask people directly about the topic. "What is X?" "How do you reason about X?" "Can you give me an example from your own life of when you encountered a problem that involved X?" There is some merit to this direct approach. Certainly it gives people the opportunity to define the problem in their own terms. But you may quickly discover that it comes up short. Perhaps the greatest problem is that people have concepts about many aspects of the topic on which they cannot directly reflect. Rather, you will usually be better served by employing an alternative approach. As is common in social cognitive research (see Kahn, 1999, chap 5, for a discussion of methods), you could interview people about a hypothetical situation, or a common everyday event in their lives, or a task that you have asked them to solve, or a behavior in which they have just engaged. But, no matter what you choose, the important point is a priori to conceptualize what the topic entails, if possible demarcating its boundaries through formal criteria, and at a minimum employing issues or tasks that engage people's reasoning about the topic under investigation.

3.9 Heuristics for Technical Investigations

When engaging in value-oriented technical investigations, the following three heuristics can prove useful:

First, the value sensitive design of technical mechanisms will often require adjudicating multiple if not conflicting values, often in the form of design trade-offs. We have found it helpful to make explicit how a design trade-off maps onto value tensions and differentially affects different groups of stakeholders. For example, in investigating the use of real-time displays of a local outdoor scene for people who work in windowless offices, Kahn et al. (2008) found that the technology may provide physiological benefits for those in the inside offices (the direct stakeholders), yet may impinge on the privacy and security of those walking through the outdoor scene (the indirect stakeholders), and especially women (Friedman et al., 2006b).

Second, unanticipated values and value tensions often emerge after a system is developed and deployed. Thus, when possible, design flexibility into the underlying technical architecture so that it can be responsive to such emergent concerns. In UrbanSim, for example, Freeman-Benson and Borning (2003) used agile programming techniques to design an architecture that can more readily accommodate new land use, transportation, and environmental indicators and models.

Third, the control of information flow through underlying protocols—and the privacy concerns surrounding such control—is frequently a strongly contested area. Ubiquitous computing and augmented reality, with sensors that collect and then disseminate information at large, has only intensified these concerns. We suggest that underlying protocols that involve the release of information should provide mechanisms to turn off that release (and in such a way that the stakeholders are confident that is has been turned off).

4

One Method in Action: Value Scenarios across Contexts

Having provided descriptions of a number of methodological strategies and heuristics, we now turn to a detailed illustration of the use of one method—value scenarios—across a range of contexts, stakeholders, and purposes as a way to explicate the robustness and integration of the methods more generally. Importantly, value sensitive design methods are often used together to achieve research and design goals. Thus, in the process of illustrating value scenarios, other methods such as the value sensitive action-reflection model, value sketches, and Envisioning Cards^{TM} are also discussed.

Same method, different type of investigations. The same method can be used in support of different types of investigations. As one illustration, value scenarios have been used in conceptual, empirical and technical investigations as follows. In their conceptual analyses of parenting technologies with teenagers, Czeskis et al. (2010) used value scenarios early in their work to explore the research and design space and to surface potential tensions among various stakeholders. Specifically, they generated approximately 20 value scenarios, each one focused on a different constellation of elements that followed from their conceptual work. Below is one scenario they wrote that provides a vision for how a

mobile phone tracking and context monitoring application might influence the lives of direct stakeholders (teens and their parents) as well as indirect ones (the teen's friends and those friends' parents). In the scenario, while providing some comfort for parents and a particular sense of connection, values such as trust and respect appear to be eroded as the technology easily allows parents to watch their teens unnoticed. At its broadest level the scenario points to the possibility for far-reaching changes in societal expectations and norms around what constitutes good parenting.

Value Scenario: One Dad's Dilemma

Mobile parenting technology. PhoneTracker is a hypothetical mobile phone application and website designed to help parents keep track of their teens. Once installed on a mobile phone, parents can use the application to surreptitiously turn on the phone's microphone or to read text messages on the teen's phone at any time (by logging into a webpage).

Scenario. Paul puts a great store of trust in his 14-year old son Ben. He's been raising Ben in a suburb of San Jose, California since Ben's Mom passed away six years ago. They talk to each other a lot: share baseball, play music, take canoe trips. Although they are very close, things have changed a bit since Ben entered high school a few months ago. Ben hangs out with friends more, communicates less, and generally spends less time around the house. Paul misses the connection with Ben but figures this is normal for a teen. After all, teens need their privacy and space from their parents.

At Paul's work, talk of "life with teens" is common conversation. Several of Paul's coworkers have been telling tales: they suspect their teens of experimenting with drugs, notice alcohol on their teens' breath, and reckless driving. Last

week, Betty bragged about a mobile phone app her husband had secretly installed on their daughter's cell phone: PhoneTracker. Now Betty knows where her daughter is hanging out, with whom, and what they're talking about. From reading text messages on her daughter's cell phone, Betty got a tip that the party planned for Saturday night would be pretty rough. So Betty planned a family gathering for Saturday night and "nipped that one in the bud." In no uncertain terms, Betty told Paul that in this day and age, any parent who isn't using a tool like PhoneTracker to keep tabs on their teens is being a negligent parent. Downright irresponsible. And, irresponsible not only with respect to their teen but also with the other teens involved. At first Paul is appalled that Betty is "spying" on her daughter. But over time, pressured by Betty's stories as well as her comments that he is oblivious and naive, Paul begins to question his own judgment as a parent. He secretly installs PhoneTracker on Ben's phone.

Over the next several months, Paul checks Ben's activities regularly. Paul notices no discontinuities between Ben's stories and what PhoneTracker reports. Paul also develops a good sense of whom Ben hangs out with, where they go, and how they spend their time. It's a funny but comforting sort of communication. To his surprise, Paul also learns a great deal about Ben's best friend Jon. Things Jon's parents probably don't know. Paul wonders about that—is he spying on Jon too? Is he obligated to tell Jon's parents? How would he feel if Jon's parents were watching Ben in this way?

Then the whole thing fell apart. One evening, while Paul was checking Ben's activities on PhoneTracker's website, Ben came up behind him. Ben saw what his father was looking at. Ben went ballistic—storming out of the house, shouting that Paul does not trust him. The next day, Ben threw his phone away and clams up. He's mad and sullen.

> Somehow, Paul's and Ben's relationship is never quite the same. [Czeskis et al. (2010, p. 4)]

In contrast to the conceptual use of designer-generated value scenarios in Czeskis et al. (2010), as part of an empirical investigation Woelfer et al. (2011) placed value scenarios in the hands of homeless young people and the service providers and police officers with whom they interact regularly. Specifically, to elicit ideas for how a mobile phone could help homeless young people stay safe, Woelfer and her colleagues instructed participants to write their own value scenarios addressing safety, with this prompt:

> Homeless youth and young adults may face special challenges in keeping safe from harm. Please write a story about how a cell phone could help to keep a homeless youth or young adult safe. There are no right answers. The story can be as long or short as you like. It can be about a real situation or about a fictional situation. [Woelfer et al. (2011, p. 1710)]

This prompt resulted in value scenarios that, taken together, revealed key considerations for the design of mobile phones for improving safety, including situation (e.g., reaction to a hostile event, accident), purpose (e.g., warn others of an impending event, document an event), mobile phone technology (e.g., functionality such as making calls or recording audio), and locus of welfare (e.g., self or other-directed). For example, one homeless young man wrote about the use of mobile phones to document police abuse:

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

A homeless young woman called attention to the benefits of having a mobile phone (functional or not) and wrote:

> "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 all of the value scenarios pointed to benefits from mobile phones. For instance, another homeless young man foregrounded the reality of living on the streets and highlighted the potential for increased vulnerabilities and risk to safety:

> "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."

Yoo et al. (2013a) extended this empirical work with homeless young people to a technical co-design activity that employed value scenarios as a key design prompt. Specifically, in the context of the value sensitive action-reflection model, Yoo and her colleagues asked homeless young people and those with whom they interact regularly to design (including physically constructing a paper prototype or mock-up) a mobile phone that would help to keep homeless young people safe. 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.

Following the value sensitive action-reflection model, once participants had an initial design and prototype in hand, they were given a sample of 11 stakeholder-generated value scenarios from the Woelfer et al. (2011) study above, repurposed to use as stakeholder prompts. Participants were instructed to select one value scenario card and to consider their prototypes in light of the situation described in the scenario. Then, they completed a specification sheet to record any changes they would make to their prototypes or to explain why no changes were needed to accommodate the situation conveyed in the value scenario.

Same method, different stakeholder groups. While it seems readily apparent that the same method can be used with the different stakeholder groups, it nonetheless bears saying. In the detailed example above regarding value scenarios, Woelfer et al. (2011) used value scenarios with four stakeholder groups: homeless young people, service providers, police officers, and community members; and Yoo et al.

(2013a) with three of those four stakeholder groups: homeless young people, service providers, and police officers.

Same method, different purposes. It is also the case that the same method can be used for different purposes in the research and design process. Depending on the method, purposes might include:

- Communicating with a client
- Representing values relevant to a particular technical design
- Elicitating values from diverse stakeholder groups both direct and indirect
- Legitimating value considerations to key decision-makers
- Prompting value considerations in a prototyping or mock-up context
- Selecting among various technical options in a design process
- Evaluating the quality of a proposed technical design
- Providing assessment criteria for a deployed technology.

Returning to the detailed discussion of value scenarios above, Czeskis et al. (2010) used value scenarios to guide their initial conceptual analysis of values relevant to a particular technical design, that of mobile parenting technologies for teens; Woelfer et al. (2011) as a values elicitation method with diverse stakeholder groups including homeless young people, service providers, and police officers; and Yoo et al. (2013a) as a value sensitive design prompt in a co-design activity as part of the value sensitive action-reflection model.

Same purpose, different methods. At times, well-chosen methods used in combination may yield more meaningful results than a single method in isolation. In fact, any mixed method approach typically would be based on a similar rationale. Recall from above, in their work with homeless young people and those with whom they regularly interact, Woelfer et al. (2011) were interested in eliciting participants'

understandings of safety for homeless young people and the potential for mobile phones to improve those situations. To do so, they employed value scenarios as a means to tap into participants' stories about safety (or the lack thereof) in conjunction with value sketches of the local neighborhood in which participants identified safe and less safe places within the community as a means to tap into participants' experiences of safety tied to physical place. As a second example and working with similar populations, Yoo et al. (2013a) used stakeholder-generated value scenarios (from the Woelfer et al. (2011) study) as structured prompts in a co-design process that, in turn, was part of a value sensitive action-reflection model. Moreover, as part of that model, Envisioning Cards™ were also employed as designer-generated structured prompts in the same co-design prototyping process. Thus, to achieve the goal of eliciting participants' ideation for using mobile phones to improve safety for homeless young people, value scenarios, Envisioning Cards™, value-oriented prototyping, and the value sensitive action-reflection model were used in combination.

Same stakeholder group, different methods. A corollary following from the discussion of "same purpose, different methods" entails the observation "same stakeholder group, different methods." Specifically, the stakeholder groups in Woelfer et al. (2011) each engaged with value scenarios and value sketches; those in Yoo et al. (2013a) value scenarios, Envisioning Cards™, value-oriented prototypes, and the value sensitive action-reflection model.

5

Concluding Reflections

We conclude with reflections on core characteristics of value sensitive design methodology and opportunities for innovation.

5.1 Some Core Characteristics of Value Sensitive Design Methodology

Stepping back, value sensitive design methodology has the following core characteristics:

1. *Engaging the theoretical constructs.* Value sensitive design comprises a constellation of theoretical commitments, including an interactional stance on socio-technical systems, the tripartite methodology, consideration of both direct and indirect stakeholders, and engagement with value tensions. (See Chapter 1 for a summary of the theoretical constructs for value sensitive design.) A robust value sensitive design approach entails engaging these commitments throughout the technical design process. While employing a single value sensitive design method is unlikely to satisfy all of the theoretical commitments, using a variety of methods in combination positions the designer to do so.

2. *Employing the tripartite methodology.* A robust value sensitive design process typically involves all three types of investigations in the tripartite methodology—conceptual, empirical, and technical—employed in an integrative and iterative manner. Individual methods comprise critical building blocks for the tripartite methodology. Each method does a specific type of work relevant for engaging with values in technical design and, in so doing, makes a critical contribution to the value sensitive design process.

3. *Mapping method onto type of investigation.* In principle, a particular method can be used in any type of investigation—conceptual, empirical or technical. As illustrated in this article, the value scenario method can be used conceptually to explore a technology's anticipated impacts on potential stakeholders, as well as empirically to investigate stakeholders' views and visions for an emerging technology.

4. *Methodological innovation.* There are many opportunities for methodological innovation in value sensitive design. The 14 methods documented here provide a good jumping off point. Innovation is often spurred by specific projects that require the invention of new methods in order to make progress. Moreover, innovation can take many forms, ranging from small changes or adaptations of existing methods to the invention of entirely new methods. Some areas in which methodological innovation is particularly needed include identifying and prioritizing indirect stakeholders (and especially, how in some cases to make and justify the difficult decision to set some aside); eliciting emotions closely tied to values; multi-lifespan envisioning; and resolving value tensions.

5. *Sequencing methods in a design process.* The purpose and design rationale for each method provides guidance on when that method will be helpful in the design process, to what end, and in what sequence with other methods. By and large, there are no *a priori* constraints on when a particular method can be used in the design process, or be preceded or succeeded by other methods.

6. *Integrating value sensitive design into an overall development process.* Value sensitive design is intended to be used alongside of other technical processes and approaches. In principle, value sensitive design can be used with a wide range of technical approaches, such as various approaches to agile software engineering, to security and trusted computing, and others.

5.2 Innovating Method with Value Sensitive Design

Being *sensitive* to the design situation—including stakeholders, tools and technologies, values, and value tensions—is a key commitment of value sensitive design. To be responsive and engaged in a design situation—that is, to be sensitive to it—often requires nuanced use of theory and creative appropriation of method. Innovating method when needed, in short, can be a key element of using value sensitive design. The prior chapters reveal some of the innovative aspects of using method. Still, skillful practice defies easy written description. It has to be learned experientially, through action and reflection.

How should a researcher or designer use a particular method and for what purposes? In brief, whichever method or methods in combination make good sense for the design situation. The following considerations, while not exhaustive and based on our experience only, may help to guide the creative appropriation of methods.

1. Draw on the interactional stance, and seek an iterative and integrative use of method as the design process unfolds over time. Be sensitive to the design situation; expect to appropriate and extend method to your own purposes.

2. Use methods to identify and avoid blind spots. For example, early in the design process, conduct a conceptual investigation to identify key stakeholders (direct and indirect), benefits and harms, values, and value tensions; and when pursuing an empirical investigation, rather than relying on a single values elicitation method, use a variety of methods to accommodate the expressive preferences of diverse stakeholders.

3. Distinguish between designer values, explicitly supported project values, and stakeholder values. Periodically check for and document alignments and tensions among these value sources; use this analysis to develop rationale for the selection and use of method.

4. Consider how stakeholders can take on the role of designer and be positioned to employ method. Analyze participants' design products, and move forward with the design process.

5. Continue to elicit stakeholder values throughout the design process, to support problem definition, to shape and refine design solutions, and to inform the evaluation of the evolving system. If new values of import surface during the design process, engage them. As appropriate, draw on the existing literature to develop criteria for defining these values and write working definitions.

6. There are almost always unanticipated consequences of newly designed and deployed technologies. Thus, if possible, continue the value sensitive evaluation process throughout the deployment phase, and plan to make changes to the system and the implementation if new issues of import surface.

5.3 Conclusion

The central contribution of this survey article is to bring together a collection of value sensitive design methods. These methods—along with the heuristics and examples discussed here—go a good distance toward providing tools for engaging substantively with human values in the technical design process. At the same time, emerging technologies continue to change societies in complex and nuanced ways. Accordingly, we anticipate that new methods used alone or in combination will be needed to advance these new frontiers. In response, researchers, designers, and engineers will bring their experience with methods from a wide array of disciplines, along with their imaginations and creativity, to produce new methods and design knowledge. Through such activity, value sensitive design methods and design knowledge will expand, providing an ever-richer toolset.

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