

Reflective Design Practices in Human Computer Interaction and Software Engineering

Effie Lai-Chong Law

Eidgenössische Technische Hochschule Zürich
ETH Zentrum, TIK, Gloriastrasse 35, CH-8092 Zürich, Switzerland
law@tik.ee.ethz.ch

ABSTRACT

Three theories of reflection of Dewey, Vygotsky and Schön can presumably well inform the development of different aspects of HCI and software engineering. Upon reflecting on the related literature, we derive some boundary conditions for reflective design practice and formulate three questions, of which the understanding is enhanced through the three theoretical models of reflection.

INTRODUCTION

In the recent literature on design, be it of architectural constructions, software systems, or professional training programs, Donald Schön's theory of reflection [18,19] has frequently been referenced. In fact, Schön's theory is rooted in that of Dewey[1] and Vygotsky[27]. A common thread linking the social constructivist theories of these three scholars is that knowledge and actions are fundamentally social in origin, organization and use, and are situated in particular context. Presumably, Dewey's social pragmatic, Vygotsky's socio-linguistic and Schön's communicative views of reflection (see below) can well inform the development of different aspects of Human-Computer Interaction (HCI) and software engineering (SE). Specifically, some boundary conditions for reflective design practice can be derived.

In HCI and SE various design models have become popular in the last decade, including participatory design, situated design, scenario-based design, user-centered design, and evolutionary design. A basic tenet shared by these models is that design, as a form of creativity enabled by ample opportunities for reflection [11], is essentially a social practice – a core concept echoing the three views of reflection. Furthermore, the ever-increasing research interest and effort in these social constructivist approaches (cf. rationalist-cognitivist approach) to design [28] has paralleled the prolonged analyses on human-machine and work-technology relationships [3]. Both lines of inquiry can mutually influence each other. For instance, the supposition that there is an inherent asymmetry between human beings and machines in terms of their differential access to resources embedded in the social and material environment [21, 22] can inform the design of intelligent software agents [15]. Moreover, the social constructivist approaches to design imply that software engineers need to address a vast array of issues when designing a system. Reflective thinking is

necessary to cope with the overwhelming demand. The concomitant question is: *What should designers reflect on?*

The recalcitrant gap between HCI and SE has lately drawn much attention and concern of professionals from both domains [9]. Issues pertaining to usability have been one of the starting points to coordinate the efforts of HCI specialists and software engineers. There exist joint endeavors on incorporating usability into software architecture, identifying usability patterns, constructing taxonomies of usability problems, and improving usability evaluation methods (UEMs). Since analyzing each of these aspects is beyond the scope of this position paper, we elaborate our view only on UEMs, of which several problems are basically design in nature, including design of usage scenarios, evaluation procedures and tools, and data analysis scheme. A number of UEMs have been criticized as not adequately rooted in a sound theoretical framework and rather pragmatic in nature. Since evaluation is essentially a reflective practice, we assume that theories of reflection can somehow enhance our understanding of UEMs. The concomitant question is with such an increase in knowledge: *How UEMs can be rendered more effective?*

Besides, the definition of usability is problematic. The core definition of usability concept as a set of measurements (i.e., ISO 9241) is too limited and too technical to explain phenomena and to support design and research activities when social and cultural aspects have to be dealt with [6]. Contextual approaches to usability have been put forward but not yet adequately explored. Similarly, the notion “cultural usability” has been addressed. It is a working hypothesis for a design practice that reaches beyond the functional interests of contemporary usability research and interface development by situating design in its wider socio-cultural contexts [25]. While the technical definition of usability is too narrow, its social counterpart can be too broad to manage. The concomitant question is: *What is the manageable scope of usability?* In the ensuing discussion, we first briefly delineate the three theoretical models of reflection and then derive some boundary conditions for reflective design. Next, we examine how they can improve our understanding of the three questions raised above.

THEORIES OF REFLECTION

Historically, the challenge of defining reflection has been entertained by scholars of different epochs. For Dewey, it is

a preferred form of thinking triggered by doubt and perplexity perceived in a situation, resulting in problem resolution in light of previous experiences. For Vygotsky, reflection is the transferal of argumentation from a social level to an internal one. For Schön, it is a dialogue of thinking and acting through which performance can be enhanced. In sum, the definition of reflection is beset by its temporal (anticipatory, contemporaneous, and retrospective) and developmental dimensions (ranging from technical to critical reflection).

Dewey's Social Pragmatic View of Reflection

According to Dewey [1], the role of reflection is to regulate the dialectic relationship between knowing and acting, and reflective thinking is a tool for problem resolution and operates through the progressive cycle of 'inquiry'. An inquiry is a teleological impetus for determining a course of actions to counteract instability of a situation. There exist two types of inquiry. Whereas a perceptual inquiry entails adapting to the affordances of a situation and results in ad-hoc actions, a reflective inquiry entails manipulating symbolic representations and leads to planned actions. Besides, Dewey's evolutionary point of view implies that reflective inquiry develops out of perceptual inquiry through persistent agent-world transactions. Dewey [2] emphasized the role of tools in the emergence of mind, especially language. In accord with Dewey's pragmatic social behaviorism, communication and action in a social setting can facilitate reflective thinking.

Dewey [1] postulated five phases of reflective thinking: problem recognition; enumeration of possibilities of new actions or beliefs; evaluation of the possibilities through consulting memory, questioning, or experimenting; revision of possibilities; decision-making on next appropriate actions. These phases, varying in duration with the type of inquiry, can overlap in time. He also specified three attitudes required for reflection: open-mindedness, absorbed interest and responsibility in facing consequences.

Vygotsky's Sociolinguistic View of Reflection

According to Vygotsky [27], reflection can be understood as self-regulation, which is acquired by a process that involves first experiencing "other-regulation" which occurs in the zone of proximal development where adult guidance or collaboration with more capable peers is available. Through this special mode of social interaction, the form and content of self-regulation are gradually transferred from the more competent partner and internalized by the learner. The Vygotskian views also stress that sociolinguistic experience is indispensable for the emergence of metacognition and that intersubjectivity is a primary means for knowledge construction. The corollary is that modeling and verbal communication (including self-verbalization) are strong facilitators for reflection.

Vygotsky also advocated the thesis that reflection plays a mediating role by transforming meaningful experiences into learning which leads to development. Vygotsky, like Dewey, regarded language as the most

potent cultural tool in achieving convergence of meaning and co-construction of knowledge during social interactions. Based on Vygotsky's theory of dialectical relationship between the intra- and inter-psychological and transformation of one into another, high-order thinking like reflection is developed through consistent agent-world dynamic interactions.

Schön's Communicative View of Reflection

According to Schön [18,19], reflection-on-action and reflection-in-action as essential factors for the development of professional artistry, which refers to kinds of embodied skills practitioners demonstrate in problematic situations of practice. Whereas reflection-on-action refers to thinking back on the action already accomplished or pausing in the midst of an action to make a "stop-and-think" (i.e., offline), reflection-in-action occurs while a practice is being undertaken (i.e., online) and implies moment-by-moment "active experimentation". Besides, reflection-in-action is conceptually more complex, developmentally more mature, and functionally more significant than reflection-on-action. Based on his communicative views, Schön believed that the effectiveness of a practicum depends crucially on social interactions, especially reciprocally reflective dialogues between coach and student who have to maintain communication which eventually leads to convergence of the interpretations of the concepts in question.

Schön's model of reflective practice consists of four central components: perceiving an indeterminate zone of practice precipitated by instability of a specific situation; framing the problem in terms of the particulars of the situation, analyzing and criticizing such an initial problem framing; reframing the problem in light of the inquirer's repertoire of domain-specific knowledge and previous experiences; generating moves for future actions leading to the new coherence of the situation. This sequence of operations can be seen as an individual's attempt to converse with the situation in which he is embedded. Reflective conversation is a highly dynamic and dialectical cognitive enterprise. The inquirer shapes the situation, but in conversation with it, his idiosyncratic methods and appreciations are in turn shaped by the situation.

Implications of the Three Views of Reflection to Design

Based on the basic assumption that reflective thinking is requisite for design activities, we infer some boundary conditions for design from the three views of reflection.

- First, design is essentially a social practice and mediated by artifacts and tools socio-historically constructed, of which language is particularly important. Hence, collaborative working environments, where pluralistic and meaningful social discourse among stakeholders is supported, are conducive to design [12].
- Second, design entails a contextualized problem and a source of stimulation, which, according to Dewey and Vygotsky, can be described as dialectical transactions

between internal and external. Hence, to design systems with any integrity, it is imperative for designers to develop them in relation to specific settings of use [23] and to sustain ongoing interactions with the social and material environment, which can ‘talk back’ [18] to designers to propel the related works.

- Third, design is inherently evolutionary in nature, undergoing progressive and iterative steps (cf. Dewey’s evolutionary view on perceptual and reflective inquiry; Vygotsky’s notion of spiral cognitive development; Schon’s “framing-reframing” cycle). Hence, design plans (cf. requirement specifications in SE) have to be flexible and adaptive so as to accommodate emergent needs. Plans can actually serve as a kind of resource to bridge the gap between knowing and acting [9,21]. In fact, evolutionary approaches to design have been advocated by some contemporary scholars [4, 14].
- Fourth, design is a highly dynamic mental activity that tends to overburden our cognitive load [24] - a problem closely related to the issue of intrinsic motivation. Hence, objects of reflection should not be too encompassing. Besides, well-articulated but negotiable goals, which are somehow compatible with institutional arrangements, need to be set, thereby increasing the designer’s sense of ownership of the problem as well as his or her motivation. Besides, the attitudes of open-mindedness and responsibility have to be reinforced.
- Fifth, design anchors in a rich declarative and procedure knowledge base. This explains expert-novice qualitative and quantitative differences in design activities. Hence, to enrich the skills required, it is desirable to provide designers with just-in-time training or tutorial support. Among others, expert modeling seems to be a relatively promising training strategy.

PROBLEM RESOLUTIONS

In this section, the three questions posed in the foregoing discussion will be examined. We point out that each of the questions touches upon a large scope of intricately related problems. While we cannot provide any conclusive answers, we aim to stimulate further reflective conversations in the community of practice and interest.

What Should Designers Reflect on?

Identifying appropriate objects of reflection is the foremost and crucial step leading to the personal and professional growth. We propose an expanding scope of reflection with

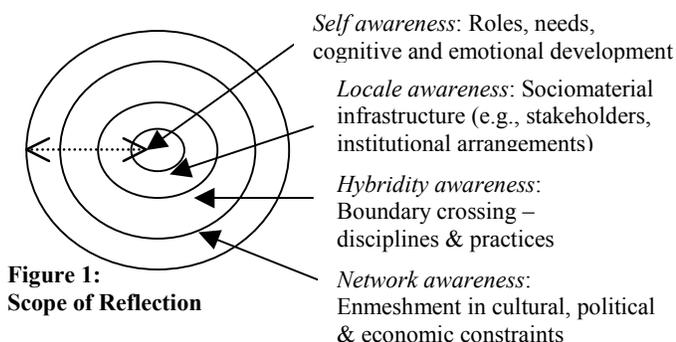


Figure 1:
Scope of Reflection

four levels of awareness (Figure 1). Evolution of self [13] is the most significant function of reflection; consolidating a coherent self enables one to reach out to other levels. Locale is defined as a setting where design works get done. It is imperative for designers to be aware of what kinds of resources (e.g., expert guidance, reusable ideas in database) are accessible and what local constraints they must observe.

Hybridity implies our constant moving across disciplines and practices, leading to frequent shifts of perspectives [25] and even feelings of alienation and inadequacy [23]. Nonetheless, domains are not natural entities [20] and disciplinary boundaries can be seen as artifacts created to sustain the power and vested interest of their upholders [7]. The implication of this line of argument is that designers need to reflect on their roles in relation to elements of the socio-material infrastructure that constitutes technical systems. Besides, to optimize contributions of the workforce involved in a design project, the following factors are deemed necessary: reciprocal learning of complementary concepts, genuine respect for divergent views, high accountability, and ongoing dialogue facilitated by (partial) translation of the concepts in interest. It is noteworthy that the perimeters of the concentric rings presented in Figure 1 are “permeable” in the sense that the flows of information and knowledge among the four levels are basically possible, as illustrated by the double-arrow. With consistent practices of reflective activities entailed by the four levels of awareness, designers can develop an integrated view of the field where they are embedded.

How UEM can be Rendered More Effective?

Co-construction of knowledge is a paradigm commonly upheld by the three views of reflection. Collaborative discourse is congruent with reflective approaches to knowing because articulation to others helps one to share and clarify one’s ideas. Mutual intelligibility of the concepts of interest can be attained through ongoing negotiations among conversational partners [21]. The implication is that the effectiveness of UEMs can be enhanced in a collaborative context. For empirical UEMs such as usability tests, in contrast to the ‘standard’ arrangement where single users work independently, there exist team usability tests where users in dyad or a small group co-discover usability problems while collaboratively performing given task scenarios on prototypes or operational products [5, 26]. For analytic UEMs, there exist collaborative usability inspections [10], where usability experts, representative users, developers, and graphic designers jointly identify usability problems in prototypes or models. However, whether these “social-based” UEMs are more cost-effective than their “individual-based” counterparts in detecting usability problems cannot yet be consistently confirmed by the empirical data. The key may lie in the techniques employed for extracting data on the first place (i.e., thinking aloud in usability tests; heuristics/principles selected) and in the methods adopted to compare the effectiveness of different UEMs. Nevertheless, we believe that collaborative usability

evaluation is a promising approach worthy of closer investigation.

What is the Manageable Scope of Usability?

The three views of reflection are rooted in the socio-constructivist theories, which have challenged the basic assumptions underlying the rationalist-cognitivist tradition and dethroned its hegemony. Indeed, different types of phenomena entail different frameworks to make sense of them. Similarly, the narrow, technical definition of usability should be supplemented (not replaced) by a broader, social one. Another reason for the need of an alternative definition is the “ubiquitization” of human-machine interaction with concomitant increase in user heterogeneity and their needs. What they require from a product is more than effectiveness and efficiency. Hence, usability is measured more in qualitative rather than quantitative terms and more experiential rather than conceptual. With the shift from a rigid to a relatively fluid conceptualization of usability, we need to review existing UEMs. Specifically, we may have to ask users different questions concerning their emotional, aesthetic, ethical, attitudinal, and social values towards the usage of a product. One crucial point is that usability problems are relative to product and service goals. The challenge is how to map different UEMs to different goals. Such mappings may serve as general guidelines, and usability specialists need to adapt them to the particularities of an application context. We assume that the manageability of social-based usability can be optimized if there are well-coordinated collaborations among stakeholders and usability is addressed at the very beginning of a product design and sustained throughout the process.

Concluding Remark

We cannot provide any conclusive answers to the three questions we posed, partly due to the limited empirical data available. But they are significant issues that need to be addressed in the future research of HCI and SE. We remark that a reflective design practice implies critical sensibility to design [25]. Accordingly, we should be cognizant of the tacit assumptions underlying the discourses and usages of new technologies, and of the socio-historical background of existing cognitive tools (e.g., metaphors, taxonomies, templates) with which design artifacts are represented and constructed.

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