On the Role of Value Sensitive Concerns in Software Engineering Practice

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Abstract—The role of software systems on societal sustainabil-
ity has generally not been the subject of substantive research
activity. In this paper we examine the role of software engineering
practice as an agent of change/impact for societal sustainability
through the manifestation of value sensitive concerns. These
concerns remain relatively neglected by software design processes
except at early stages of user interface design. Here, we propose
a conceptual model that can contribute to a translation of value
sensitive design from its current focus in participatory design
to one located in mainstream software engineering processes.
Addressing this need will have an impact of societal sustainability
and we outline some of the key research challenges for that
journey.

Index Terms—Value Sensitive Design, Values, Co-Design, Re-
quirements elicitation

I. I N T R O D U C T I O N

Sustainability concerns have been substantively critiqued
from an environmental perspective since the 1960s, with the
dominant, normative definition in the literature centering from
that published in the United Nations Commission on Environ-
ment and Development (UNCED) report “Our Common
Future” [1]: “Sustainable development is development that
meets the needs of the present without compromising the
ability of future generations to meet their own needs”.

 Debate around this definition has seen sustainability further
discussed in terms of economic and social / societal sustainabil-
ity [2] where the latter includes a focus on processes, systems
and structures to support healthy and liveable communities.
Others† have noted that sustainability is a social goal and
ultimately there is no dichotomy between environmental and
societal sustainability and this requires that “social scientists
working on these issues cooperate in interdisciplinary projects
with scientists who assess the life-cycle-wide material and
energy flows attributable to products and services, as well as
ICT developers who understand the resulting requirements to
be placed on ICT applications.” [3, p19].

The National Research Council of USA reported on the
centrality of the role of Computer Science research to support
societal sustainability and identified a number of strategies
and recommendations [4] based on the assumption that most
sustainability issues require inter-connection and human in-

1Following communication from an anonymous reviewer.
The concept of value has been investigated in its role to systems design. Friedman is generally credited with introducing the study of values to IS practice through the Value-sensitive design (VSD) [9]. She defines value as: *what a person or group of people consider important in life*. Values that are particularly pertinent to information systems include: ownership and property; privacy, freedom from bias, universal usability, trust, autonomy, informed consent, identity and others. In systems design, values have, to-date, been integrated mostly with participatory design approaches [11] or more recently Co-Design. Co-Design involves potential (un-trained) end users working jointly with researchers and designers to jointly create artefacts that lead directly to the end product and, as Yoo et al. [12] note: “become a dominant user study methodology in the fields of product design, service design, interaction design and HCI [13]”. Several researchers have commented that whilst participatory design is a dominant mode of technological design, end-users still struggle to influence the direction of design within the participatory process. Furthermore, end-users may not fully understand the ecology of available technologies. It may be that the reductionist principles of software engineering could be argued to have hindered the integration of values approaches into mainstream practice and so making it harder to monitor such concerns.

Value-sensitive design (VSD) emerged to integrate moral values (and more broadly ethics) with the design of systems. A key premise of VSD is that it seeks to design technology that accounts for human values throughout the design process (over and beyond the identification of functionality and visual appearance) of systems. Thus VSD has a stated goal that there should be freedom from bias in systems. That is: computer systems should not systematically and unfairly discriminate against certain individuals or groups of individuals in favour of others [10]. VSD has developed both methods and theory that incorporate particular values into technologies through conceptual, empirical, and technical investigations.

In the Yoo et al. model, the traditional co-design core blends methods from value-sensitive design to structure the co-design engagement with inputs from stakeholders and considerations of values. The co-design process may be initiated by free-form thinking, but their key innovation is in the introduction of two types of structured interventions. Designer prompts entail materials that originate from expert designers and may comprise personas, scenarios or the use of envisioning cards. Stakeholder prompts originate from the end-users and may utilise value based scenarios addressing concerns such as unintended uses of the system; changes of the use of the system over time and so on. Values will be, typically, those derived from the list suggested by Friedman in [14]. The reflection element of the model provides a way of representing how prompts may be generated by either a stakeholder or a designer as a result of joint participation in the co-design space.

In software engineering, Goguen’s latter work in requirements elicitation has emerged from formal computer science but presents a similar discourse on the importance of values that could be seen as a plea to move from a reductionist principle to one that proposes “semi-formal approaches that take account of social processes can be valuable. Values are the key to unlocking ...the enormous dangers of contemporary technologies.” [15]. Goguen recognized that there are limitations to formalisms but also noted that ethno-methodologies present challenges in collection of data and the subsequent grounding of data in the design of the target technical artefact. Thus “methods based on ethnomethodology cannot be applied directly to systems that have not yet been built”. Other approaches to consideration of values in software engineering focus on return on investment calculations and therefore are not the type (moral) values that we propose also need to be addressed in the software engineering process [16], [17].

III. A Proposal for a Conceptual Model for Handling Value Sensitive Concerns

Conceptual modelling is the activity of formally describing some aspects of the physical and social world around us for the purposes of understanding and communication [18]. Currently there are no formal or semi-formal models and their associated processes for handling values and requirements into the software engineering design process. Building on the work of Yoo et al. [12], we have developed a co-design workshop method that exposes value concerns such as security and privacy. The approach has been applied on a research project (Mobile Apps for Youth Offending Teams – MAYOT) aimed at developing social technology for use by young people and their caseworkers in youth offending teams in the UK. The project raised requirements on design methods to incorporate the voice of stakeholders with respect to privacy issues and an outcome of that work is the conceptual model presented here.

The Co-Design activities in the various workshops yielded a rich set of data including design and specification of features/functions of the MAYOT app. We focus on one design feature. The *Exclusion Zone* feature is a function that is available on the MAYOT app that allows a case worker to define a geographic region from which a young person is prohibited (with potential risks to violating their youth order with obvious detrimental effects). The feature alerts the young person in possession of the smart phone hosting the app that they are in an exclusion zone. During the course of a number of workshops, the feature went through a number of design changes representing the designer’s view, a case worker’s view, and views from young people who believed that the prototype app feature violated their privacy. Such concerns were considered seriously by the research team to ensure that a balance was struck between relative privacy and security of information. Further, there was a clear challenge that if we are to incorporate value sensitive requirements into the design of software then we need a way of understanding, managing and exploring the impact of values through the requirements process.
Prompts are mechanisms or props that provoke reflection in the Co-Design Space. They are the main concept that needs to be tracked with respect to engendered values in the requirements elicitation and design process. The Exclusion Zone is an example of an initial prompt. Prompts can ultimately become a Feature of the system and become tools for describing how functions of a system may behave by appearing in scenarios of use. As noted by Yoo et al [12]. Scenarios incorporate Values and thereby bring Values into the co-design process. A Value may be of a particular type (e.g. Moral, Privacy etc.) and have properties such as name and description and relationships with other concepts that capture the provenance of a value. The Exclusion Zone raised value concerns of privacy and autonomy. A Prompt may become a Value Based Prompt (i.e. it raises concerns or addresses a value of interest to a stakeholder). A Value Based Prompt ultimately requires some resolution as different actors may attribute different measures to the same value (c.f. the value of privacy and autonomy associated with the “Exclusion Zone” prompt). To cater for this, we propose that we integrate components from the Contextual Design participatory design method [20]. In particular, the Contextual Design method utilises the notion of a Cultural Model that provides an analytical capability for showing the cultural or political forces in the organisation. Such forces ultimately have an effect on belief values held by individuals performing a task. The Cultural Model also allows for values and for different forces to be applied by stakeholders to those values in order to arrive at a resolved status for a value. We account for this by appliesForce association between Actor and Value-Based Prompt and a function that computes the net force of a Value Based Prompt.

It is only when the net forces applied are balanced that the prompt becomes a feature. Forces that are applied to “balance” value sensitive concerns can be expressed in an arbitrary unit and can be resolved as part of the co-design process. To support the model we propose some sample constraints:

Constraint:R1: Not all prompts may become features. In the illustrative case study, a designer prompt aimed at making available individual intervention plans from the MAYOT app was rejected by case workers as potentially an example of a privacy breach and therefore value-sensitive.

Constraint:R2: A feature must be agreed by all participating stakeholders. This raises some other issues such as the availability of all stakeholders throughout the co-design process. To overcome this we propose that a feature is accepted by all stakeholders in at least one co-design workshop.

Constraint:R3: For value-laden features the associated value-based prompt must have a net force of nil as a result of negotiation across one or more Co-Design Spaces.

IV. Discussion

We discuss our proposal by raising two open questions and offer an initial response. (1) What purpose can a conceptual model for managing value sensitive concerns serve towards a sustainable society? We suggest that developing a clear, causal, traceable link that chains together stakeholders, value concerns
raised by stakeholders, the scenarios and space in which concerns were raised and the feature that is impacted can provide a more nuanced approach for determining priorities found in more traditional requirements engineering approaches. In particular, values that impinge or impede sustainability concerns can be surfaced. Key to this, is recognising that stakeholders can include networks that go beyond the designers and users of the system. For example, a system designed for a security organisation may meet the values of both designers and the immediate users. However, (privacy) values that reside amongst in-direct stakeholders could be violated and such stakeholders may make behavioural changes that have an impact on environmental sustainability. Given that sustainability is about multi-generational issues, how to represent un-born generations in the design process is a challenge. Two options are possible: firstly one could involve stewardship from a state advocacy policy and recognise that participatory design is not always appropriate; or secondly, given that we now have inter-generational use of IT systems, research instruments that can identify and evaluate generational concerns can be developed.

(2) How does the conceptual model enhance existing practice of analysis and design? From software engineering, requirements elicitation/management perspective, a benefit of tracking value concerns is the opportunity provided for early evaluation of a particular concern. Other research that we have undertaken examines how values related to privacy can be subject to early evaluation through the use of expert domain knowledge encoded in a Bayesian network [21]. Systems thinking that has evolved from the participatory design school has had a traditional strength in examining the socio-technical elements of systems design but artefacts from that approach are partially lost in translation in the task of implementation. We suggest that such a translation loss may be attributed to a lack of appropriate languages that can bridge different domains. Language based approaches lend themselves to model checking and verification processes.

V. CONCLUSION

The process of creation of information systems involves stakeholders, both direct and indirect who approach systems design activities with a pre-conceived set of values (such as privacy). These values have a critical influence on the design process and have not yet successfully been translated into current software engineering practice. This paper has posited a conceptual model for beginning this translation. The model has been induced from a single but rich case study from an ongoing research project aimed at developing mobile apps to support engagement between young people and their case workers in the UK youth justice system. The limitations of the model and the case study approach are apparent, none the less, the research presented can be seen as a call to arms and a vision for the SE community to recognise how systems impact on society at large. Currently the language has been formulated as an abstract syntax but preparations are underway to develop appropriate tool support using domain specific modelling technologies such as Meta-edit+ and to also explore how methods such as the Architecture Tradeoff Analysis Method (ATAM) [22] can be extended to include value concerns. A further branch of work is exploring the role of value concerns in enterprise modelling languages and business motivation modelling. Given the role that corporations play in constructing communities we consider that may also be a fruitful avenue for research in societal sustainability.

REFERENCES