Value Sensitive Design: Theory and Methods

Batya Friedman
The Information School
University of Washington
Box 352840
Seattle, WA 98195 USA
+1 206 616 2548
batya@u.washington.edu

Peter H. Kahn, Jr.
Department of Psychology
University of Washington
Box 351525
Seattle, WA 98195 USA
+1 206 616 9395
pkahn@u.washington.edu

Alan Borning
Dept. of CS and Engineering
University of Washington
Box 352350
Seattle, WA 98195 USA
+1 206 543 6678
borning@cs.washington.edu

ABSTRACT

Value Sensitive Design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process. It employs an integrative and iterative tripartite methodology, consisting of conceptual, empirical, and technical investigations. We explicate Value Sensitive Design by drawing on three research and design projects. One project involves cookies and informed consent in web browsers; the second involves projection technology in an office environment; the third involves user interactions and interface for an integrated land use, transportation, and environmental simulation.

Keywords

Awareness, cookies, democracy, design methods, ethics, human values, indicators, informed consent, privacy and public space, projection technology, simulation, social computing, theory, Value Sensitive Design, web browsers

INTRODUCTION

The CHI community has had a longstanding interest in designing systems that support enduring human values. Numerous researchers have focused, for example, on the value of *privacy* [1, 2, 9, 10, 20, 26], *ownership* and *property* [15], *physical welfare* [14], *freedom from bias* [8], *universal usability* [24, 27], *autonomy* [25, 29], *informed consent* [16], and *trust* [3, 20, 22, 30].

Despite such interest, there remains a need for an overarching theoretical and methodological framework by which to handle the value dimensions of design work. In response, such an approach has emerged, called Value Sensitive Design. Value Sensitive Design's early work helped to shape successful CHI panels in 1994, 1999, and 2001, and an edited volume titled *Human Values and the Design of Computer Technology* [4]. More recently, the National Science Foundation sponsored two successful workshops on Value Sensitive Design (see www.ischool.washington.edu/vsd). These workshops have, in turn, led various workshop participants to draw on Value Sensitive Design in their current work. Moreover, Value Sensitive Design helped frame a chapter titled "Human Values, Ethics, and Design" in the recent *Handbook of Human-Computer Interaction* [6].

Dept. Of Computer Science & Engineering
University of Washington
Technical Report 02-12-01
December 2002

Although Value Sensitive Design has become increasingly useful and visible in the CHI community, there has not yet been an overarching account of it in the literature. In this paper, we offer such an account, emphasizing Value Sensitive Design's theory and methods. Our goal is to provide enough detail such that other researchers and designers can systematically build on and critically examine this approach.

We begin by situating Value Sensitive Design in the context of other approaches to ethics and design. Then we describe Value Sensitive Design's integrative tripartite methodology that involves conceptual, empirical, and technical investigations, employed iteratively. Next, we explicate Value Sensitive Design by drawing on three research and design projects. One project involves cookies and informed consent in web browsers; the second involves projection technology in an office environment; the third involves user interactions and interface for an integrated land use, transportation, and environmental simulation.

WHAT IS VALUE SENSITIVE DESIGN?

Value Sensitive Design is a theoretically grounded approach to the design of technology that accounts for human values in a principled and comprehensive manner throughout the design process.

Early interest in computer technology, values, and design emerged in the work Norbert Wiener (1954) and others. More recently, such interest has led to such areas as Computer Ethics, Social Informatics, Participatory Design, and Computer-Supported Cooperative Work.

Elsewhere [6], we have reviewed these approaches in some depth, delineating what each brings in terms of values and design to the HCI community, and where in our view each is limited. In brief, Computer Ethics advances our understanding of key values that lie at the intersection of computer technology and human lives. However, the field often remains too divorced from technical implementations, and has focused too often on a single value at a time. Yet, as HCI professionals, we commonly wrestle with design trade-offs among competing values. Social Informatics has been successful in providing socio-technical analyses of deployed technologies. But it, too, often yields too little in terms of actual changes in design and says little about the design process. Computer Supported Cooperative Work (CSCW) has been successful in the design of new technologies to help people collaborate effectively in the workplace. But its original domain (the workplace), and its emphasis on the value of cooperation, are narrowly framed. Finally, Participatory Design substantively embeds democratic values into its practice and brings to the table important techniques, such as Future Workshops. However, when applied in diverse contexts, Participatory Design may not provide enough guidance when divisive constituencies argue on the basis of narrowly conceived self interests and hostile prejudices: after all, at least in principle, Participatory Design values each participant's voice, even those that appear uncaring and unjust.

While sharing and adopting many interests and techniques from the above approaches, Value Sensitive Design brings forward a unique constellation of features. First, Value Sensitive Design seeks to be proactive: to influence the design of technology early in and throughout the design process. Second, Value Sensitive Design enlarges the arena in which values arise to include not only the work place (as traditionally in the field of CSCW), but also education, the home, commerce, online communities, and public life. Third, Value Sensitive Design enlarges the scope of human values beyond those of cooperation (CSCW) and participation and democracy (Participatory Design) to include all values, especially those with moral import. Fourth, Value Sensitive Design contributes a unique integrative methodology that involves conceptual, empirical, and technical investigations. Fifth, Value Sensitive Design is an interactional theory: values are viewed neither as inscribed into technology (an endogenous theory), nor as simply transmitted by social forces (an exogenous theory). Rather people and social systems affect technological development, and new technologies shape (but do not rigidly determine) individual behavior and social systems [6]. Sixth, Value Sensitive Design draws on moral epistemology to offer a principled approach to design that maintains that certain values (such as those that pertain to human welfare, rights, and justice) have moral standing independent of whether a particular person or group upholds such values. Seventh, moral epistemology aside, Value Sensitive Design maintains that certain values are universally held, although how such values play out in a particular culture at a particular point in time can vary considerably. For example, even while living in an igloo, Inuits have conventions that ensure some forms of privacy; yet such forms of privacy are not maintained by separated rooms, as they are in most Western cultures. Generally, the more concretely (act-based) one conceptualizes a value, the more one will be led to recognizing cultural variation; conversely, the more abstractly one conceptualizes a value, the more one will be led to recognizing universals. Value Sensitive Design seeks to work both levels, the concrete and abstract, depending on the design problem at hand.

THE TRIPARTITE METHODLOGY: CONCEPTUAL, EMPIRICAL, AND TECHNICAL INVESTIGATIONS

Think of an oil painting by Monet or Cézanne. From a distance it looks whole; but up close you can see many layers of paint upon paint. Some paints have been applied with careful brushstrokes, others perhaps energetically with a palate knife or fingertips, conveying outlines or regions of color. The diverse techniques are employed one on top of the other, repeatedly, and in response to what has been laid down earlier. Together they create an artifact that could not have been generated by a single technique in isolation of the others. So, too, with Value Sensitive Design. An artifact (e.g., system design) emerges through iterations upon a process that is more than the sum of its parts. Nonetheless, the parts provide us with a good place to start. Value Sensitive Design builds on an iterative methodology that integrates conceptual, empirical, and technical investigations; thus, as an initial step toward conveying Value Sensitive Design, we describe each investigation separately.

Conceptual Investigations

What are values? Whose values should be supported in the design process? How are values supported or diminished by particular technological designs? How should we engage in trade-offs among competing values in the design, implementation, and use of information systems (e.g., autonomy vs. security, or anonymity vs. trust)? Should moral values (e.g., a right to privacy) have greater weight, or even trump, non-moral values (e.g., aesthetic preferences)? Value Sensitive Design takes up these questions under the rubric of conceptual investigations: philosophically informed analyses of the central constructs and issues under investigation.

Careful working conceptualizations of specific values clarify fundamental issues raised by the project at hand, and provide a basis for comparing results across research teams. For example, in their analysis of trust in online system design, Friedman, Kahn, and Howe [7] first offer a philosophically informed working conceptualization of trust. They propose that people trust when they are vulnerable to harm from others, yet believe those others would not harm them even though they could. In turn, trust depends on people's ability to make three types of assessments. One is about the harms they might incur. The second is about the good will others possess toward them that would keep those others from doing them harm. The third involves whether or not harms that do occur lie outside the parameters of the trust relationship. From such conceptualizations, Friedman et al. were able to distinguish what they meant by trust online from what other researchers have meant by the term. For example, the Computer Science and Telecommunications Board, in their thoughtful publication *Trust in Cyberspace* [23], adopted the terms "trust" and "trustworthy" to describe systems that perform as expected along the dimensions of correctness, security, reliability, safety, and survivability. Such a definition, which equates "trust" with expectations for machine performance, differs markedly from one that says trust is fundamentally a relationship between people (sometimes mediated by machines).

Conceptual investigations do not by themselves involve costly empirical analyses, but instead thoughtful consideration of how stakeholders might be socially impacted by one's technological designs. Two classes of stakeholders exist: direct and indirect. Direct stakeholders refer to parties – individuals or organizations – who interact directly with the computer system or its output. Indirect stakeholders refer to all other parties who are affected by the use of the system. Often, indirect stakeholders are ignored in the design process. For example, computerized medical records systems have been designed with many of the direct stakeholders in mind (e.g., insurance companies, hospitals, doctors, and nurses) but with too little regard for the values, such as the value of privacy, of a rather important group of indirect stakeholders: the patients.

Empirical Investigations

Conceptual investigations can only go so far. Depending on the questions at hand, many analyses will need to be informed by empirical investigations of the human context in which the technical artifact is situated. Empirical investigations are also often needed to evaluate the success of a particular design. Empirical investigations encompass any human activity that can be observed, measured, or documented. Thus, the entire range of quantitative and qualitative methods used in social science research may be applicable here, including observations, interviews, surveys, experimental manipulations, collection of relevant documents, and measurements of user behavior and human physiology.

Empirical investigations can focus, for example, on the following questions: How do stakeholders apprehend individual values in the interactive context? How do they prioritize competing values in design trade-offs? How do they prioritize individual values and usability considerations? Are there differences between espoused practice (what people say) compared with actual practice (what people do)? Moreover, because the development of new technologies affects groups as well as individuals, questions emerge of how organizations appropriate value considerations in the design process. For example, regarding value considerations, what are organizations' motivations, methods of training and dissemination, reward structures, and economic incentives? How can designers bring values into consideration, and in the process generate increased revenue, employee satisfaction, customer loyalty, or other desirable outcomes for their companies?

Usability stands in a unique relationship with Value Sensitive Design. In terms of a general framework, four relationships between usability and human values with ethical import can be identified. First, a design can be good for usability and independently good for human values with ethical import (e.g., a highly usable adaptable interface can also promote user autonomy). Second, a design can be good for usability but at the expense of human values with ethical import (e.g., a highly usable system for surveillance that undermines the value of privacy). Third, a design can be good for human values with ethical import but at the expense of usability (e.g., a web browser setting that asks the user to accept or decline each cookie individually supports the value of informed consent, but is largely unusable due to the nuisance factor). And fourth, a design good for usability may be necessary to support human values with ethical import (e.g., in order to have a fair national election using a computerized voting system, all citizens of voting age must be able to use the system). It is important for HCI professionals to be aware of the complex relationships between usability and human values with ethical import. At times, the two support one another; at other times it will be necessary to give ground judiciously on one or the other to create a viable design.

Technical Investigations

Value Sensitive Design adopts the position that technologies in general, and information and computer technologies in particular, provide value suitabilities that follow from properties of the technology. That is, a given technology is more suitable for certain activities and more readily supports certain values while rendering other activities and values more difficult to realize. For example, a screwdriver is well suited for tightening screws but functions poorly as a ladle, pillow, or wheel. Or an online calendar system that displays individuals' scheduled events in detail readily supports accountability within an organization but makes privacy difficult.

In one form, technical investigations focus on how existing technological properties and underlying mechanisms support or hinder human values. For example, some video-based collaborative work systems provide blurred views of office settings, while other systems provide clear images that reveal detailed information about who is present and what they are doing. Thus the two designs differentially adjudicate the value trade-off between an individual's *privacy* and the group's *awareness* of individual members' presence and activities.

In the second form, technical investigations involve the proactive design of systems to support values identified in the conceptual investigation. For example, Fuchs [9] developed a notification service for a collaborative work system in which the underlying technical mechanisms implement a value hierarchy whereby an individual's desire for privacy overrides other group members' desires for awareness.

At times, technical investigations – particularly of the first form – may seem similar to empirical investigations insofar as both involve technological and empirical activity. However, they differ markedly on their unit of analysis. Technical investigations focus on the technology itself. Empirical investigations focus on the people who or larger social systems that configure, use, or are otherwise affected by the technology.

VALUE SENSITIVE DESIGN IN PRACTICE: THREE RESEARCH AND DESIGN PROJECTS

To illustrate Value Sensitive Design's integrative and iterative tripartite methodology, we draw on three research projects with real world applications, one completed and two under way. Each project represents a unique design space.

Cookies and Informed Consent in Web Browsers

Informed consent provides a critical protection for privacy, and supports other human values such as autonomy and trust. Applying Value Sensitive Design, Friedman, Felten and their colleagues [5, 16] sought to improve the support for informed consent in web-based interactions, particularly through the development of new technical mechanisms for cookie management in the web browser.

Friedman et al. began their project with a conceptual investigation of informed consent itself. They drew on diverse literature, such as the Belmont Report (which delineates ethical principles and guidelines for the protection of human subjects), to show that the concept of "informed" encompasses disclosure and comprehension. Disclosure refers to providing accurate information about the benefits and harms that might reasonably be expected from the action under consideration. Comprehension refers to the individual's accurate interpretation of what is being disclosed. In turn, the concept of "consent" encompasses voluntariness, competence, and agreement. Voluntariness refers to ensuring that the action is not controlled or coerced, and that an individual could reasonably decline participation should he or she wish to. Competence refers to possessing the mental, emotional, and physical capabilities needed to give informed consent. Finally, agreement refers to a clear opportunity to accept or decline to participate.

To validate and refine their resulting conceptual analysis, and initiate their technical design work, Friedman et al. then conducted a retrospective analysis of how the cookie and web-browser technology embedded in Netscape Navigator and Internet Explorer changed – with respect to informed consent – over a 5-year period, beginning in 1995. This investigation of each browser's technological properties and underlying mechanisms led them to conclude that, while cookie technology has improved over time regarding informed consent, some startling problems remained. For example, as of 1999, in both Netscape Navigator and Internet Explorer, the information disclosed about a cookie still did not adequately specify what the information will be used for or how the user might benefit or be harmed by its use. Moreover, the default setting for both browsers was to accept all cookies with no obvious visibility to the user.

Friedman et al. then used the results from the above conceptual and technical investigations to guide their redesign of the Mozilla browser (the open-source code for

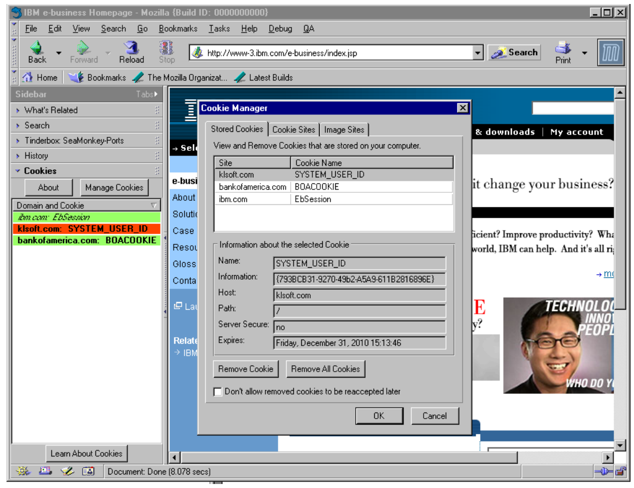

Figure 1. Screen shot of the Mozilla implementation showing the peripheral awareness of cookies interface (at the left) and the just-in-time cookie management tool (in the center). Each time a cookie is set, a color-coded entry for that cookie appears in the sidebar. Third party cookies are red; others are green. At the user's discretion, he or she can click on any entry to bring up the Mozilla cookie manager for that cookie.

Netscape Navigator). Specifically, they developed three new types of mechanisms: (a) peripheral awareness of cookies; (b) just-in-time information about individual cookies and cookies in general; and (c) just-in-time management of cookies (see Figure 1). They periodically conducted formative evaluations of their work in progress to assess how well their design supported the user experience of informed consent. Their assessment instruments for informed consent also drew from and later provided guidance to their conceptual investigation. For example, during one of the initial empirical investigations, Friedman et al. discovered that users wanted to control cookies with only minimal distraction from their task at hand. This finding not only contributed to the technical designs described above (which in response incorporated peripheral awareness and just-in-time interventions), but also enhanced the initial conceptual investigation (for example by adding the criterion of minimizing distraction from the task at hand).

Thus, this project helps illustrate the iterative and integrative nature of Value Sensitive Design. While the project began with a conceptual investigation of relevant values, it moved quickly to the development of new technical mechanisms to support those values, to empirical validation of the technical work in light of the conceptual investigations, and back again to the refinement of the technical mechanisms. This project also demonstrates that Value Sensitive Design can be applied successfully to mainstream Internet software for a diverse group of users.

Office Window of the Future

> *Steve glances up from his desk to see the plaza and fountain area outside his building. The sun has broken through the clouds and small groups of people are gathering, including two co-workers he has wanted to*

catch up with. Spur of the moment, Steve grabs his lunch and dashes outside to catch his co-workers.

There's nothing particularly startling about this workplace scenario – except that Steve works in an interior office. Instead of a real window looking out onto the plaza, Steve has a large screen video plasma display that continuously projects the local outdoor scene in real-time.

This scenario – an inside "office window of the future" – is currently being researched as both a laboratory experiment and a field study by Kahn, Friedman, and their colleagues. Previous psychological literature suggests that viewing natural scenes can promote positive physiological and psychological effects [12]. Accordingly, there is an increasing awareness that buildings need to be designed with nature in mind, and in view. But can technology substitute for a direct view of nature?

Kahn et al.'s laboratory experiment involves individuals working in one of three conditions in the otherwise identical office: a real window view of a beautiful nature scene (of a fountain, plaza, and extended green areas and trees); a real-time HDTV projection of the identical scene on a large plasma display that covers the original window (see Figure 2); and a blank wall (mimicking an inside office). Psychological measures include (a) physiological data (electrocardiogram and skin conductance), (b) behavioral data (performance on cognitive and creativity tasks; video and audio observational data); and (c) social-cognitive data (based on an hour-long interview with each participant at the conclusion of the tasks to garner each participant's perspective on the experience). Kahn et al.'s overarching hypothesis is that the HDTV video plasma display window will garner some but not all of the psychological benefits of the real window, and more psychological benefits compared to the blank wall.

In shaping their research, Kahn et al. explicitly drew on Value Sensitive Design. Three ideas are worth highlighting. First, Kahn et al. engaged in an initial conceptual investigation of the values implicated and stakeholders affected by such projection technology. At that point, it became clear that an important class of indirect stakeholders (and their respective values) needed to be included: namely, the individuals who, by virtue of walking through the fountain scene, unknowingly had their images displayed on the video plasma display in the "inside" office. In other words, if this application of projection technology were to take hold societally (as web cams and surveillance cameras have begun to) then it would potentially encroach on the privacy of individuals in public spaces – an issue that has been receiving increasing attention in the field of computer ethics and public discourse [17]. Thus, in addition to their experimental data collection with potential users of this future plasma window (direct stakeholders), Kahn et al. embarked on two additional but complementary empirical investigations with indirect stakeholders: (a) a survey of 750 people in the

Figure 2. Person (demonstrator) working in an office with a "window of the future" – a large screen plasma display that is projecting real-time HDTV images of the local outdoor scene.

plaza about privacy in general, and in particular having their real-time images captured and projected on plasma displays in nearby and distant offices; and (b) in-depth social cognitive interviews with 30 people in the plaza about similar issues.

Second, under the rubric of empirical investigations, Value Sensitive Design supports multiple empirical methods to be used in concert to address the question at hand. For example, in assessing whether human welfare is enhanced by the plasma window, Kahn et al. sought physiological and performance data, as well as data regarding the user's conscious perceptions of those effects.

Third, Kahn et al. plan to draw on the results of their conceptual and empirical investigations to help shape their future technical investigations, particularly in terms of how nature (as a source of information) can be embedded in the design of projection technologies to further human well-being. Their goal here is to address values early on in the design of what may become a potentially widely deployed technology.

UrbanSim: Integrated Land Use, Transportation, and Environmental Simulation

In many regions in the United States (and globally), there is increasing concern about pollution, traffic jams, resource consumption, loss of open space, loss of coherent community, lack of sustainability, and unchecked sprawl. Elected officials, planners, and citizens in urban areas grapple with these difficult issues as they develop and evaluate alternatives for such decisions as making a major transportation investment, establishing an urban growth boundary, or changing incentives or taxes. These decisions interact in complex ways, and, in particular, transportation and land use decisions interact strongly with each other. There are both legal and common sense reasons to try to understand the long-term consequences of these interactions and decisions. Unfortunately, the need for this understanding far outstrips the capability of the analytic tools used in current practice.

In response to this need, Waddell, Borning, and their colleagues have been developing UrbanSim, a large simulation package for predicting patterns of urban development for periods of twenty years or more, under different possible scenarios [18, 28]. Its primary purpose is to provide urban planners and other stakeholders with tools to aid in more informed decision-making, with a secondary goal to support further democratization of the planning process. When provided with different scenarios – packages of possible policies and investments – UrbanSim models the resulting patterns of urban growth and redevelopment, of transportation usage, and of resource consumption and other environmental impacts. Currently UrbanSim is undergoing a large-scale 5-year redevelopment and extension in terms of its underlying architecture, interface, and social goals. Under the direction of Borning and Friedman, Value Sensitive Design is central to this endeavor.

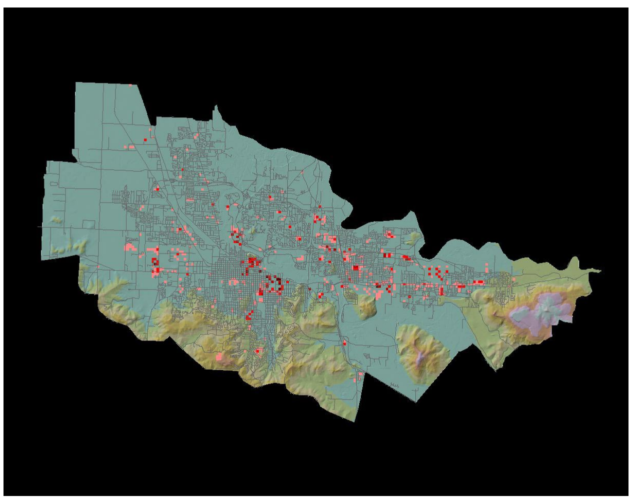

Figure 3. Results displayed in a map format from UrbanSim of the Eugene/Springfield, Oregon simulation, forecasting land use patterns over a 14-year period (in this case, employment density). The outputs are generated by the simulated interactions among demographic change, economic change, real estate development, transportation, and other actors and processes in the urban environment.

To date, UrbanSim has been applied in Eugene/Springfield, Oregon (Figure 3), Honolulu, Hawaii, and Salt Lake City, Utah. Application to the Seattle, Washington, and Houston, Texas regions is under way. Moreover, UrbanSim has been recently been brought into the middle of a land use and transportation dispute in Salt Lake City. The situation is this. A new freeway had been planned for the Salt Lake City area, and after years of controversy, construction was imminent. In response, an environmental group (the Sierra Club) brought a lawsuit, wherein they claimed that the potential land use and environmental impacts of the proposed freeway had not been adequately evaluated, as required by law. In a June 2002 out-of-court settlement, all parties agreed to use UrbanSim to conduct this evaluation. Still more recently, the Governor's Office in the state of Utah has sought to move land use and transportation decision-making away from litigation and toward mediation. The plan is to use UrbanSim as an integral part of this endeavor, to proactively shape social process.

From the standpoint of conceptual investigations, UrbanSim as a design space poses tremendous challenges. For one thing, the UrbanSim research team cannot focus on a few key values, as occurred in the Web Browser project (e.g., the value of informed consent), or Office Window of the Future project (e.g., the value of privacy in public spaces, and physical and psychological well-being). Rather, disputing stakeholders bring to the table widely divergent values about environmental, political, moral, and personal issues. How does one characterize the wide-ranging and deeply held values of diverse stakeholders, both present and future? Moreover, how does one prioritize the values implicated in the decisions? Should the simulation handle moral and non-moral values differently, particularly in the interface? What if stakeholders' beliefs about human psychology, land use patterns, and economic development (and their related benefits and risks) are misinformed or shortsighted? Should the simulation seek to educate its users? The questions abound. Defensible conceptual answers are needed for the success of the technical artifact.

To illustrate how Value Sensitive Design is being applied in this project, we describe a few emerging answers. In their conceptual investigations, Borning et al. distinguished between *explicitly supported values* (i.e., ones that they explicitly wanted to embed in the simulation) and *stakeholder values* (i.e., ones that were important to some but not necessarily all of the stakeholders). Examples of stakeholder values are environmental sustainability, walkable neighborhoods, space for business expansion, affordable housing, freight mobility, minimal government intervention, minimal commute time, open space preservation, property rights, and environmental justice. In contrast to the explicitly supported values, these stakeholder values may often be in conflict. Next, Borning et al. committed to three specific moral values to be explicitly supported. One was *fairness*, and more specifically *freedom from bias*. The simulation should not discriminate unfairly against any group of stakeholders. A second was *accountability*. Insofar as possible, stakeholders should be able to confirm that their values are reflected in the simulation, evaluate and judge its validity, and develop an appropriate level of confidence in its output. The third was *democracy*. The simulation should support the democratic process in the context of land use, transportation, and environmental planning. In turn, as part of supporting the democratic process, Borning et al. decided that the model should not *a priori* rule out any one set of stakeholder values, but instead, should allow different stakeholders to evaluate the alternatives according to the values that are important to them.

Most of the technical choices in the design of the UrbanSim software are in response to the need to generate indicators and other evaluation measures that respond to different strongly-held stakeholder values. For example, for some stakeholders, walkable, pedestrian-friendly neighborhoods are very important. But being able to model walking as a transportation mode makes difficult demands on the underlying simulation, requiring a finer-grained spatial scale than is needed for modeling automobile transportation alone. In turn, being able to answer questions about walking as a transportation mode supports two explicitly supported values: fairness (not to privilege one transportation mode over another), and democracy (an important value to a significant number of stakeholders). As a second example of technical choices being driven by value considerations, UrbanSim's software architecture is designed to support rapid evolution in response to changed or additional requirements. For instance, the component models were designed to be easily reconfigured; and the system was designed to write the simulation results into an SQL database such that individuals can easily query it to produce new indicators quickly and as needed. For the same reasons, UrbanSim's software development methodology (an adaptation and extension of Extreme Programming) is tuned toward an agile development process.

UrbanSim's involvement in the Utah dispute also helps to illustrate how Value Sensitive Design's iterative and integrative investigations can play out in a large social and political landscape. For example, the original UrbanSim interface contains a preset group of indicators that can be displayed in a graph or cartographic format. This interface assumes that determining the set of indicators is not itself a critical activity for the stakeholders during negotiations. But in the context of facilitating a settlement, it could be very useful for the interface to the simulation to help stakeholders characterize their underlying values, and agree upon the indicators to be computed by the simulation to help them evaluate the outcomes in light of those values. To support this process, Borning et al. have prototyped a new interface for UrbanSim, which fundamentally changes how the users interact (and perceive their interaction) with the underlying simulation.

In the coming years, the value of informed democratic participation will become a more prominent part of the UrbanSim agenda. For example, it is common for state and local elected officials to debate complicated legislation about land use and transportation that may eventually find its way onto the ballot for public vote. UrbanSim has the potential to contribute to this democratic process by providing a tool which legislators, the press, and ultimately the voting public can use to understand better the short and long-term implications of the proposed legislation. In the coming years, Borning et al. will also draw on existing empirical research on people's environmental concepts and values [12, 13] to shape their conceptual investigations. In other words, conceptualizations of people's values in complex and long-standing disputes need to be rooted empirically in human psychology, not just philosophy.

Thus, in brief, Borning et al. are using Value Sensitive Design to investigate how a technology – an integrated land use, transportation, and environmental computer simulation – affects human values, on the individual and organizational levels; and how human values can continue to drive the technical investigations, including refining the model, data, and interface.

CONCLUSION

Elsewhere, we have argued that the CHI community needs to hold out human values with ethical import as a central design criterion – along with the traditional criteria of usability, reliability, and correctness – by which systems and the work of their designers may be judged [6]. As with the traditional criteria, we need not require perfection, but commitment. One of our goals in this paper has been to provide enough specificity to the theory and methods of Value Sensitive Design such that values can become more coherently part of the CHI standards.

Taken more broadly, Value Sensitive Design offers a response to researchers who have identified a pervasive problem across fields related to Human Computer Interaction, namely that various approaches do certain things well, but leave out crucial components. For example, Orlikowski and Iacono [19] reviewed ten years of work in Information Systems Research and found that the technological artifact itself "tends to disappear from view, be taken for granted, or is presumed to be unproblematic once it is built and installed" (p. 121). Similarly, in reviewing the field of Social Informatics, Johnson [11] writes: "One aspect that still confounds me is how to reconcile the basic premise of social informatics – that it is critical to gain knowledge of the social practices and values of the intended users – with the basic work of system developers. How, if at all, can programmers practice and apply social informatics?" (p. 18). Value Sensitive Design answers this question by arguing that in socio-technical analyses, both the social and the technical need to be taken seriously, and integrated. Toward this end, Value Sensitive Design proposes the integration and iteration of conceptual, empirical, and technical investigations – and seeks to ground them within an overarching theory with intellectual commitments from the social sciences, philosophy, and system design.

ACKNOWLEDGMENTS

Value Sensitive Design has emerged over the past decade and benefited from discussions with many people. We would like particularly to acknowledge Edward Felten, Jonathan Grudin, Clifford Nass, Helen Nissenbaum, John Thomas, Terry Winograd, and our respective research groups. This research was supported in part by NSF

Awards IIS-9911185, SES-0096131, EIA-0121326, and EIA-0090832.

REFERENCES

1. Ackerman, M. S., and Cranor, L. Privacy critics: UI components to safeguard users' privacy, in *Extended Abstracts of CHI 1999*, ACM Press, 258-259.
2. Agre, P. E. Introduction. In P. E. Agre and M. Rotenberg (eds.), *Technology and Privacy: The New Landscape* (pp. 1-28). MIT Press, Cambridge, MA, 1997.
3. Fogg, B. J., and Tseng, H. The elements of computer credibility, in *Proceedings of CHI 1999*, ACM Press, 80-87.
4. Friedman, B. (ed.) *Human Values and the Design of Computer Technology*. Cambridge University Press, New York NY, 1997.
5. Friedman, B., Howe, D. C., and Felten, E. Informed consent in the Mozilla browser: Implementing Value-Sensitive Design, in *Proceedings of HICSS-35*, 2002, IEEE Computer Society, Abstract, p. 247; CD-ROM of full papers, OSPE101.
6. Friedman, B. and Kahn, P. H., Jr. Human values, ethics, and design. In J. Jacko and A. Sears (eds.), *Handbook of Human-Computer Interaction*. Lawrence Erlbaum Associates, Mahwah NJ, in press.
7. Friedman, B., Kahn, P. H., Jr., and Howe, D. C. Trust online. *Commun. ACM, 43*, 12 (Dec 2000), 34-40.
8. Friedman, B., and Nissenbaum, H. Bias in computer systems. *ACM Transactions on Information Systems, 14*, 3 (1996), 330-347.
9. Fuchs, L. AREA: A cross-application notification service for groupware, in *Proceedings of ECSCW 1999*, Kluwer, Dordrechet Germany, 61-80.
10. Jancke, G., Venolia, G. D., Grudin, J., Cadiz, J. J. and Gupta, A. Linking public spaces: Technical and social issues, in *Proceedings of CHI 2001*, 530-537.
11. Johnson, E. H. Getting beyond the simple assumptions of organization impact [social informatics]. *Bulletin of the American Society for Information Science, 26*, 3 (2000), 18-19.
12. Kahn, P. H., Jr. *The Human Relationship with Nature: Development and Culture*. MIT Press, Cambridge MA, 1999.
13. Kahn, P. H., Jr., and Kellert, S. R. (eds). *Children and Nature: Psychological, Sociocultural, and Evolutionary Investigations*. MIT Press, Cambridge MA, 2002.
14. Leveson, N. G. Software safety in embedded computer systems. *Commun. ACM, 34*, 2 (1991), 34-46.
15. Lipinski, T. A., and Britz, J. J. Rethinking the ownership of information in the 21st century: Ethical implications. *Ethics and Information Technology, 2*, 1 (2000), 49-71.
16. Millett, L., Friedman, B., and Felten, E. Cookies and web browser design: Toward realizing informed consent online, in *Proceedings of CHI 2001*, ACM Press, 46-52.
17. Nissenbaum, H. Protecting privacy in an information age: The problem with privacy in public. *Law and Philosophy, 17*, (1998), 559-596.
18. Noth, M., Borning, A., and Waddell, P. An extensible, modular architecture for simulating urban development, transportation, and environmental impacts. *Computers, Environment and Urban Systems*, in press. Available at www.urbansim.org/papers.
19. Orlikowski, W. J., and Iacono, C. S. Research commentary: desperately seeking the "IT" in IT research—a call to theorizing the IT artifact. *Information Systems Research, 12*, 2 (2001), 121-134.
20. Palen, L., and Grudin, J. Discretionary adoption of group support software: Lessons from calendar applications. In B.E. Munkvold (ed.), *Organizational Implementation of Collaboration Technology*, London, England, Springer, in press.
21. Riegelsberger, J., and Sasse, M. A. Face it – Photos don't make a web site trustworthy, in *Extended Abstracts of CHI 2002*, ACM Press, 742-743.
22. Rocco, E. Trust breaks down in electronic contexts but can be repaired by some initial face-to-face contact, in *Proceedings of CHI 1998*, ACM Press, 496-502.
23. Schneider, F. B. (ed.). *Trust in Cyberspace*. National Academy Press, Washington, D.C., 1999.
24. Shneiderman, B. Universal usability. *Commun. of the ACM, 43*, 5 (2000), 84-91.
25. Suchman, L. Do categories have politics? The language/action perspective reconsidered. *CSCW Journal, 2*, 3 (1994), 177-190.
26. Tang, J. C. Eliminating a hardware switch: Weighing economics and values in a design decision. In B. Friedman (ed.), *Human Values and the Design of Computer Technology*, (pp. 259-269). Cambridge Univ. Press, New York NY, 1997.
27. Thomas, J. C. Steps toward universal access within a communications company. In B. Friedman (ed.), *Human Values and the Design of Computer Technology*, (pp. 271-287). Cambridge Univ. Press, New York NY, 1997.
28. Waddell, P. UrbanSim: Modeling urban development for land use, transportation, and environmental planning. *Journal of the American Planning Association, 68*, 3 (2002), 297-314.
29. Winograd, T. Categories, disciplines, and social coordination. *CSCW Journal, 2*, 3 (1994), 191-197.
30. Zheng, J., Bos, N., Olson, J., & Olson, G. M. Trust without touch: Jump-start trust with social chat, in *Extended Abstracts of CHI* 2001, ACM Press, 293-294.