

## **Design and Complexity: Research into Practice**

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**Abstract:** The paper proposes a rethinking of design practice through the lens of complexity. The paper analyzes design and HCI theories related to reflective practice, context, and embodied interaction as approaches complexity. The paper calls for the framing of larger research agenda in this area with the need to further work on issues of research into practice in design.

**Keywords:** *design theory, complexity, reflective practice, design practice, human-computer-interaction*

### **Introduction**

A current challenge is that most design and human-computer-interaction theories implicitly claim that many design situations are virtually unapproachable, or at least better ignored. Further, design practice engages such situations in only a fragmented and tacit manner. This set of design situations lie between design problems as well-defined tasks and goals which characterizes most design today. For example, the designing of a mobile phone, and highly complicated problems for specialists such as designing a project management system for a mission to Mars are achievable outcomes. Yet what falls between these two examples on a continuum of design activities is a space in the middle that has been referred to as “wicked problems” (Rittel and Webber, 1973), and “ill-structured problems” (Newell and Simon, 1972), and as such are argued to be “unsolvable” or at best “coped” with by the designer. Examples of wicked problems included urban planning and environmentalism. These problems were seen to be complex due to the large scale and extraordinary uniqueness of the situations. Recently, ubiquitous computing has again raised the issue of complexity in design situations – situations that are beyond definable tasks and not of a specialist nature. Yet unlike the wicked problem, the very nature of ubiquitous computing challenges design in relatively small scale and in everyday design situations. Revisiting the role of complexity in design such that complexity is not of a special order represented in large scale and unique situations, but rather is seen as a ubiquitous attribute of design found across the continuum of design activities is a way forward in addressing challenges in HCI, and in providing a more comprehensive understanding of the role of design in HCI. In this research, the proposed way forward involves the concurrent development of knowledge in theory and practice, involving the synthesis and augmentation of fragmented theories that approach complexity in design through ideas of reflective practice, context, embodied interaction, interactive cognition, and human activity. While this paper argues from an exclusively theoretical point it will raise in the conclusion issues of our understanding of design and HCI *practice*.

### **What do we know about complexity in design?**

This research program connects an understanding of the practice of design with an understanding of complexity in design. The need for establishing this connection arises out of the author’s practice in interaction design, where design is approached socially and contextually, especially in the emerging applications of ubiquitous computing. Interaction design is understood to be an inter-disciplinary convergence of design and HCI (human-computer-interaction), inclusive of aspects of interactive art, performance, computing science, cognitive science, psychology and sociology (Sanders and Dandavate, 1999, Winograd, 1997, Löwgren, 2002, Preece et al., 2002). In the contexts of design and HCI, complexity has been discussed in isolated pockets along three dimensions, all of which assume a design process but

rarely acknowledge it<sup>1</sup>. Firstly, design outcomes are understood to be complex, as expressed in architecture, evolutionary theory, and human factors engineering (Dawkins, 1986, Norman, 1998, Venturi, 1966). Secondly, attention has been given to the definition of design problems as complex, from Rittel's notion of the "wicked problem" to Simon's "ill-structured problems" to Alexander's "pattern language" (Rittel and Webber, 1973, Buchanan, 1995, Simon and Siklóssy, 1972, Alexander et al., 1977). Thirdly, there has been discussion on the role of HCI and Information Design in supporting end users' complex problem solving (Gay and Hembrooke, 2004, Albers and Mazur, 2003, Mirel, 2004). These discussions have taken place against the backdrop of the socio-technical aspects of design, participatory design and the tradition of Computer Supported Cooperative Work. However, another trajectory is emerging, in which the term complexity is not explicitly used. This includes the ideas of reflective practice and contextual design. Design is seen to be boundless and dynamic rather than bounded and quantifiable (Buchanan, 1995, Barnard et al., 2000, Nardi and O'Day, 1999, Thackara, 2001, Dourish et al., 2004, Fischer, 2000, Schön, 1983). This latter trajectory is the starting focus of this research program.

Two key issues emerge from the current state of discourse on complexity and design. The fields of design and HCI are moving closer together and at times discussed interchangeably and at other times understood to be intertwined (Ehn, 1989, Norman, 1998, Fallman, 2003, Coyne, 1995, Gay and Hembrooke, 2004, Fischer, 2004, Zimmerman et al., 2004). Winograd was among the first to identify this trend (Winograd, 1997, Winograd, 1996). In large part, the motivating factor is the need to acknowledge the unique contextual aspects of interaction and the need to *design* in response to specific (typically complex) and not generic situations, a shift he coined as the move from *machinery to habitat* (Winograd, 1997). The second key issue is the lack of a coherent theory on complexity in design, especially inclusive of the practice of designing.

While many argue that design produces complex artifacts, and that design practice can be captured as complex formalisms, this research argues that we need to understand design as an activity that responds to situations of varying complexity. The key distinction is a question of understanding design as a prospective action, that is actively reflecting within a present moment on future action and contingency, as opposed to a retrospective event from which we view the design process or artifact as a stable past action with little attention to context. In the former, the relationship between activity and situation in design is integral and dynamic. For example, Schön views design as a conversation (Schön, 1983). Rittel understands design as argumentation (Rittel and Webber, 1973). In either case, each metaphor implies a dynamic act reliant on interpretation and multiple perspectives. The metaphors explicitly describe an activity in which the actions of speaking/listening, and the nature of what is being said/understood are intertwined and dynamically inform each other. In addition, like a conversation, design is quite ordinary and ubiquitous. And so, an alternate way to consider design is that it is an activity that is integrally related to complex, yet everyday situations.<sup>2</sup>

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<sup>1</sup> Daniell Fallman contends that in HCI, there is little evidence of interest or concern for the designing of systems or prototypes. A syndrome he refers as "it just happens", see Fallman, D. (2003) Design-Oriented Human-Computer-Interaction, Proceedings of the conference on Human factors in computing systems, Ft. Lauderdale FL, 225-232.

<sup>2</sup> Dourish in discussing his related concept of embodied interaction has commented on the ordinariness of conversation as discussed by Sacks in his analysis of conversation. Dourish argues that ordinariness is a feature of context as it is understood within embodied interaction, see Dourish, P. (2004) What We Talk About When We Talk About Context, *Personal and Ubiquitous Computing*, forthcoming. This argument can equally be applied to complexity. What we then understand is that complexity is not a factor of scale (largeness) and extra-ordinariness.

For example, a visit to a museum reveals an everyday, yet complex interaction situation. The factors within museum experiences are social, cultural, historical and psychological. The influences on the experience vary from the actions and previous knowledge of the visitor, visitor's learning style, the dynamics of others around them including friends, family and strangers. Naturally, the experience is affected by the presence of the artifacts and the relationships within collections as an outcome of institutional history, curatorship, exhibition design, and architecture. The time of day, duration of visit, room temperature and so on -- all have an impact. The experience can be characterized as *multivariate*, that is, it cannot be assessed by a single factor such as exhibit design, signage, or time spent in front of an artifact. Instead, the museum experience is subject to multiple influences and results in multiple outcomes (Leinhardt and Crowley, 1998). Identifying a design intervention that may have a direct and positive impact on experience is clearly not easy! Many other complex situations have been discussed in design research such as how we work (Ehn, 1989), seek information (Nardi and O'Day, 1999), learn (Gay and Hembrooke, 2004), and live in our homes (Tolmie et al., 2002, Bell and Kaye, 2002). Yet, few discussions include how we might design for these situations.

In part this lack of exploration of design practice as a response to complex situations is a result of the unwarranted focus given to viewing complexity in design as a quality of artifact or process. Such views tend to abstract or isolate either the design object or process from their context. To a large degree, this complexity in outcome is seen to be the result of a complex design process. Such symmetrical linking of design process and outcomes is what Gedenryd describes as an inaccuracy in today's understanding of design methodology; a misconception that the structure of the process of design is reflected in the outcome (Gedenryd, 1998)

Are design processes really complex or do we just assume that a complex outcome is the result of a complex process? And therefore should we assume that a simple outcome is the result of a simple process? Clearly we should not. I think we all understand that while many design outcomes are complex artifacts and actions, many outcomes are extraordinarily simple. And the reverse is true, simple processes can prove to be very effective. We have a tendency to analyze design retrospectively as opposed to prospectively – and in the process over-interpret for rational attributes such as logic and symmetry. If we did view design prospectively, as in fact design practice demands, we would see that complexity precedes, accompanies and follows design action. Complexity is contextual, situated and dynamic and therefore cannot be isolated in processes or artifacts. That is design and designers' actions respond to complex situations. What we find is that the process is not pre-determined as complex, symmetrical or simple in structure, rather it is a dynamic process that is improvisational and responsive to the changing design situation. An active stance is required in design. Such design strategies have come to be understood as reflective, embodied, or contextual in practice.

Another reason for the lack of research in design processes is that in many ways the issues discussed in this research are part of a call for a new research agenda in viewing design as contextual, social and diverse in strategies (Nardi, 1996, Dourish, 2004, Louridas, 1999). In achieving that goal it is important to underscore the creative as well as reflective aspects of such an undertaking. There is a need to generate a theory of the complex through the making in design and there is a need to create or make concrete, the possibilities of the complex in design.

### **A Call for Research into Practice**

Schön makes the argument against what he refers to as “technical rationality,” whose basis lies in logic and reasoning in theory outside of practice. The rational in his view is the logical abstraction of thought and action (Schön, 1983). Gedenryd, in analyzing design methodologies, traces the rational view of design practice to math, logic and cognitive

science. In his arguments, design methodologies adopt a rational approach to design methods characterized by the common principles of separation and sequence (Gedenryd, 1998). Design, based on traditional cognitive science has to date, adopted the linear model of analysis, synthesis and evaluation. To a large degree this approach has been inadequate in addressing the ordinary complexity of design situations.

In contradistinction, is the practice we know only tacitly “non-rational,” an approach that guards against abstracting views of practice, and rather grounds interpretation and reflection on practice -- in practice? In Gedenryd’s terms, the approach is interactive and in the world, rather than intra-mental. In other words, the movement from design decision to design decision is like dead reckoning in navigation where one determines the next destination in absolute reference to the last. And the movement between design choices is like rotating puzzle pieces or Tetris pieces to find the right fit – it can only be done through action. In relation to Dourish, complexity is seen as an “interactional” issue where it is understood through and by action, as opposed to a “representational” issue – it simply cannot be mapped out beforehand (Dourish, 2004). Situated in context of place, people, and technical systems, the design approach encourages action to manipulate the context through *playtypes* such as play-Doh objects, Wizard of Oz systems, and of course, directly through dialogue with participants and designers (Wakkary, 2004).

However, certain limitations are evident in further research in design and HCI practice. This includes further research in the analysis and observation of design practice.<sup>3</sup> This would naturally entail work on the methodologies for documentation and analysis of design practice, including first-person methodologies, ethnography in action, protocol analysis, and other methods. It is by far more common to record interactions and real-time observations of “users’ but not practitioners.

#### Discussion

Limitations to current theories related to complexity are readily admitted. The contextual approaches based on activity theory are quick to point out that the theory is a research framework for understanding individual consciousness that has strong implications for better understanding the nature of human activity and interactive technologies but says little about practice (Nardi, 1996, Gay and Hembrooke, 2004). The related ecological approaches have only begun to examine how to bridge the sociological methods of ethnography and participatory design with emergent systems that characterize information ecologies. Reflective practice has mostly remained a descriptive theory in design. In design, the nature of addressing complexity can be characterized by Christopher Alexander’s idea of “building over time” and the embodiment of design knowledge in pattern languages over time and through social use. What is not clear in Alexander’s pioneering work is again the method by which patterns occurs (Alexander, 1979).

Coyne acknowledges the need to make operational the alternative methods to rational models, such as reflective practice (Coyne, 1995 p. 226). There is a clear need to move the theory of reflective practice in design beyond critique and into practice where it can be evaluated and considered fairly in relation to other approaches. Schön’s account of reflective practice in design rests on a single account of a conversation between an architecture teacher and his student (Schön, 1983 p. 226)! Needless to say, more accounts, case studies and examples of reflective practice in design are required.

Reflective practice relies on knowing-in-action as an embodied state of practitioner knowledge and theory. In effect it is a descriptor of tacit knowledge or know-how related to practice – all experienced practitioners carry this within them (Schön, 1983 pp. 50-51). Reflection-in-action arises through surprise when intuitive and spontaneous performance lead

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<sup>3</sup> See for example the pioneering longitudinal study on the practice of engineering, specifically an aspect that investigated reflective practice through the use of protocol analysis, Adams R., Turns, J. and Atman, C. J. (2003) Educating Effective Engineering Designers: The Roles of Reflective Practice, *Design Studies*, 24, 275-294

to unexpected results: “in such processes, reflection tends to focus interactively on the outcomes of action, the action itself, and the intuitive knowing implicit in the action”(Schön, 1983 p. 56). Generated theories, knowledge and actions as a response to the surprise and result of the reflection become new and unique to that design situation. States of knowing-in-action and reflection-in-action could be understood as attributes of many designers and only tell us part of the story of design. Excellent research in the area of design and reflective practice in the domain of design education have focused on reflection-in-action (Adams et al., 2003). However, the critical need for the mobilizing of the theory of reflective practice is in the domain of design practice and in pursuing the state of reflection-in-practice.

According to Schön, the role of reflection-in-practice is to ask: what is practice? Understanding the new and unique theories arising from reflection-in-action within a design situation is understood as part of a creation of practice - an epistemology of practice, based on divergence and complexity (Schön, 1983 p. 60). It is only on the level of reflection-in-practice that the theory can be compared with an understanding of design in the design science sense – as an alternative epistemology of design, and the methodological approach – as an alternative epistemology of design practice.

By way of a conceptual underpinning, the idea of complexity is proposed as a *framing experiment* for a translation, synthesis and augmentation of design practice and the role of context, human activity, and experience in HCI. Complexity is used as a descriptive term and not in the mathematical sense. The aim is not to quantify or create an abstraction of design practice based on the epistemologies of mathematics or science. I do not believe that is possible. Rather, complexity is proposed as a descriptive term based on the general understanding of the complex and the emergence of the term in design and HCI theory and practice.

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