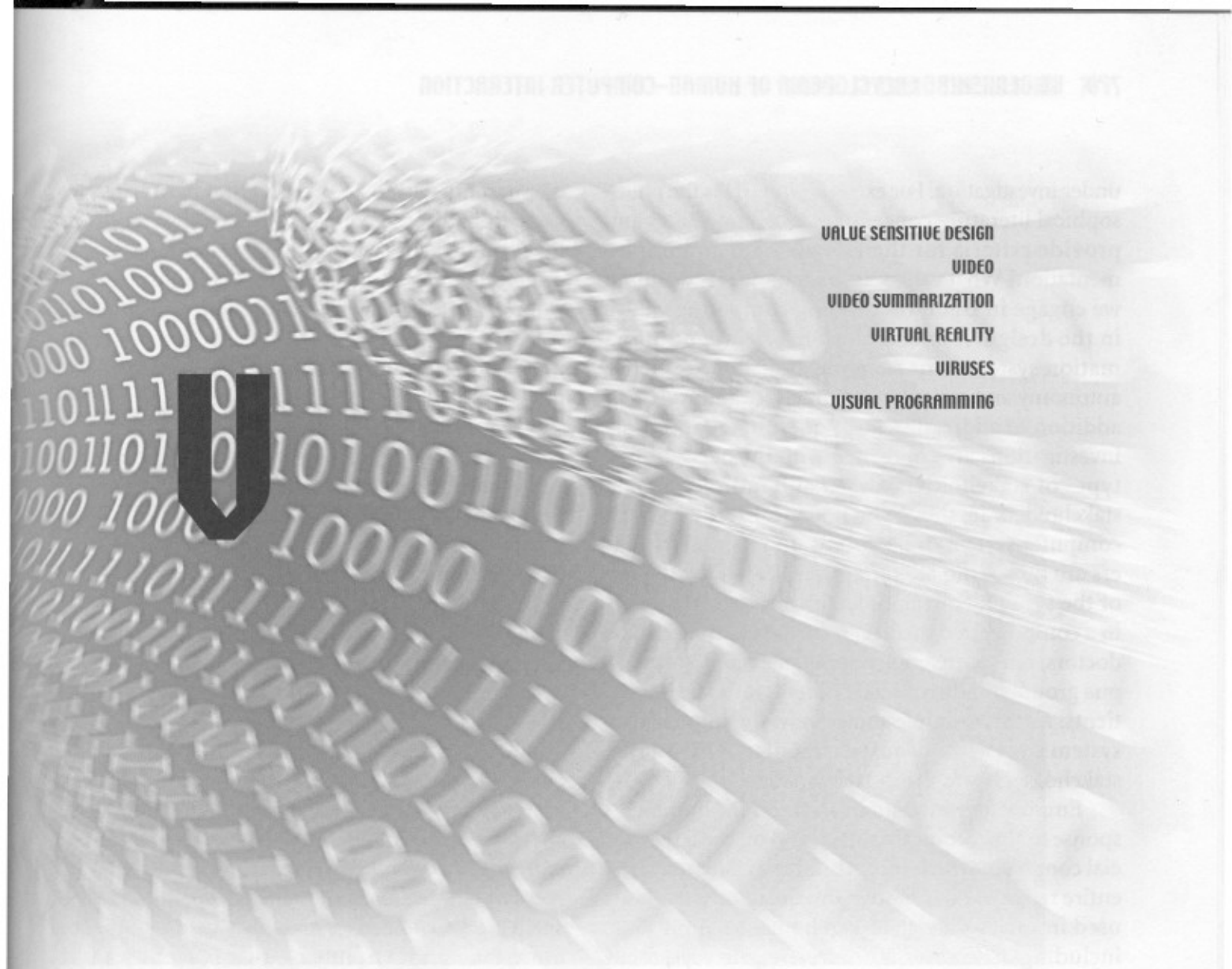

VALUE SENSITIVE DESIGN

Information technologies may either support or undermine enduring human values; sometimes they do both at the same time. For example, surveillance cameras in banks, malls, and airports increase individual and sometimes national security, but often at the expense of individual privacy. Similarly, images and text available on the Web increase access to and use of information, but can lead to infringements of intellectual property rights. In response to such problems, value sensitive design emerged in the mid-1990s as an approach to the design of information and computer systems that accounts for human values in a principled and comprehensive manner throughout the design process. Value sensitive design particularly emphasizes values with moral import, including privacy, trust, informed consent, respect for intellectual property rights, universal usability, freedom from bias, moral responsibility, accountability, honesty, and democracy. Value sensitive design also addresses values of usability (for example, how easy a system is to use), conventions (for example, standardization of protocols), and personal taste (for example, color preferences within a graphical user interface). Methodologically, value sensitive design integrates and iterates on three types of investigations: conceptual, empirical, and technical.

The Tripartite Methodology

Conceptual investigations comprise philosophically informed analyses of the central constructs and issues

under investigation. For example, how does the philosophical literature conceptualize certain values and provide criteria for their assessment and implementation? What values have standing? How should we engage in trade-offs among competing values in the design, implementation, and use of information systems (for example, how do we balance autonomy and security, or anonymity and trust)? In addition to addressing these questions, conceptual investigations are concerned with the needs of two types of stakeholders: direct and indirect. Direct stakeholders are those who interact directly with the computer system or its output. Indirect stakeholders are those who are otherwise affected by the use of the system. For example, the direct stakeholders in a computerized medical records system would be doctors, nurses, insurance companies, and hospitals; one group of indirect stakeholders would be the patients. As this example shows, how the information system works can be just as important to indirect stakeholders as to direct stakeholders.

Empirical investigations focus on the human response to the technical artifact, and on the larger social context in which the technology is situated. The entire range of quantitative and qualitative methods used in social-science research may be applicable, including observations, interviews, surveys, focus groups, experimental manipulations, measurements of user behavior and human physiology, contextual inquiry, collection of relevant documents, and heuristic evaluation. Typically, empirical investigations serve to validate and expand key values identified in the conceptual investigations and to assess stakeholders' experience of the value-oriented features of a system at various stages in the design and deployment process.

Technical investigations focus on the design and performance of the technology itself. It is assumed 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, 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. In a second form, technical investigations involve the proactive design of systems to support values identified in the conceptual or empirical investigations.

The three types of investigations—conceptual, empirical, and technical—are employed iteratively such that the results of one type of investigation are integrated with those of the others, which in turn influence still other investigations of the earlier investigations.

Value Sensitive Design in Practice: An Example

To illustrate the practice of value sensitive design, consider the attempt by the researchers Batya Friedman, Edward Felten, and their colleagues to design web-based interactions that support informed consent in a web browser through the development of new technical mechanisms for cookie management. (A cookie is a small text string—often no more than an ID number—that is sent by a Web server to a browser. The text is then stored by that browser, typically on the user's hard drive, and sent back to a Web server at a later time.)

The team began their project with a conceptual investigation of informed consent itself. They drew on diverse literature, such as the 1987 Belmont Report (which delineates ethical principles and guidelines for the protection of human research subjects), to develop a model for informed consent in online interactions. In the model, *informed* means that the online sites provide adequate information in an intelligible fashion, while *consent* encompasses voluntariness, competence, and agreement. Next, the researchers used the results from their conceptual investigation—the model of informed consent online—to structure a technical investigation, which in this case was a retrospective analysis of how the cookie and web browser technology embedded in Netscape Navigator and Internet Explorer (the two most commonly used Web browsers) changed

AIBO, a robotic dog, moves toward a preschool child who has been petting the dog. Researchers at the University of Washington studying preschool interactions with robotic pets note that the such contacts may impede children's development by substituting for interactions with live animals. Photo courtesy of Kahn, P. H., Jr., Friedman, B., Perez-Granados, D. R., Freier, N. G. (2004). Robotic pets in the lives of preschool children. In Extended Abstracts of CHI 2004. *New York, NY: Association for Computing Machinery Press.*

with respect to informed consent over a five-year period beginning in 1995. Specifically, they used the five criteria of disclosure, comprehension, voluntariness, competence, and agreement to evaluate how well each browser supported informed consent. This technical investigation revealed that while advances were made in providing information so as to elicit informed consent, problems remained. For example, in both Netscape Navigator and Internet Explorer, the information disclosed about a cookie still did not adequately specify what the information would be used for or how the user might benefit or be harmed by its use. Moreover, the default setting, hidden from view on both browsers, was to accept all cookies.

Friedman and her colleagues then used the results from their first two investigations to guide a second technical investigation: a redesign of the Mozilla browser (the open-source code for Netscape Navigator). Specifically, they developed three new types of mechanisms: peripheral awareness of cookies, just-in-time information about individual cookies and cookies in general, and just-in-time management of cookies. (In this case *just-in-time* means

that users can call up information with a single mouse click regarding a specific cookie or cookies in general at any time during their Web browsing.) The researchers also conducted empirical investigations—formative evaluations to assess how well their working designs were providing the user with informed consent. The results of the empirical investigation eventually led the researchers to add the criterion of minimizing distraction from the task at hand to their original set of five criteria in the initial conceptual investigation.

This project helps illustrate the iterative and integrative nature of value sensitive design. It also demonstrates that value sensitive design can be applied successfully to mainstream Internet software for a diverse group of users.

What Is Unique About Value Sensitive Design?

At least four other overarching approaches have sought to account for human values in systems design: computer ethics, social informatics, computer-supported cooperative work, and participatory design. Value sensitive design builds on many of the strengths (and techniques) of these approaches, but in addition value sensitive design offers a unique approach based on a constellation of seven features.

First, as described above, value sensitive design builds on the integration and iteration of conceptual, empirical, and technical investigations. Second, value sensitive design seeks to be proactive, to influence the design of technology early in and throughout the design process. Third, while value sensitive design can be employed alongside of existing successful software engineering methodologies, it dovetails particularly well with those that support open, agile, and flexible information architectures that respond quickly to new value considerations as they emerge throughout the design and deployment process. Fourth, value sensitive design enlarges the arena in which values are considered from the workplace (as is traditional in the field of computer-supported cooperative work) to education, the home, commerce, online communities, and public life. Fifth, value sensitive design takes not only such values as cooperation (as in computer-supported cooperative work), participation, and democracy (as in participatory design) into consideration, but all values, especially those with moral import. Sixth, value sensitive design is an interactional theory: Values are viewed neither as inscribed into technology nor as simply transmitted by social forces. Rather, value sensitive design believes both that people and social systems affect technological development and that new technologies shape (but do not rigidly determine) individual behavior and social systems. Seventh, value sensitive design maintains that certain values (such as those that pertain to human welfare) 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 one conceptualizes a value (that is, the more it is captured in actual actions), the more one will recognize cultural variation; conversely, the more abstractly one conceptualizes a value, the more one will recognize universals. Value sensitive design seeks to work on both concrete and abstract levels.

Recent Work and Future Directions

Studies that have successfully drawn on value sensitive design have focused on such topics as bias in computer systems, search engines, privacy in public spaces, informed consent, electronic access to information in the public domain, the human-robotic relationship, autonomy and privacy in hardware design, and the use of simulations to explore the interactions of land use, transportation, and environmental planning in urban development.

Numerous opportunities exist to extend and validate value sensitive design. Here are seven areas in which we can expect to see future work emerge.

1. The integrative and iterative methodology. Value sensitive design builds on an emerging methodology that integrates and iterates on conceptual,

empirical, and technical investigations. Each component needs further development and explication, as does their interaction.

2. Diverse values. Researchers will want to investigate how value sensitive design handles diverse values within the same information or computer system, particularly when those values come into conflict. A subset of this problem is how to balance moral and nonmoral values.
3. Diverse technologies. Value sensitive design should be successful across a wide range of technologies, including ones that involve large systems embedded in the social and political landscape (such as simulations that look at how land use, transportation, and environmental planning interact in urban development).
4. Diverse populations. Value sensitive design should be successful for populations that are diverse in terms of age, culture, and lifestyle. It should be able to account for such diversity while allowing for some universal standardization of design.
5. Industry. Value sensitive design should be able to adapt to an industry context, where economic constraints and the need for fast product development drive much of the technical development.
6. Value-oriented metrics and evaluation. Value sensitive design should provide techniques for evaluating the value-oriented features of information and computer systems.
7. Transfer of methodology. Given its multidisciplinary nature, the methodology behind value sensitive design should be transferable to a larger academic community and industry. Questions still need to be answered about how to apply value sensitive design and to integrate these methods with industry practice

Value sensitive design seeks to offer a response to a pervasive problem in fields related to human-computer interaction, namely, that various approaches do certain things well, but leave out crucial components. For example, Orlikowski and Iacono (2001) 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" (121). Similarly, in reviewing the field of social informatics, Johnson 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?" (Johnson 2000, 18). Value sensitive design answers this question by proposing the iterative integration of conceptual, empirical, and technical investigations, grounded in an overarching theory with intellectual commitments from philosophy, the social sciences, and system design.

Batya Friedman

See also Social Informatics

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VIDEO

Video is the visual element of television and movies. People also use video to communicate with computers, robots, information systems, the Internet, and other media whose displays present video for entertainment or understanding. Understanding of video by such media provides scientific rationale for searchable video databases, robotic navigation, biometric security systems (based on face recognition), industrial inspection systems, and machines commanded by eye gaze or gesture.

Creating Video

Video input devices include analogue and digital cameras and electronic video capture systems. Examples include cameras for television and cinematography and desktop computer video cards that transmit live video streams or store video clips for subsequent retrieval. Multiple or mobile camera systems can provide information for reconstruction of three-dimensional (3D) scenes.

Capture

Video cameras typically scan scenes into regular patterns (rasters) of scanning lines organized into picture elements (pixels) with fixed separation (resolution) responding to primary colors (red, blue, green). Each frame is defined by the time it takes the scanning mechanism to complete one scan. In noninterlaced video, each frame is scanned by reading all the lines of each stored image pixel by pixel with electronic circuitry that addresses and determines the charge state of the memory element corresponding to each pixel, retracing the scan to start the next frame. In interlaced video, each frame is scanned by reading certain lines of the image, retracing to scan lines missed on the previous scan. By contrast, the human eye focuses peripheral regions of a scene onto rods of the retina for monochrome vision at low resolution (peripheral vision) while making involuntary movements to focus selected regions of a scene onto centrally located cones of the retina sensitive to primary colors at higher resolution (foveal vision).

Television cameras and movie cameras typically provide electrical signals encoded in standard formats, including those developed by the National Television Standards Committee (NTSC, 29.97 frames per second), primarily used in the United States and Japan; the international committees for the Sequential Couleur Avec Memoire (SECAM [sequential color with memory], 25 frames per second), a system widely used in France and the Commonwealth of Independent States; and Phase Alternating Line (PAL, 25 frames per second) systems that are found in the United Kingdom and West Germany. These electrical signals are often digitized in accordance with the Consultative Committee for International Radio (CCIR) digital standards. Analogue video is captured as the intensity and displacement in time (phase) of an electrical signal relative to a broadcast carrier wave, unlike the logical on and off signals of digital video. Common analogue video storage formats include VHS, Super VHS, and Betacam SP, whereas digital storage formats include the widely used Digital Betacam and DVCPro50.

Animation

Animation is another use of video. Animation relies on the phenomenon of human persistence of vision to create an illusion of continuous motion by displaying a sequence of images (frames).