How to See Values in Social Computing: Methods for Studying Values Dimensions

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ABSTRACT
Human values play an important role in shaping the design and use of information technologies. Research on values in social computing is challenged by disagreement about indicators and objects of study as researchers distribute their focus across contexts of technology design, adoption, and use. This paper draws upon a framework that clarifies how to see values in social computing research by describing *values dimensions*, comprised of *sources* and *attributes* of values in sociotechnical systems. This paper uses the framework to compare how diverse research methods employed in social computing surface values and make them visible to researchers. The framework provides a tool to analyze the strengths and weaknesses of each method for observing values dimensions. By detailing how and where researchers might observe interactions between values and technology design and use, we hope to enable researchers to systematically identify and investigate values in social computing.

Author Keywords
Value sensitive design; values in design; research methods

ACM Classification Keywords
Human-centered computing → Collaborative and social computing theory, concepts and paradigms

INTRODUCTION
Social computing research studies sociotechnical factors in the design, deployment, and use of computing systems [49,61]. This work considers *values* as important to a technology's fit into, and impact on, the world [10,22,40]. Social computing research has developed a rich body of work exploring the role of values in, for, and from information technology design [10,12,17,22,40]. However, there is a lack of precision in how the construct of values is defined, applied, and investigated. Values are understood to contribute to technology design, to shape affordances that mediate technology use, and to pervade the social contexts mediated by technology [28,60]. Values are also personal, shaping how people evaluate their behaviors, respond to others, and make judgments [47,50].

While values are increasingly considered in relation to design [30], these various definitions suggest diverse understandings and uses of values in the social computing literature. Social computing's focus on the intersection of social behavior and computational systems creates significant challenges for values research. Should we look for values in communities, or in interactions between people and technologies? Should we look for values in technologies themselves, or in the design groups responsible for those technologies? Design research traditions do not currently provide a theoretically-grounded discussion of where values occur in sociotechnical systems, and subsequently what methods can best study those values. Values in social computing are sometimes core beliefs held by people; sometimes attributes of systems and policies; and sometimes features of contexts, users, or technologically-mediated interactions. For example, values of import to researchers may be the personal values of the end users (i.e. dignity) or embedded within the heuristic principles of a technology (i.e. freedom from bias). A social computing study on privacy, for example, may struggle to specify whether privacy is a value of a person or group, a value intentionally embedded within a technology by designers, or a value materialized by a technology's affordances through human interaction. There have been few efforts to connect these understandings and uses of values through empirical research and theory-building.

To answer these questions and improve the precision of our methods, we separate the source of values from attributes of values themselves. We have developed a framework defining sources and attributes of values along six dimensions, as a heuristic to support research in social computing [53]. This paper reviews existing methods in values and social computing research, and uses the framework to highlight indicators for values to which each method is particularly suited: how each method sees values. This analysis illuminates the impact that methodological choices have on the values we investigate, and illustrates a range of qualitative and quantitative methods for observing values across different dimensions in social computing. The analysis also exposes gaps in the literature and

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opportunities for future interrogation of how researchers choose values to study. We hope to engage researchers by providing a heuristic to better describe the sources and attributes of values, and by cataloging methods to examine how values impact both the design process and the technologies that result from that process.

VALUES IN SOCIAL COMPUTING

Research emphasizing the values incorporated into, and embodied in, technologies is often grouped under two theoretical umbrellas: Values in Design (VID) (http://www.nyu.edu/projects/nissenbaum/vid/) and Value Sensitive Design (VSD) (http://www.vsdesign.org/). There is also a related body of research in worth-centered design, which examines design contexts in terms of "worth" and "value propositions" [10]. This paper focuses primarily on the VID and VSD traditions. The similar traditions of VID and VSD, developed in the human-computer interaction (HCI), information studies, and media studies literatures, explore the ways in which moral or social values become part of technological artifacts. Values research in these traditions is characterized by a proactive perspective, seeking to influence technology during the design process [20]. This literature highlights the discursive nature of values embedded in technologies, which are shaped endogenously by their designers and technical affordances, as well as exogenously by users and use contexts [22].

These influential traditions have also received calls for refinement [1,2,34,48]. For example, Le Dantec et al. write: "What is needed is more prescription in methods that inform value-centered investigations, and less prescription in the kinds of values considered" [34]. In response, this paper uses the values dimensions framework as a lens to examine methods for values research in social computing. As three researchers with different backgrounds and approaches to values and social computing, we struggled to communicate what values were in our work, and where they intersected with social computing. As we began to compare our empirical projects, which have employed methods such as ethnography of computing design, content analysis of values in online communication, and interviews focused on values in computing, we realized that we needed to separate the source of the values under investigation from the attributes of the values themselves. We iterated on dimensions to describe the source and attributes of values over dozens of drafts, challenging and refining the emerging framework using case studies from the HCI, values and design, and social computing literatures. Because construction of such a framework is in itself a values-laden task, we do not claim that ours is comprehensive or singular. Instead, drawing on the needs of social computing research projects, we claim that it is useful for providing a more precise vocabulary for describing values research, as well as suggesting a set of methods demonstrated to be appropriate for studying values dimensions of interest to social computing researchers.

VALUES DIMENSIONS

We draw distinctions between dimensions that describe the source of the value – the setting, environment, or context from which values are elicited – and dimensions that describe attributes of the values themselves [53]. The term "dimensions" connotes continual spectra between extremes, rather than dichotomous pairs of attributes. The first three dimensions of the framework relate to the source of values; the remaining three are attributes of values themselves [53].

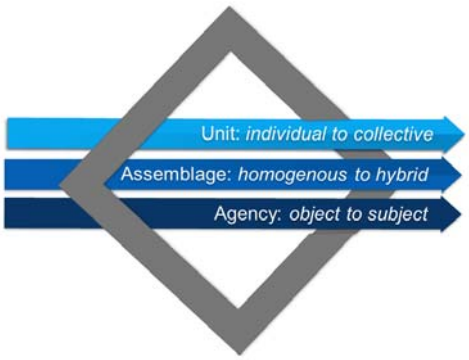

Figure 1: Dimensions Describing the Source of Values

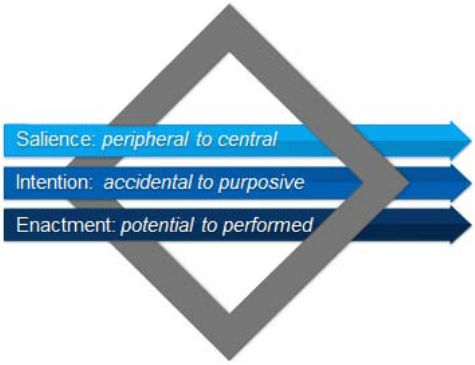

Figure 2: Dimensions Describing Attributes of Values [53]

The first source dimension describes the Unit from which values are elicited, moving from values of an *individual* to a *collective* [53]. Points along this continuum might include individuals, families or work groups, institutions, sub-cultures, and cultures. Values of an *individual* source are held by a person and are a core component of his or her identity [51]. Values of *collective* sources are the goals embedded in a given sociotechnical context [39].

The second source dimension describes the Assemblage of the source, moving from values of *homogenous* to *hybrid* human and technological actors [53]. Values in a design project might emerge from a relatively homogenous set of actors – a group of people belonging to a single demographic, for example, or technologies of similar types. Or the source of values may be a *hybrid* assembly that combines people entangled with technologies – groups of human actors embedded in an augmented reality video game simulation, for example. Points on this dimension include sources ranging from an all-machine group or a

homogenous group of humans to diverse humans of various types to groups of human actors interacting with multiple sociotechnical systems.

The third source dimension describes the Agency of a source, moving from *object* to *subject* [53]. Agency takes into account the degree of autonomy and self-determination sources have in possessing and expressing values. *Objects* have values ascribed to them while *subjects* have the ability to determine and express their own values. For example, humans are often treated as *subjects* who may express their own values, and machines are often *objects* to which humans ascribe values. But because this is a spectrum, there are many examples in which non-humans take agency or humans lose agency. For example, humans are sometimes considered objects in specific situations or stages of life [26]. Cyborg hybrids [25] blend *object* and *subject*: cyborgs are likely to both express agent values as well as have values ascribed to them. Similarly, autonomous machines [35] can be studied as *subjects* with their own agent values, as well as *objects* with ascribed values.

The first attribute dimension, Salience, is a continuum from *peripheral* to *central* values [53]. A primary challenge for values researchers is identifying which values are of particular importance in a technology design or use context. The qualifier "salient" implies that some values will be more important in one context, while other values have more importance in another context [56]. The Salience dimension depends on the source of the values (i.e. the first three dimensions) such as individuals, groups, or social context.

The second attribute dimension, Intention, describes the degree to which a designer or system intends to materialize a value on a continuum from *accidental* to *purposive* values [53]. Values are surfaced, exposed and negotiated through design. This negotiation affects the shape and characteristics of the resulting technology, and eventually the social impact of design products [34]. *Purposive* values are those intentionally built into a technology's affordances and policies by its designers. Examples might include Winner's "technical arrangements as forms of order," in which artifacts are "deliberately designed to achieve a particular social effect" [62:123], as well as Suchman's observation that some early CSCW technologies "cast [computer scientists] into the role of designer not only of technical systems but of organizations themselves" [57:186–187]. Towards the other end of the dimension, *accidental* values are unintentional features or biases embedded in a technological system [21].

The third attribute dimension, Enactment, is the degree to which values are enacted within a sociotechnical system [53]. The Enactment dimension highlights a continuum between *potential* and *performed* values. "Potential" is used in the same sense as potential energy: *potential* values are present but inert. *Performed* values are those that an actor or system materializes in the world. "Performed" is used as it is increasingly employed in science and technology studies, to describe a factor that makes a difference or brings about the world it envisions [37,42].

This paper applies the framework to empirical studies in social computing to illustrate the precision it adds to our understanding of the intersection of values and design. To classify studies, we asked the following questions:

- Does a study illuminate the values of individuals, groups, or societies? (Unit)
- Does a study illuminate the values of people, technologies, or blended sociotechnical systems or cyborgs? (Assemblage)
- Does a study illuminate the degree to which people, systems, or materials determine their values? (Agency)
- Does a study illuminate the degree of importance of various values to stakeholders or systems? (Salience)
- Does a study illuminate the degree to which participants mean to materialize a value? (Intention)
- Does a study illuminate the degree to which values are materialized in a system or setting? (Enactment)

Like any classification project, application of this framework to existing studies is challenging and leaves room for debate. We make these classificatory choices to illustrate how using the six dimensions can unpack values investigations in social computing. Researchers can look for the values at their sources, examine attributes of values themselves, or both. Returning to our earlier example, a social computing study on privacy could use these dimensions to specify whether privacy is an intended goal of a technology, a core value of an individual or group, or some combination of the two.

METHODS TO STUDY VALUES IN SOCIAL COMPUTING

Each dimension can be studied with a variety of empirical methods; however, each method elicits some dimensions more effectively than others. The following sections describe methods used to study sources and attributes of values in social computing research. Considering how methods surface different dimensions moves the field closer to providing greater prescription in methods for values research in social computing [13].

Ethnographies of Computing Design and Use

Social computing research frequently uses observation methods to discern how values are selected and incorporated into system features and policy, or applied within varying use contexts. Ethnographic methods are common in the values and design literature, and provide techniques to observe a broad range of values dimensions during design and use of social computing systems.

Ethnographies of technology design often embed an observer or participant-observer in a laboratory, workplace, or other design environment to study the dynamics and

decisions of computing design [41]. Ethnographies of computing design are particularly suited to studying attribute dimensions of Salience, Intention, and Enactment (for example, *central* values of a design team that are *purposively* built into technical features) among *collective*, *hybrid,* and *subject* sources (for example, a group of people making values decisions while interacting with material constraints of technological systems). In the VSD and VID traditions, ethnographies of design have included observations of artificial intelligence laboratories [18], open source software development [29], and Web 2.0 technology development [44].

For example, Shilton used participant-observation to study values in a lab developing mobile phone systems to gather data about people and their environments [56]. We classify her study as focused on both ends of the Salience, Intention, and Agency dimensions, because she examined what values were important to the team, and examined how the team tried to build those values into technical features. Shilton observed that engineers' ability to transform *peripheral* to *central* values into *performed* features was impacted by work practices. Self-testing practices within the laboratory surfaced previously *peripheral* values such as equity, as designers confronted with their personal data debated who they would be willing to share that data with, and what power dynamics that data revealed. *Peripheral* values such as consent were also enforced by institutional policies such as IRB requirements, and were therefore *performed* within user interfaces. Enforcing access control and data retention policies to protect the *central* value of privacy required careful data practices, making this value difficult to incorporate into technical features. These tensions illustrated challenges to the Agency dimension: though designers felt privacy was important, it was challenging to *perform* that value in technical products.

Ethnographic observation of technology use can also reveal values dimensions in social computing. Observation of users can reveal how the *central* values of *hybrid collectives* impact the *performed* values of technology in use. For example, Ames et al. observed how parents' attitudes about their children's use of technology were modulated by values attributed to social class [3]. We classify the source of parents' values in this framing as the *collective* of their class membership. Their *collective* values in turn impacted their technological practices. For example, middle-class parents in the study disallowed television but encouraged phone calls to long-distance family, attempting to *perform* values of connection by restricting or encouraging use of particular technologies. Similarly, Alsheikh et al. demonstrated how participants used technologies to *perform collective* Islamic values in long-distance romantic relationships. Because video chat used by unmarried couples could undermine *ikhtilat*, or cultural conventions that regulate mixing between the sexes (which we frame as *accidental* and *potential* values of video chat software), respondents reported using voice chat instead of video to *perform* their values [2]. Roberson and Nardi used ethnography to explore how homeless users employed mobile technologies (what we classify as a *hybrid collective* of people and systems) to *perform* values of survival (such as finding food and shelter) and social inclusion (such as establishing ties with the housed) [46].

Ethnography can study both values attributes and sources of values such as *hybrid*, *collective* configurations of designers, users, and technologies, but has limited scalability and generalizability. Future work mapping social computing studies along the dimensions framework might aid in comparison of similar attributes and sources of values across studies.

Sources of Values	Attributes of Values
individual ⇔ **collective**	**peripheral ⇔ central**
homogenous ⇔ **hybrid**	**accidental ⇔ purposive**
subject ⇔ object	**potential ⇔ performed**

Table 1. Dimensions highlighted by ethnographies

Values Advocacy

An alternative approach to studying and simultaneously influencing the Intention and Enactment of values in design contexts is inserting an advocate for particular values onto design teams. This approach is formally codified in some research areas due to grant guidelines that include "Ethical, Legal and Other Societal Issues" (ELSI) requirements. Van der Berg [59] and Rabinow and Bennett [45] relate mixed success intervening in biotechnology design labs. A project led by Fisher [11] embedded humanities graduate students in science laboratories to influence ethical decision points. Guston and Sarewitz propose a method for social scientists to intervene in design with "Real-time Technology Assessment" [23:93]. Manders-Huits and Zimmer [38] also conducted work as values advocates in commercial design settings.

A values advocate focuses on ethical and values-based concerns during design [20,38]. As Friedman et al. [20] describe the role, advocates lead conceptual investigations, enumerating stakeholders (what we would categorize as one or more *collective* sources of values) and how system features impact those *collectives* by identifying both *accidental* and *purposive* values within systems. Advocates also facilitate technical investigations into how system properties materialize values. Advocates therefore investigate the intersection between Intention (what the system designers built into properties) and Enactment (the degree to which those properties make a difference) [20]. Finally, advocates undertake empirical evaluations of user experience, testing whether *purposive* values were *performed*.

Values advocates may also discuss the Salience of values. As a values advocate during the ethnography described above, Shilton [56] facilitated discussions of the *hybrid*

context of people using mobile sensing systems to build consensus around *peripheral* and *central* values (e.g. privacy, consent, equity, and forgetting) of the lab *collective*. Her intervention also helped operationalize those values in features (such as user interface considerations, data retention procedures, and secure data storage [54]), materializing *purposive* values into *performed* values.

Because values advocacy introduces values discussions into a design setting, it can be difficult to determine the *peripheral* and *central* values in the context before the advocate arrived. It is also a time- and resource-intensive method for values investigation. And at times, full membership in the design team can compromise a values advocate. There is a large literature in sociology discussing insider versus outsider status, and the line between participant-observation and participation [36].

There is also controversy surrounding what or whose values advocates should promote [5,34]. Advocates may introduce discussion of values writ large, or may focus on instilling a particular set of values. Both interventions qualify as values advocacy. Values discussions might focus on helping a *collective* define their *central* or *peripheral* values, or advocates may focus on encouraging particular *purposive* and *performed* values.

Sources of Values	Attributes of Values
individual ⇔ **collective**	**peripheral ⇔ central**
homogenous ⇔ **hybrid**	**accidental ⇔ purposive**
subject ⇔ object	**potential ⇔ performed**

Table 2. Dimensions highlighted by values advocacy

Design Activities

A targeted intervention method is the use of design activities – focused games, toolkits, or structured conversations with designers – to elicit discussion and considerations of values. One example is the deployment of values levers: practices or interventions within design meant to build consensus around values as important design concerns [55]. An example of a values lever is having designers pilot their own software, which can highlight instances where a system's *performed* values conflict with the lab's or an individual's *peripheral* to *central* values.

Researchers have also developed card-based design activities to elicit *peripheral* to *central* values of designers and stakeholders (i.e. *individuals*), or *hybrid* design settings. These activities stem from a longer tradition of design games in participatory design [6]. One example is the Envisioning Cards [19]. These cards are intended to provoke conversations about values issues before, during, or after design. The cards have four categories, each of which evokes questions about sources and attributes of values. Stakeholder cards evoke Units (*individual* to *collective*) and Assemblages (*homogenous* to *hybrid*). Time cards evoke future impacts, with a focus on appropriation and integration of a system in social contexts. We classify this as a focus on the future Enactment of values, including those both *potential* and *performed*. Values cards explicitly draw attention to what individuals or groups think is important, highlighting the Salience of values from *peripheral* to *central*. Pervasiveness cards, designed to emphasize "systemic interactions" [19:1146] may raise discussions of Agency (such as whether a pervasive system takes on a *subject* role with its own values impacts) as well as Enactment (such as whether a *purposive* value remains *potential* when a system is embedded in a larger system.).

Similarly, the Grow-A-Game cards [4] are a tool to help groups brainstorm and design games based around a set of prescribed values. By assigning a familiar game (such as Checkers or Pac Man), and then assigning a particular value (such as generosity, peace, or autonomy), this method encourages a team to rethink game mechanics and play based upon an assigned value. The Grow-A-Game cards create a *hybrid* environment where people interact with, and are constrained by, game mechanics. Both the players and the game have *subject* properties: the players as *subjects* who decide upon new rules, and the game's mechanics that limit the range of possibilities. Finally, by prescribing values, Grow-A-Game encourages discussion of *purposive*, *performed* values as players build infrastructures that materialize their assigned values.

Related to cards are design activities intended to elicit discussion of values. Cultural probes have been used to foster discussion of values in computer-supported collaborative work across disciplines [24], which we classify as drawing attention to values in *hybrid collectives*. Reflective design [52] focuses on bringing unconscious choices in design (which we classify as *accidental* values) to the surface to critique and evaluate their impact.

Sources of Values	Attributes of Values
individual ⇔ collective	**peripheral ⇔ central**
homogenous ⇔ **hybrid**	**accidental ⇔ purposive**
subject ⇔ object	**potential ⇔ performed**

Table 3. Dimensions highlighted by design activities

Interviews

Interviews with developers can be used to study all source dimensions, as well as attribute dimensions such as Salience and Intention. Fleischmann and Wallace [16] used interviews to study values in the design of computational models in corporate, academic, and government research labs. They interviewed modelers by asking questions about what role values played in the design of their models and if they observed value conflicts between their organization and other stakeholders such as clients and users [15,16]. Because they asked directly about the importance of values, they observed values that were *central* and *purposive* at specific labs, such as transparency in the corporate lab [15]. Questions about values conflicts [14,16] also elicited

Agency dimensions. The interviews revealed the relationship between the values of the designers on the *subject* side of the Agency dimension, and the values embedded in models on the *object* side of that dimension.

Interviews with users can also elicit important findings for values in social computing research. Le Dantec and Edwards used interviews to ground a values-sensitive design project for a homeless population [33]. They used photo-elicitation interviews (a diary study in which participants use cameras to prompt discussion during interviews) to ask *individuals* about their interactions with technologies, which we classify as *hybrid* sources. Homeless participants photographed objects they used in their daily lives, and researchers asked questions about the photographs to explore values along the Salience dimension (such as the *central* value of connectedness) and Agency dimension (such as the features of mobile phones that enabled connectedness)**.** Poole et al. also used an adapted interview technique combining interviews and photo elicitation to study *individuals'* values in a *hybrid* setting: the ubiquitous computing environment of RFID technologies [43]. These interviews revealed the Salience of diverse values, including system trust, data protection, consumer choice, and precise divisions of social appropriateness for RFID tracking of humans.

Interviews face potential self-selection bias and social desirability bias. In particular, researchers risk proscribing values of the source by priming respondents. But if interviewers avoid naming explicit values, interviews may suffer in clarity of focus. Interviews benefit from combination with other methods to elicit *central*, *purposive* values such as surveys or ethnographies.

Sources of Values	Attributes of Values
individual ⇔ collective	**peripheral** ⇔ **central**
homogenous ⇔ **hybrid**	accidental ⇔ **purposive**
subject ⇔ **object**	potential ⇔ performed

Table 4. Dimensions highlighted by interviews

Content Analysis

Content analysis can overcome limitations such as social desirability and self-selection biases by evaluating existing documents such as public hearings [8] or social media [31]. Fleischmann et al. used this approach to study values in found data [13,31], and explored scaling content analysis using automation [27] and crowdsourcing [58]. Values detected via content analysis are those invoked most frequently in texts, so tend to be what we classify as *central* (important to individuals who invoke them); *purposive* (intentionally embedded in texts); and *performed* (brought into being through their invocation in text). Content analysis mainly focuses on actors towards the *subject* end of the Agency dimension, but facilitates studies of diverse Units (ranging from *individual* writers to *collective* group conversations) and Assemblages (ranging from analysis of content in non-mediated to computer-mediated settings).

A challenge for content analysis is achieving sufficient inter-coder agreement to ensure reliability of coding procedures. In addition, developing and testing a coding rubric is time- and labor-intensive. However, content analysis of found data is more scalable than field research methods and may be applied to large datasets [13].

Sources of Values	Attributes of Values
individual ⇔ **collective**	peripheral ⇔ **central**
homogenous ⇔ **hybrid**	accidental ⇔ **purposive**
subject ⇔ object	potential ⇔ **performed**

Table 5. Dimensions highlighted by content analysis

Technical Investigations

Friedman et al.'s work suggests that "technological properties and underlying mechanisms support or hinder human values" [20:4], and argue that values can be elicited through technical investigations: systematic examination of the components and operation of a technology. We classify these investigations as focused upon the Intention and Enactment dimensions of *hybrid*, *subject* systems, because they look at designed features and the values impact of those features upon larger systems. Similarly, Brey [7] proposes disclosive computer ethics, which describes similar technical investigations focused on whether a chosen value (such as privacy or democracy) is supported by technical features. Because of the focus on system support for a value, we classify these as *potential* to *performed* values. Nissenbaum [39] provides a heuristic to determine whether systems uphold the values of a *collective* (a social group), *hybrid* (involving both technological and human agents) context or system. The heuristic includes examining whether the information transmission principles of a system match the roles, activities, and norms of the context in which a system is deployed.

Technical investigations provide systematic ways to evaluate values along the Enactment dimension within technologies that are already built and in use, when values are *potential* or *performed*, but therefore concretized and difficult to alter. Post-hoc technical investigations are excellent for descriptive work, but less useful for investigating the values reasoning behind system decisions.

Sources of Values	Attributes of Values
individual ⇔ **collective**	peripheral ⇔ central
homogenous ⇔ **hybrid**	**accidental** ⇔ **purposive**
subject ⇔ object	**potential** ⇔ **performed**

Table 6. Dimensions highlighted by technical investigations

Surveys

A common approach to studying the Salience of values within Units (often starting with *individual* values and then

aggregating results to study values of the *collective* values of a group or culture) has been to use values inventories: surveys in which individuals rate the relative importance of a list of values or value statements [9]. This approach assumes a source of values towards the *subject* end of the spectrum (able to have and express values). Perhaps best-known is the Schwartz value inventory, comprised of 56 human values organized into ten value types [51]. This framework underlies the Portrait Values Questionnaire (PVQ), developed to study the relative importance of each value type across *individuals* to *collectives*. The PVQ has been found to provide comprehensive coverage of *central* values recognized across *collective* cultures [51].

Constructing surveys to find values in *hybrid* sociotechnical contexts, rather than values of *individuals*, is a challenge for social computing researchers. To address this challenge, value surveys can be altered to fit social computing contexts. For example, Koepfler conducted a survey that examined *central* values (by asking the relative importance of values to survey participants) of collectives (multiple stakeholders related to the social issue of homelessness) within the technologically-mediated and therefore *hybrid* context of Twitter [32]. Broadmindedness emerged as a shared *central* value in the context of Twitter for all of the stakeholders pointing to a potentially shared *central* value among all stakeholder groups. Wealth and equality were *central* to those who had experienced homelessness, but no other groups, pointing to potentially conflicting *central* values among different stakeholder groups. These sociotechnical value portraits offered a starting point for engaging with the study of values along the Salience dimension in the design of *hybrid* social computing environments such as online communities. When administered at the beginning of a design process, surveys might also elicit values along the Intention dimension by asking designers about *purposive* values in their systems.

Survey methods are not ideal for addressing all values dimensions, however. Because surveys do not assess technology directly (e.g. we cannot yet ask a technology about its central values), they cannot assess values *performed* after the completion of design or deployment, and are unlikely to find *accidental* values. And because surveys are designed to elicit a respondent's *central* values, they may not capture *peripheral* values.

Sources of Values	Attributes of Values
individual ⇔ **collective**	peripheral ⇔ **central**
homogenous ⇔ **hybrid**	accidental ⇔ **purposive**
subject ⇔ object	potential ⇔ performed

Table 7. Dimensions highlighted by surveys

DISCUSSION

Applying the values dimensions to social computing research highlights the ways in which a variety of methods afford the study of specific dimensions, and also highlights dimensions that are less explored in current research. Though not exhaustive, this analysis illustrates that methods reviewed here all consider source dimensions (Unit, Assemblage, and Agency). This is not surprising; the source of values is an important consideration for researchers as they define the boundaries of their study and their objects of interest (e.g. groups or individuals, people or machines). The analysis also illustrates that methods address the attributes dimensions quite differently. Methods that interrogate groups of people, or their expressions and communications (such as ethnographies, interviews, content analysis and surveys) often highlight values along the Salience dimension. Methods that interrogate design processes (such as ethnographies, values advocacy, design activities, and interviews) often highlight values along the Intention dimension. And methods that interrogate technologies in use (such as ethnographies, technical investigations, and content analysis) often highlight values along the Enactment dimension.

These distinctions provide a heuristic for planning future values research in social computing. Researchers focused on values and agency, for example, might find ethnography, design activities, or interviews better suited to determining when values are ascribed to humans or systems. Researchers focused on values underlying design decisions, or looking for values conflicts between designers and users, might first consider surveys or content analysis methods to elicit *central* values. For example, Walmart is piloting a new smartphone checkout option in stores [63]. Introducing mobile applications into physical shopping experiences may raise concerns for values such as privacy, consent, or equity. A social computing researcher might consider *central* values of *individual subject* Walmart shoppers within this *hybrid* human-mobile device context. A mixed-methods approach of interviews and technical investigations would be well suited to investigating these dimensions. Or a researcher might consider *performed* values of the *object*, *hybrid* mobile system. Technical investigations and participant-observation through use of the system would illuminate these dimensions. Evaluating the effectiveness of the dimensions framework for planning and conducting values in social computing research will be a critical next step for this work.

The dimensions framework also exposes the fact that methods widely used in values and design research are frequently better suited for addressing values towards one end of a dimensions spectrum. For example, surveys are useful for studying values of *subject* actors on the Agency dimension (i.e. it is difficult to survey *object* machines in a sociotechnical system). And both interviews and surveys can solicit *central* and *purposive* values (what people say they care about and do), but may not pick up *peripheral* or *accidental* values as effectively. Indeed, many of the methods discussed are excellent for eliciting *central*, *purposive*, and *performed* values on the attributes dimensions. An opportunity for social computing research

is to develop methods and cases that can observe *peripheral*, *accidental*, and *potential* values more effectively. These less visible attributes of values are currently underrepresented in values and design research, but could provide new concepts and domains for analysis. Future work should adapt existing methods or explore new methods to collect data at underrepresented ends of dimensions. For example, developing interview methods to elicit peripheral values, or methods beyond technical analysis to examine accidental values, would advance values research in social computing.

Though the dimensions framework enables description of sources and attributes of values in social computing, a final challenge remains: identifying which values are important in a research context [5,34]. Should researchers explore intrinsic values such as justice and virtue? Or instrumental values such as privacy, openness, or trust? Is there a list of prescribed values for which researchers should look, or should researchers examine emergent values? We believe that values may be found using preexisting inventories, or *in situ* through observation. Researchers should identify their approach and be aware of its limitations. *A priori* approaches using values inventories risk missing values important to research subjects. *In situ* approaches, also known as descriptive ethics [12], risk comprehensiveness by focusing on a subjective set of values.

CONCLUSION

Our application of the values dimensions framework to social computing highlights the fact that values are not fixed in people, or systems, or use contexts [22]. Instead, values can be observed among a complex collection of designers, artifacts, infrastructures, social contexts, and use practices. Values researchers must therefore distribute their focus across contexts of design, adoption, and use.

To support a more unified conversation, we suggest that researchers use a shared vocabulary for describing where in the social computing ecology values are being investigated, without prescribing what values should be considered. We believe that researchers can more precisely describe, operationalize, and study values in social computing by considering dimensions that describe where and how values occur in technology contexts. Values dimensions include the source of the value – the setting from which values are elicited – as well as attributes of the values themselves. Mixed methods and a consistent vocabulary for describing where in the design ecology values are being investigated will be critical to this emerging research agenda.

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