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Technology Development with an Agenda: Interventions to Emphasize Values in Design

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ABSTRACT

Researchers have begun exploring techniques to promote social values within the technology design process. Increasingly, such projects include interventions: action research that inserts social scientists into design to promote values of interest. This article evaluates interventions to promote privacy and anti-surveillance values in a ubiquitous computing laboratory. Data from two years of participant observation suggest how interventions by outside social scientists, mentors and colleagues, clients and research subjects, and institutional authorities increase designers' ability to foreground, react to, and incorporate privacy and anti-surveillance ethics into design. The article also suggests criteria by which social science researchers can evaluate the success of a values in design intervention, including 1) moving the values advocate from outsider to insider; 2) changing the topic of conversation; 3) making values considerations a positive, rather than negative, part of design work; and 4) materializing new values in resulting technologies. Though the project features a difficult-to-replicate blend of personalities and situations, analysis of the structures that enabled successful interventions can be useful to researchers concerned with values in design.

Keywords

Values in design; ubiquitous computing; surveillance

INTRODUCTION

How values are expressed, encoded and materialized in technology design is an ongoing topic of interest in disciplines such as information studies (IS) and science and technology studies (STS) (Friedman & Kahn Jr., 1997; Friedman & Nissenbaum, 1997; Miller, Friedman, & Jancke, 2007). Recent work has postulated that social science researchers concerned with values in design might intervene directly in the design of controversial technologies, such as tools for genetic engineering

(Rabinow & Bennett, 2008) and ubiquitous computing (Manders-Huits & Zimmer, 2009). This paper presents data from two years of action research as a social scientist embedded in a ubiquitous computing laboratory. A series of interventions by a variety of actors have successfully promoted dialogue about social challenges raised by ubiquitous computing, including privacy, consent, and equity. These interventions have resulted in the development of new technologies which materialize privacy and anti-surveillance values. This paper uses ethnographic data to characterize successful values interventions and analyze structures and techniques that led to their success.

RESEARCH SETTING AND VALUES

This article describes work undertaken at the Center for Embedded Networked Sensing (CENS), an NSF Science and Technology Center. Among other projects, CENS develops mobile phone software to collect data about humans and their environment. Mobile phones are increasingly equipped with cameras, audio sensors, and location and motion awareness. Widespread data collection using phones as sensors is referred to as *participatory* or *urban sensing*, and is a subject of research at a number of technology labs in the U.S. and Europe (Eisenman et al., 2007, 2006; Burke et al., 2006; Khan & Markopoulos, 2009; Miluzzo, Lane, Eisenman, & Campbell, 2007).

For example, Your Flowing Data¹ is a project that asks users to send short messages recording data points (e.g. weight, exercise accomplished, mood, or food eaten) throughout the day. The project provides users with visualizations to explore patterns and learn from their data. A different example is the Personal Environmental Impact Report (PEIR),² an application that uses participants' mobile phones to record their location every thirty seconds. PEIR uses this time-location series to infer how much a participant drives each day, giving participants a daily calculation of their carbon footprint and exposure to air pollution.

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¹ <http://your.flowingdata.com/>

² <http://peir.cens.ucla.edu/>

Applications like these store and process large amounts of personal information, creating massive databases of individuals' locations, movements, images, sound clips, text annotations, and even health data. Sharing such data with application providers may be necessary to produce results from granular observations. But applications built in a design culture that encourages maximum data collection and retention, without consideration for targeting, focus or deletion, risks creating databases ripe for "function creep": using amassed personal data for secondary, unforeseen purposes to which data subjects have not consented (Curry, Phillips, & Regan, 2004). In addition, designers trained in software cultures where openness is a virtue (Kelty, 2008), or institutions that emphasize data sharing to aid scientific and engineering innovation (Borgman, 2007), may find these values in conflict with users who wish to share personal data very selectively. Providing best-practice security to protect this data from theft is also difficult in small design laboratories or for projects hosted by individuals (Shilton et al., 2009). Finally, with no specific legal protections for participatory sensing data, comprehensive databases documenting individuals' movements are prime targets for subpoena and government surveillance (Phillips, 2003).

Anti-Surveillance Values

The risks of participatory sensing to individual privacy suggest that sensing designers need to be attentive to anti-surveillance values as they develop their systems. In prior work, our team defined these values as including *local control of data*, *user participation*, *data and system legibility*, and *parsimony* (Shilton et al., 2009). Local control dictates that users manage all data generated from sensing devices and make ongoing decisions about when, how, and with whom to share data. User participation suggests the need for continued review and revision of sharing decisions on the part of the participant. *Legibility* requires that the user have tools to understand what their data and sharing decisions reveal. *Parsimony* asks designers to limit data collection to targeted, purposeful, and temporary information.

Designers at CENS are interested in values of local control, user participation, legibility, and parsimony, but they face significant competing values that sometimes outweigh ethical principles. There are technical limitations on the projects and system features that designers can pursue. Students face stringent deadlines and pressure to publish their ideas quickly, and sometimes values-based design is seen as an impediment to fast progress. The constant pressures of technical innovation combine to make a slower, stickier, values-oriented design process unattractive. Such challenges to values in design demand interventions to counter these pressures and promote anti-surveillance values.

METHODS AND INTERVENTIONS

To analyze and promote social values in participatory sensing design, I have pursued a qualitative research project that draws on ethnography as well as action research. I was hired three years ago to work with CENS' team of roughly thirty students, staff and faculty to address privacy challenges. As a team member, I have been able to closely observe and participate in CENS system design. I spend at least 10 hours a week working, attending meetings, socializing, contributing to email listservs, and collecting field notes in the CENS laboratory. I have participated in several design projects from start to finish, including a documentation project for cyclists and a project designed to monitor environmental footprints.³ I have also held in-depth interviews with 27 members of the design team (including students, staff and faculty), to talk explicitly about how values such as local control, participation, legibility, and parsimony factor into their work. I have additionally incorporated techniques of action research (Khanlou & Peter, 2005) into my research. I intervene in projects, expressing ideas and highlighting anti-surveillance values during design conversations. And I am not the only force intervening on behalf of social values. I have observed the effects of mentors and collaborators, interactions with clients, designers testing their own software, and institutional ethical mandates as implemented by UCLA's Internal Review Board (IRB). I discuss details of each of these interventions below.

Intervention of an Ethics Advocate

An ethics advocate has a designated interest in, and lobbies for, social and ethical concerns within the design process (Friedman, Kahn, & Borning, 2006; Manders-Huits & Zimmer, 2009). Initial studies in engineering ethics have shown promising results of such interventions (Fisher, 2007; McGregor & Wetmore, 2009). A variety of individual and social factors, however, may limit the effectiveness of an ethics advocate. Principle investigators and design team leaders often see the advocate's role as marginal to the major thrust of the research (Guston & Sarewitz, 2002; Manders-Huits & Zimmer, 2009). To be successful in such a situation, Manders-Huits and Zimmer (2009) define critical factors such as an advocate's ability to justify a values framework; the ability of the advocate to adopt a leader (rather than authoritarian or supporter) role; and the ability of the advocate to negotiate between competing values. Perhaps most importantly, ethics advocates need to be able to work alongside designers to operationalize values into features that can be built into a technical system.

Disciplines and Mentors

The existing social environment in a lab can also influence the ethical problems and decisions confronted during design. Disciplinary training can affect both the range of

³ See <http://biketastic.com/> and <http://peir.cens.ucla.edu/>.

knowledge from which a designer draws, as well as the methods designers use during design in response to that knowledge (Borgman, 2007). Disciplinary affiliation is influential in the development of an individual's base of knowledge, research practices, professional identity, and subsequent values and ethical decisions (Herkert, 2001). Engineers also have mandated relationships with faculty advisors, and receive informal mentoring from other lab leaders. The values held by an adviser or mentor may affect the projects a student designer pursues, and their willingness to consider and tackle ethical problems within the design process (Hollander, 2001). Students who have forged mentoring relationships outside of the advisor/advisee role may also be influenced by these mentors' values and ethics (Weil, 2001).

The Designer as System Tester

Designers' values and ethical concerns may also be influenced by individual experiences. In an environment where engineers design technologies for broad public use, it is not uncommon for designers to pilot their software on themselves and colleagues. Because such testing often involves uploading and sharing personal data with colleagues, designers experience privacy and surveillance problems during the course of self-testing. Designers, however, have a much different perspective than "naïve" users. During the course of design, an engineer normalizes the practices required to use a sensing technology, and may not find these practices alien or troubling (Suchman, 2007). Designers may well make connections between ethical problems and their design process by testing their own systems. But this form of learning should be contrasted against another type of testing: user testing as described within user-centered and participatory design traditions.

User-Designer Feedback Loops

Clients and users are also important entities in the CENS design process. Gathering, accepting, and iterating on feedback from clients and users has long been a tenet of user-centered and participatory design traditions (Carroll, 2003; Schuler & Namioka, 1993; Shneiderman & Plaisant, 2005). Though interactions with users raise both logistical and epistemological challenges (Dourish, 2001), almost all the literature on user-designer feedback loops emphasizes the importance of interactions between designers and users for the benefit of system usability (Shneiderman & Plaisant, 2005; Vredenburg, Mao, Smith, & Carey, 2002). Some participatory design literature additionally emphasizes that engagement with users can change designer perspectives and attitudes (Kensing & Blomberg, 1998). This project investigates whether engagement with, and learning from, users can affect not just product usability, but the ethical perspectives and decision-making of designers.

Institutional Ethical Mandates

Because this study focuses on research in an academic setting, institutional structures also influence ethical decision-making. Basic ethical requirements for research on

human subjects are nationally mandated for U.S. educational institutions (Office for Protection of Research Subjects, 2007) and are enforced by UCLA's Institutional Review Board (IRB). As a result, participatory sensing designers collecting data about human subjects must regularly interact with a regulatory body focused on ethics. The UCLA IRB requires a short online training of all research staff, and if requested, offers educational presentations for investigators and research staff. IRB staff members also communicate requirements and changes to researchers who have submitted applications for IRB approval. Lessons and influences (positive or negative) that designers take away from this interaction may affect their values and decision-making during the design process.

CHARACTERIZING AND EVALUATING SUCCESS

Data from two years of observing as CENS designers grappled with values such as privacy, participation, and parsimony suggest several ways that a successful values intervention can be characterized and evaluated. Success includes: 1) changing the dynamic between the values advocate and designers from outsider to team member; 2) observing changes in the design conversation; 3) encouraging changes in the perception of usefulness of values in design; and 4) documenting values-based modifications to the technologies themselves.

A successful intervention begins with a shift in the role and the work of the outside values advocate. The importance of this step cannot be overstated. The values advocate must become a full member of the design team. This means joining problem-solving discussions rather than simply observing; authoring papers with designers; making presentations both to the designers in meetings and alongside the designers at conferences; and otherwise participating in the academic work of the design lab. I discuss the successful integration of my role as values advocate in detail in the next section.

Once a values advocate is firmly cemented in the team, a successful intervention changes the topic of conversation, making values such as local control of data, user participation, system legibility, and parsimony part of regular design meeting discussions. Over the last two years, privacy and consent have become regular topics in design at CENS. Student designers regularly wrestle with consent, because CENS implemented an online review protocol for all new participatory sensing projects. In order to receive equipment such as phones to conduct a study, students must create consent forms and consider participatory concessions such as allowing users to audit and delete their data. This attention to social issues extends beyond laboratory projects, as well. CENS designers also raise values concerns such as privacy and data control outside of the lab, in internships, seminars and classes. As one student recalled (with some pride):

I remember once, we had an [outside] speaker for a seminar, where he built some system related to

privacy. And [CENS] people were like, does this really protect privacy? What is the definition of privacy and blah blah. And [the speaker] had a really hard time answering those questions.

A successful intervention does more than add discussion of values to the conversation in a design lab. It changes the perception of a values-based design process, from slow and cumbersome to creative and fruitful. Values are not only a constraint on design, but also a creative set of potential conditions that can be met with innovative new designs. As one computer science graduate student said in an interview:

At first I wasn't really interested in [privacy]... Before, when I thought about privacy in computer science, I just thought about like security problems or what kind of security protocol to use. I'm not really a security person so I'm not really interested in what kind of security protocol you use... But our process is more like, we believe that we already have secure systems and then we try to build, develop services with which people have control over data. And that's, I think, more interesting. But before I never really tried this topic because privacy is really difficult to define. So people tend to avoid working on that topic... I didn't really know that privacy could mean that the user has control over the data. I feel it's exciting actually ... it's kind of a new concept for me, defining privacy by having control over the data.

And when values-based design is seen as a boon to creativity, values begin to materialize in laboratory technologies. This can take the form of new technologies that use the values in question as design principles, or adjustments within a given technology based on the values. In the last year and a half, CENS designers have begun technical work on questions related to values in design. The most visible manifestation is work on the Personal Data Vault (PDV). The PDV is protected cloud storage for personal sensing data that is controlled by the individual data collector (Shilton et al., 2009). In early CENS systems, data flowed from a participant's phone directly to a sensing application provider (in this case, CENS servers). Due to concerns about privacy and participation, CENS began work on the PDV. The PDV is explicitly intended to give individual users the power to collect, aggregate, and interpret their own data before sharing them with third parties. The vault is built to sustain values of local control, participation and transparency, translated as design principles (Shilton et al., 2009). The PDV is currently under development, and will be deployed as part of several CENS data collection projects.

Though signs of successful intervention can be seen in CENS conversations, design practices and technologies, there are also many points of variability. There are important differences in values held and expressed among individual designers and lab leaders. New graduate students

may express different values than mature graduate students. Students affiliated with privacy-related technology development (such as the PDV) may be concerned with different values than those working on, for example, battery life challenges. Among lab leadership, there are differences of opinion about values critical to participatory sensing research. Further analysis of the interview data to look for patterns among these variations is necessary to fully evaluate the impact of these variables on values in design.

In addition, individual intervention tactics vary in their relative success. Some interventions have been much more successful than others at promoting discussion and action based on anti-surveillance values. At the same time, not all privacy and anti-surveillance values have been equally adopted at CENS. The following sections discuss interventions which have contributed to the success of the values in design process.

Teamwork as the Ethics Advocate

Although inserting an ethics advocate onto the design team is one of the most common interventions discussed in the values in design literature, it has the disadvantage of being one of the hardest to replicate. As with any successful collaboration, the success of a values advocate depends upon personalities, a fit between interests and subject matter of the lab, and the acceptance of lab leaders. The last factor is of critical importance; without it, ethics advocates and social scientists are marginalized within the design process (Manders-Huits & Zimmer, 2009; Rabinow & Bennett, 2008). This project benefits from laboratory leaders who value ethics of privacy, consent and participation. The strong ethical interests of lab leaders facilitated my acceptance by, and indeed a strong relationship with, lab directors.

In addition, a byproduct of my ethnographic method was the luxury of spending a lengthy amount of time at CENS. Such a long (indeed, unsustainable) commitment, however, is not a requirement for a successful values advocate. My primary motivation for a multiple-year stay was ensuring validity of my ethnographic research methods, not building influence as an ethics advocate. I began exerting values influence after an initial stay of only a month or two, beginning almost immediately with an active role drafting privacy policies for the PEIR project. What was much more important than the length of lab tenure was the *density* of time spent in the lab: regular attendance at weekly meetings, use of a work station in the lab, and immediate availability for ad-hoc meetings and casual interactions. As one lab leader responded when asked why the ethics advocate relationship worked:

It's a kind of respect. It's a kind of respect, but it's also engagement. There's a balance of respect and engagement, because you gained respect by becoming engaged.

Ultimately, engagement is much more important than length of stay. This finding suggests that the ethics advocates role could be adapted to the time constraints of consultants or senior researchers with months, rather than years, to spend on a project. But such advocates may need to rearrange their work, consulting, or research schedules to allow total immersion in a design lab during those critical months.

Beyond a dense time commitment, Manders-Huits and Zimmers' (2009) emphases on justifying values frameworks, adopting a leadership role, and operationalizing values into concrete design implementations proved useful at CENS. Justifying values frameworks to CENS designers is an ongoing process. Sometimes this involves giving presentations to spark discussions on troubling topics, such as surveillance powers enabled by participatory sensing or the undefined legal status of the data our lab collects. Justifying values frameworks to lab leaders has been fairly easy; the majority of the laboratory faculty members hold concern for privacy, participation and social justice among their core values. Students have shown more variable concern for these values, although most have been receptive to their importance in ongoing discussions. Assuming a leadership role, along with what I define as a full team-member role, has also proven successful in advancing anti-surveillance values. Though I cannot code or design systems, I have tried to find ways to be useful to the daily work of the participatory sensing team. I also projected authority by integrating my expertise into the daily work of the lab. I helped organize focus groups with users and suggested social science methods to bolster system evaluations. I coauthored a number of papers with other CENS students. And in addition to joining existing projects, I started CENS projects of my own. I spearhead an ethics education grant that funds a course on values in design, and I have served as an organizer for an ongoing exploration of legal implications of participatory sensing. I've pursued grants with team leadership so that ethics projects might continue after I leave. Fully joining the work of academic labor helps make me part of the team, instead of an outside values consultant. Such work also helped me maintain the blessings of lab leadership and the respect of coworkers.

In addition to participation as a teammate, I try to push the boundaries of values discussion at CENS. In expanding the vocabulary around values and ethics in design, Star and Griesemer's (1989) definition of boundary objects has proven useful. Values can be difficult to discuss in design settings, because they're often abstracted from the algorithms and databases that are a daily feature of life in the design lab. Finding boundary objects or concepts to which designers can quickly relate has proven invaluable in promoting anti-surveillance values in design. The concept of "privacy," for example, proves to be an accessible boundary object. There are classes and conferences in the CS community devoted to topics of privacy and security.

Designers recognize privacy as a computer science concern. Though social scientists and computer scientists may understand the term differently, privacy gives us a place to start a discussion. Concepts without obvious boundary-spanning abilities, such as power and social inequality, are much harder to operationalize in a design setting. As part of my work as a values advocate, I continue to explore ways to find commonality and boundary-spanning possibilities for these more difficult value concepts.

At times, full membership in the design team may seem compromising for a values advocate. Indeed, the lengthy period that I have spent in the design lab, necessary for ethnographic validity, may have heightened the problems of values compromise. There is a large literature in sociology discussing the relative advantages of insider-versus outsider status, and the line between participant-observation and participation (J. Lofland, Snow, Anderson, & L. H. Lofland, 2006). In a design advocate's work, this tension is reflected in moments where core values held by the advocate, but found controversial by the design team, begin to slip. For example, I once surprised myself by suggesting a change to a health and wellness project to encourage continuous location tracking, rather than selective geo-tagging. Such a change hardly fulfills the value of parsimony that I claim to espouse.

While there are obvious problems with such ethical compromise, there are also benefits. Moments like these illustrate to designers that the advocate's ethical principles are not rigid, and that sometimes other design values (in this case, a new, valuable outcome that wouldn't have been possible without the continual location trace) outweigh anti-surveillance values. Such examples help the values advocate avoid the label of a nag or hopeless idealist, and instead emphasize the cooperative nature of cross-disciplinary work. But advocates must balance a lack of rigidity with strategies to ensure that core values are not compromised. One strategy stems from my experience with the positive influence of reporting to my dissertation committee, comprised mostly of social scientists. Because I am beholden to this committee, I am careful not to let my core values slip too far. Advocates embedded in a design lab can benefit from external supervisors who are equally concerned with core values. This might take many forms, but would best be comprised of discipline-appropriate experts in applied ethics and values in design. In addition, advocates should cultivate a community of values-minded peers. Attending conferences or professional development focused on core values will reiterate their importance, help advocates find strategies for dealing with concerns, and help embedded researchers or consultants continue to be strong advocates. Finally, time may be a factor here, as well. Perhaps advocates, like management consultants, should work for fixed terms. It is likely that researchers opting for short (but dense) stays as an ethics advocate will face less pressure around values co-option.

Diversifying Disciplinary Networks

One of the major challenges for early-stage design of ubiquitous computing technologies is that much of designers' intellectual energy needs to be spent on systems, rather than the data flowing through the systems. Most of the issues that intersect anti-surveillance ethics and values revolve around what data are collected, and who aggregates and interprets those data. However, in interviews and meetings with CENS student designers, it became apparent that the realities of early-stage design make data a secondary concern. This is reinforced by disciplinary expectations. CENS graduate students are responsible for building new systems, and as a result focus largely on the algorithms and storage undergirding and surrounding the data. Their research posits how to build these algorithms and database structures more elegantly, quickly, and efficiently. Interviews with graduate student designers included questions about who was in charge of the data collected during a given project. The answers were often quite murky, with responsibility distributed between several designers or ignored altogether.

An intervention that has refocused the participatory sensing discussion on data has been collaboration with people explicitly focused on data: namely, statisticians. While clients of course care about the data, they are often absent from weekly design meetings, and their needs and interests are necessarily viewed as different from those of the design team. Statisticians, however, attend weekly meetings and are a regular part of design. They are seen as "us" rather than "them." Their needs are almost as primary to the design process as those of the computer scientists. In meetings with statisticians (sometimes faculty, sometimes staff, and sometimes students), the comments and interests of the statisticians continually refer designers back to issues inherent in the data. This refocusing on data allows for not only statistical discussions, but also ethical debate about data representation, sharing, and security.

Designers as Testers

A different way of promoting attention to data is through designers serving as test users of the sensing technologies under production. At CENS, as in many development labs, it is common practice to try new systems internally, before they are tested with users. There is nothing novel about the finding that internal testing is important to good design. Designers throughout academia and industry are, in design-speak, encouraged to "eat their own dog food." However, the effects of such testing on designers' consideration of social values have gone unexplored. A process meant to check new products for usability and bugs has the unanticipated result of encouraging researchers to reflect on the sensitivity of the data their systems collect. As one student reported after participating in a location-tracking test run for a colleague:

But when I did data collection for [my colleague]... I actually needed to collect data throughout the day, for a week or two weeks. Then I felt like, not

privacy, but I felt that I wanted to go out more actively. I felt oh, they are watching me: I need to be more active...Because [my colleague] would keep telling me, "Oh, you don't go anywhere. You just stay at home for a week" (laughs).

Later in the interview, the same student expressed:

I think I feel safe with the data we collected, because we already knew [that my colleagues] were not really interested in my location traces. They just use my location traces for their research and they're not looking at it. But if this campaign was something owned by a company, I would feel kind of scared. Because I would not know where [the data] is actually used and how it's used.

After participating in a data collection pilot for a health application, another developer, previously blasé about issues of privacy and data control, wrote in an email to the design team: "Just browsing the survey questions, I now understand how critical privacy is for such an application." Self-testing fosters a focus on the data that is unique within the design process. The kinds of data under request, (including location as well as questions about eating, sleeping and exercise habits,) surfaced surveillance and privacy concerns concrete in a way that constructing algorithms for abstract data processing had not. Experiencing values concerns is a previously overlooked advantage of technology self-testing.

Funding Values in Design

As processes such as expanding disciplinary networks and self-testing indicate, values interventions into design cannot be implemented by social scientists alone. Funding is another crucial, but difficult to manipulate, variable in fostering a design environment open to values interventions. Money can restrict or expand value-centered design practices by affecting the availability and interplay of interventions such as values advocates, diverse disciplines, and self-testing.

The declaration that money is important is hardly surprising, but the ways in which it affects values in design are intricate and worth discussing. At CENS, larger, better-funded participatory sensing projects have correspondingly large development teams. Large teams require formal weekly planning meetings and clear lines of communication between developers. And evidence from meetings and interviews shows that it is large teams that spend more time considering the values implications of their work. Values issues tend to arise in meetings because the team tends to be more diverse. CENS leaders, statisticians, and I often attend these larger meetings. Laboratory leaders are more involved in better funded projects, bringing their interest in, and attention to, social values with them. As one project leader said:

I mean [my project involvement] is driven largely by funding. At least the CENS projects have been

largely driven by funding. So the ones where I have the most interaction are ones where there are CENS resources involved.

In addition, the discussions fostered by a larger group of people tend to reveal ethical worries and opinions, which then become design concerns.

The design of larger systems contrasts with projects which have little or no initial funding and only two or three developers. Design meetings for these projects are informal and often spur-of-the-moment. Leaders and team members communicate about these projects largely over email. The less complex systems are perceived to need less planning in advance. And fewer ethical concerns surface in the discussions of the small working team. As participatory sensing projects raise money, they progress to more mature development processes, and a resultantly greater focus on values in design.

Funding affects more than the maturity of a project. Funding guarantees that there are staff members in place to support long-term engagement with users and clients. Clients push on questions of data ethics in much the same way as do statisticians. These engagements support values like local control and participation. But there are challenges in recruiting and scheduling users for design meetings and focus groups. One of the most successful interactions with users was an information system for bicycling, which sustained several rounds of design meetings with avid area cyclists (Reddy et al., 2010). To encourage this interaction, I volunteered the time and resources necessary to coordinate user meetings and feedback sessions. A second project involving a large group of users is currently in process, and is helped by the financial resources to pay a staff member to recruit users and organize meetings. Because of the early stage of these relationships, data collection about the interactions between users and designers continues.

Finally, funding has also enabled the long-term ethics intervention. A grant focused on ethics in engineering has allowed me to immerse myself in the CENS design process. Funding has also provided legitimacy and security for my project, providing both financial means and outside justification for the importance of the project.

These findings suggest recommendations for funding future values interventions. Funders interested in promoting values in design might consider setting aside money to support cooperative design projects. Creating explicit requirements to cooperate with users, and providing financial backing for the logistics and long-term engagement necessary to make this happen, would be invaluable to opening up public participation in controversial technology design. At the same time, funders should continue to encourage disciplinary diversity in design efforts. Encouraging proposals which pair computer scientists with statisticians and social scientists can provide a solid foundation for discussion of data, and therefore data

sensitivity. Finally, funders might consider funding potentially controversial projects at levels which support larger project teams (including paid staff) and a sustained, mature design process.

LESS CONCLUSIVE INTERVENTIONS

While direct intervention by an ethics advocate, diversification of collaboration networks, and self-testing of technologies have all had a positive effect on the discussion and adoption of anti-surveillance values in design, several of the interventions discussed above have had less conclusive impacts. In contrast to the successful interventions, these are structures where the party interested in privacy and anti-surveillance ethics remains an outsider; or where the conversation around design remains unchanged; or where there is no change in the perception of usefulness of the intervention to design; or where no material changes are made to participatory sensing technologies.

The Role of Mentors

Mentoring is one area in which the relationship with ethical intervention is fairly ambiguous. Graduate students have remarkably complex relationships with their faculty advisers. All students have an assigned adviser, and their funding generally flows through this adviser. Advisers consequentially have quite a bit of power over graduate students. They can require students to take on projects, constrain research questions, and block academic progress. Because many advisers at CENS are quite concerned about values such as local control, participation, legibility, and parsimony, I assumed that advisers would function as powerful agents for values in design. And there is no doubt that the continuing presence of issues like privacy on the design agenda (thanks in part to the interests of lab leaders) affects graduate students' work. A small number (2 interviewees) openly acknowledged this influence. But the majority of graduate students interviewed were hesitant to acknowledge this power. Most do not consider their adviser to be a boss. Instead, students describe lab leaders as colleagues and sources of advice on the way to making the best decision themselves. CENS graduate students are adamant about their ability to choose their own research projects, and to decide the best ways to go about their work.

This stated independence doesn't seem completely honest. I have observed advisers forcibly change the direction of research projects using a combination of persuasiveness, authority, and control over funding. But it is quite interesting that students profess to operate independently of laboratory leaders. This complicated mentoring relationship leads to a similarly complicated relationship between mentorship and ethical learning. Many faculty involved in CENS participatory sensing espouse the anti-surveillance values described here (although some hold these values to be more important than others). Students, however, do not admit to being influenced by their adviser's values. If they care about issues of privacy, consent, participation, and

parsimony, most students declare that they have come to these positions on their own. Whether this is true is difficult to discern. On the other hand, as I have described, the power of laboratory leaders lies behind my successful collaborations with student designers and the continued attention to values in CENS design.

Institutional Mandates

A more obviously problematic intervention is the relationship between values in design and institutional ethical mandates, as imposed by UCLA's IRB. The need to seek IRB approval for some participatory sensing projects does force conversations about ethical data collection, user confidentiality, and protection of human subjects. But it also makes these discussions administrative tasks, rather than central to design decision-making. The IRB serves as a hurdle to be cleared, and students often offload much of the writing required to the administrative staff member in charge of IRB applications. In this way, the IRB functions very differently than statisticians, lab leaders, or the values advocate, who bring discussions to design meetings instead of paperwork. One computer science graduate student explained the outside nature of the IRB as follows:

I feel like actually, as a system designer, the burden shouldn't fall on me to get IRB approval. Not to say that my system shouldn't get IRB approval, but I feel like somebody else should handle that... Because like I don't know how to put this, but I am designing a system and I am really concentrating on designing the system and then this is like another process and it is a little bit outside of my... I do not do this on a regular basis. ... So that's what I found really frustrating and that's why I always hesitated to want to work on it...

IRB requirements occasionally cause students to reexamine the security of their data or their collection procedures, but most often, the engineers express frustration and resentment about the administrative overhead rather than appreciation for the questions raised. The same student continued:

The second [frustrating aspect] is that I feel like they do not really understand any... They never will understand the system and the things that they are concerned about just make me sad. They are concerned about things like these forms that we have to fill out afterwards and stuff like that... I found the fact that they approved [a particular project] to be extremely funny. Just because it is like the most invasive of all the things that we could do, you know. And they didn't care. The only gripe that they had was like some stupid form thing that we were not storing in a locked cabinet. So that obviously shows that they have no clue what is going on. So now I have no respect for them. And now that is why I really cringe whenever I have to deal with it... Like if you understood the system properly then I would have more respect for you, and then I will put

more time to actually do the application. But now that I know that you do not know what you're talking about, then why put the effort into it.

The combination of outsider status and perceived lack of understanding sometimes frustrate IRB efforts to promote values in design.

CONCLUSION

Observation of, and intervention into, the design process at CENS has suggested that of the many factors that affect the design process, a values advocate, disciplinary diversity, designer self-testing and substantial funding have particularly strong impacts on promoting values in design. These suggest that social scientists concerned with values in design have a role to play within technology design laboratories, particularly if they can successfully immerse themselves in the daily work of design. In addition, social scientists can encourage forces such as interdisciplinarity and self-testing which promote positive discussion and implementation of values in design. Attention to such factors can enable a values-oriented design process for emerging technologies.

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