Rethinking the Role of Representation in HCI

Lucian Leahu
Computer Science Department
Cornell University

lleahu@cs.cornell.edu

ABSTRACT
Although critiques of computational models and rigid representation schemes have been quite vocal in the past decades, by and large current system design still overwhelmingly relies on the equivalence between entities and processes from the outside world and their digital counterparts. My research draws on and extends existing critiques to address the demands of today's technological trends and the limitations of traditional system design. My contribution is two fold: 1) it recasts the role of representation within system design to accommodate the growing interest in experience design and the accompanying shift towards the subjective, situated, personal and idiosyncratic and 2) it argues for a holistic approach that seriously engages the limits of representation and permeates every aspect of system building (conceptualization, design, technical implementation, evaluation, etc).

INTRODUCTION
Computational technologies are inherently representational. In order to reason about the world, systems typically have access to relevant aspects of their environment via sensors or input modalities; these aspects are typically represented internally through variables and models associated to objects, entities or processes. From these representations outcomes are derived, which must hold in the outside world. As such, representation gives computers the means to participate in their environment.

As expected, any representation is a simplification: it highlights certain features which appear to be general or relevant and discards less frequent as well as harder to formalize aspects. Computational models are certainly very useful when all the aspects relevant for the system's success are captured in the model. However, problems arise when the system's focus is on aspects that are less general or the ones that resist formalization. Indeed, this is old news in CSCW as the limitations of modeling users, users' actions and work processes have been thoroughly discussed in the past two decades e.g. in the work of Suchman [10] and Robinson and Bannon [8].

In spite of these significant contributions, new and old issues related to formalization surface in current HCI practice. On the one hand, the growing interest in experience-focused technology brings out new tensions between the subjective, idiosyncratic aspects of human experience that are the focus of such systems and the objective representations required by the technology. On the other hand, mismatches between internal representations and the outside world are a recurrent source of difficulties in HCI and related fields, as evidenced by the omnipresent call for future work on better, more accurate models. This suggests that the

lessons of Suchman and others have been incorporated only superficially in current practice as current systems are still fundamentally constrained by the power, as well as the limitations, of such models. More specifically, although these hard learned lessons have informed the conceptual aspects of the design process, they have not made their way into the technical design and implementation level. As such, especially from a technical perspective, systems continue to be built with the implicit assumption that representation is in strict one-to-one correspondence with reality. While corrective measures may be taken through interface and interaction design, often the mismatches are deeply rooted in the technical implementation and often little can be done to prevent their impact on the overall experience of the system. Consequently, my research focuses on 1) how to reposition representation to better accommodate both new demands and existing critiques and 2) advancing a holistic approach to system design, in which this reorientation of representation permeates every aspect of system development, including the technical level.

EXPECTED CONTRIBUTION
My PhD thesis aims to advance current research in HCI by repositioning the role of representation in system design: moving away from representation as a one-to-one mapping to reality to an understanding of representation as partial, incomplete, subjective (i.e. influenced by the researcher's assumptions, beliefs, and epistemological commitments) and always situated in a particular socio-cultural context. Moreover, the gaps between reality and representation should not be hidden deep in the system's technical design. Instead, shortcomings related to representation should be transparent and a central concern in every aspect of system design: understanding representation as a digital scaffolding of reality and reorienting the entire system design around this understanding. One example of doing so is to use the uncertainty and ambiguity which accompanies any representation as a way to engage users in meaning making as well as reflection [5], and allowing multiple meanings to emerge [9].

My research confronts these issues across the continuum of practices associated with system design: conceptual, design, ethnography, algorithm and technical. It is informed by critiques pertaining to representation and formalization. Moreover, while grounded in subfields of HCI (e.g. affective computing) in which these problems are most evident, my work proposes a methodology for approaching such issues through illustrative case studies demonstrating heuristics for design.

CASE STUDIES
Over the years, a number of researchers have tackled the issues pertaining to representation and formalization. As such my work builds on conceptual critiques such as Winograd and Flores [11] and Agre [1] in AI, Robinson and Bannon in CSCW [8], Brooks

in robotics [3], and Dourish in HCI [4]. Perhaps most influential in HCI has been the work of Lucy Suchman [10] regarding the fundamental mismatch between the models of action underlying planning research in AI in the 1980's and actual, situated human activity in the world. Although concerned with similar issues, the debates within HCI and CSCW around representation have developed in parallel with debates within AI (with the exception of *'Plans and Situated Actions'* [10]). My work attempts to tap these resources outside HCI. One first project for my dissertation discusses the tactics developed within interactionist approaches in AI with respect to representation and discusses their relevance for today's HCI [7]. These tactics were developed to avoid the conceptual and technical pitfalls associated with complete, one-to-one representations. They demonstrate that one can achieve more with less: less in terms of effort spent representing and reasoning about the world and more in terms of the delivered experience and utility.

One such tactic is to design for engaged audiences, thus making the believability of the system a central feature. This translates into a simplified system design, driven largely by the way the system will be interpreted by friendly users, rather than by its behavior when analyzed either in a vacuum or by a hostile user. That is, system design can become simpler and more effective by making the experience and interpretation of the system by users central to every design decision (including technical), rather than only considering this when it comes to design the user interface.

As a continuation, my current research attempts to show how these tactics can be used in today's HCI. As such the focus is on an every day technology such as GPS navigation devices. Currently, I am doing fieldwork in order to document breakdowns occurring in usage. These findings will then be used to inform the redesign of such devices using more flexible representation techniques and incorporating the above mentioned tactics.

A central tenet of my research is the belief that the world is not completely available to us or to a computational system. Consequently, it is crucial for the design of real world applications that representations inside the system are understood to be partial and not always in direct correspondence to the outside world. This becomes particularly obvious in today's HCI focus on experience and also in light of the paradigmatic shifts experienced by the field [2]. One area of HCI affected by such choices is affective computing (AC). Here the central challenge is how to address the subjective, idiosyncratic, personal nature of emotions within the rigid framework offered by technology.

One difficulty lies in mapping sensor readings to their meaning. Indeed, this is not a problem specific to this area, but the limitations of such mappings are quite noticeable here: e.g. how to get from one's heart rate to the felt emotion? My previous work shows how objective measures, such as physiological signals, do not directly map to affective meaning (as often assumed in the literature). Through a participative study, my work uncovers a complex relationship between sensor readings and their significance and suggests methodologies based on user interpretation to allow complex meanings to emerge [6]. Another difficulty in this area relates to statistical models of emotions – emotion recognition by way of sensor readings.

Concerned with scenarios in which user interpretation is not feasible due to cognitive constraints placed on the user, my current work analyses the ways such models are obtained and raises epistemological questions with respect to said models ability to generalize. My current work in this area, suggests a reflective incorporation of such models in system design, one that carefully accounts for the models' uncertainty and inaccuracy, with respect to emotion recognition, as these models can offer at best an educated guess regarding the emotions felt by the user, rather than an oracle which magically accesses the user's affect. These findings are relevant beyond AC to other areas that fundamentally rely on the accuracy of the models deployed.

CONCLUSION

Focusing on issues of representation, my research contributes to an ongoing discussion in HCI, in particular, and computer science more generally on the role and limitations of computational models. My dissertation will serve researchers and practitioners with two key contributions. First, it will provide a framework to better understand the consequences of representational choices and to demonstrate feasible alternatives based on a holistic approach taking into consideration every aspect of system design. Second, it will include several example studies demonstrating an approach to address the inherent limitations encountered when addressing subjective, idiosyncratic experiences that characterize recent developments in HCI.

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