Framing complexity, design and experience: a reflective analysis

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Abstract

The paper discusses theory and practice in the roles of reflective practice and contextual design in addressing issues of complexity in design. The author defines a new understanding of the role of complexity in design. The paper reviews theories in design and HCI related to reflective practice, context, and embodied interaction. A case story of practice in interaction design and museums is presented as a practice-based investigation of the complex. The paper calls for the framing of larger research agendas in this area with the need to further work on issues of context, reflective practice, embodiment and human activity in order to provide a more comprehensive and integral view of design activity. The paper concludes with the need to reframe concerns in design in order to emphasise situated participation, non-rational design strategies, *in situ* design and a re-orientation in focus from tasks to experience.

Keywords: complexity, design methods, design theory, interaction design, reflective practice
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1 Introduction

This paper argues for a shift in design and design practice through the framing of complexity. The need for establishing this connection arises out of the author's practice in interaction design, where design is approached socially, contextually, and experientially. 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). This research is part of ongoing investigation in complexity and design. The paper will provide an overview of theoretical starting points from design and HCI for understanding design through complexity. As part of a practice-based investigation, a case story will be discussed describing a design project in ambient intelligence and museums. The paper calls for the framing of larger research agendas in this area with the need to further work on issues of context, reflective practice, embodiment, and human activity in order to provide a more comprehensive and integral view of design activity. The paper concludes with the need to reframe concerns in design in order to emphasise situated participation, non-rational design strategies, *in situ* design and a re-orientation in focus from tasks to experience.

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2 Design situations, ordinariness and complexity

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[1]. 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). However, another trajectory is emerging, in which the term 'complexity' is not explicitly used. This includes the ideas of reflective practice and context. Here, 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). The focus of my research on complexity emphasises this latter trajectory due to its implicit understanding of complexity as a common factor in design activity.

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 (1996, 1997). 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 design practice.

While many argue that design produces complex artifacts, and that design practice can be captured as complex formalisms, I argue 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 given 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, and in turn complexity, 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[2].

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 characterised 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 (Lehn et al. 2001). 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 similar 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). We can see that almost any situation is in some form complex, 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. 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 analyse design retrospectively as opposed to prospectively—and in the process over-interpret for rational attributes

such as logic and uniformity. 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.

2.1 Reflective practice: dynamism, contingency and unfolding in design

Schön's account of professional practice spanned design, engineering and psychoanalysis. His observations of professional activity lead him to reject a theory of technical rationality and to develop an alternate theory of the professional as reflective practitioner. A reflective practitioner embodies the full scope of the complexity of the design situation, a term given us by Schön that is highly appropriate for understanding complexity and design. The practitioner's knowing is embodied in action and her practice is understood through reflection. A reflective practitioner focuses on 'problem-setting' activities to overcome the limits of 'problem solving' (Schön 1983 37–39). The problem and design response is reasoned through experimentation, and fluidly engages in a variety of representations from sketching to scenarios as a mode of experimentation— what Schön refers to as 'frame experiments' (Schön 1983 150). According to Schön, the reflective practitioner as designer interactively frames the problem and names the things she attends to within this frame, she generates 'moves' toward a solution and reflects on the outcomes of these moves. The cognitive

67

scientist Gedenryd has expanded on the dialectical nature between Schon's concepts of exploration (setting the problem) and experimentation (framing the problem) (Gedenryd 1998 169–172).The designer functions by going back and forth between construction and reflection as a means to understand the designer's situation she is creating, hence the notion of the designer as having a 'reflective conversation' with the situation. Schön argues against the fabled objectivity of a rational approach by asserting that the reflective practitioner, through this type of engagement with the design situation, is shaping the situation (Schön 1983 150). As such, reflective practice accounts for the dynamic, contingent, and unfolding nature of design. For Schön, reflection is a critical element of professional activity and design.

Other theorists have added to Schön's model of the reflective practitioner. Coyne and Gedenryd root the practice in the philosophical pragmatism of Dewey, Heidegger and Rorty (Coyne 1995, Gedenryd 1998). Under the pragmatic account, design takes the form of a hermeneutic process of interpretation and creation of meaning, where designers iteratively interpret the effects of their designs on the situation at hand (Gedenryd 1998, Coyne 1995)[3]. Louridas extends the theory through metaphor. He borrows Lévi-Strauss's concept of a 'bricoleur' as a metaphor for a designer as a reflective practitioner (Louridas 1999). A bricoleur is someone who makes do with what is available or encountered in a specific situation. Like Schön's notion of reflective conversation (Schön 1983 165–66), the bricoleur operates from the available means (the concrete tools and materials offered by a specific design situation) but treats them as signs, by seeking to determine and redefine the roles they can play in the given situation. The designer as bricoleur interrogates the situation from within and from multiple perspectives while constructing with the heterogeneous means the situation affords.

2.2 Human activity and context: the 'theoretical pinch' in human-computer-interaction

Many HCI theorists and researchers have come to identify issues of 'context', 'situation' and 'practice' as putting a strain on the traditional theories of HCI (Nardi 1996, Dourish 2004, Bødker 1991, Gay and Hembrooke 2004). As Nardi puts it,

we are beginning to feel a theoretical pinch, however—a sense that cognitive science is too restrictive a paradigm for finding out what we would like to know.
(Nardi 1996 13)

The understood need is to move the theoretical trajectory of HCI from a reductivist understanding of human cognition toward an understanding of embodied and situated human activity.

In response to the rigidity of cognitive science, ethnographic and scenario-driven methods have begun to take hold in HCI practice (Suchman 1987, Carroll 2002, Carroll 2000). Further along in this direction, an emerging set of 'context-based' theories for HCI have adapted ideas from an even wider spectrum of psychological, social, political and philosophical theories based on understanding human activity. For example, Nardi, Bødker, Gay and others (Nardi 1996, Bødker 1991, Gay and Hembrooke 2004) have advocated on behalf of activity theory, a theory developed by psychologists in the early 1920s (Vygotsky [1925] 1982), as a research tool and an alternative framework for understanding human activity as it relates to individual consciousness. While the primary concern of activity theory is human activity; the insight is in the view that activities can only be understood through the role of related everyday artifacts, and that artifacts and activities are inextricably situated in a social practice. Dourish (2001, 2004) argues in his concept of embodied interaction that activity and context are dynamically linked—or 'mutually constituent' (Dourish 2004 14).

Figure 1. Visitors experiencing an installation of *ec(h)o* at the Canadian Nature Museum in Ottawa.

Based on the philosophical viewpoints of Heidegger and Wittgenstein, Dourish argues against the rational notions of abstracted cognition in favour of understanding human activity as an embodied practice that negotiates (and constructs) meanings in systems and contexts through interaction.

3 Reflective case story of practice and method

In practice, it is clear how design actions are responses to situations of varying complexity. Underpinning the responses is the simultaneous analysis and action that is prospective reflection within a present moment. The case story aims to demonstrate how a theoretical understanding of complexity in design is informed in large part through praxis.

The case story stems from a recent research project in ambient intelligence. The project is an audio augmented reality guide for museums, known as *ec(h)o*, integrated with a semantic web based and adaptive information retrieval system. The platform is designed to create a museum experience that consists of an interactive virtual layer of three-dimensional soundscapes that are physically mapped to the museum exhibition. The source for the audio

is digital sound objects. The digital objects originate in a network of object repositories that connect audio content from one museum with other museums' collections on the network. The system enables interaction by movement and gestures without the direct use of a computer device (Wakkary et al. 2003, Hatala et al. 2004). The visitors, wearing wireless headphones, experience a real-time soundscape composed of sounds related to artifacts nearby, as they move through the exhibition space. In closer proximity to artifacts on display, visitors hear and select audio information based on what is on display and choices inferred by a reasoning engine based on their pre-selected interests, past movements in the space and previous interaction. Selections are made by the visitor through gestures with a wooden cube.

In this project, the objectives for the system were to evaluate visitors' experience with *ec(h)o* in comparison with their past museum experiences. In our case, we were not interested in an objective viewpoint or quantification of experience, rather our evaluation methods were aimed at first-person evaluations by the visitors, contextualised by quantifiable data based on the reasoning engine and location-tracking data. However, the user evaluation is not critical to the

69

discussion of design/HCI practice in this paper and therefore will not be discussed here[4].

3.1 Overview of methodology

In combination with emergent actions in practice and the preliminary framework drawn from the relevant theories of reflective practice and contextual design, the author explored the development of a design method that was responsive, improvisational and emergent in structure. The method anticipates dynamic responses rather than outlines separate and sequential steps. The method is best described as having few components that react dynamically to each other until a reasonable design outcome is agreed upon. A key concept behind the method is Schön's notion of 'frame experiments'. Here this idea is instantiated in two forms, scenarios and participatory workshops.

Scenarios

As Schön argues the design process is led by 'frame experiments'. In our case, one form is a scenario. The process begins by enacting a possible outcome based on observation and conceptualising of the design situation. Like traditional use of scenarios in design, the goal is to envision a possible outcome or future as a response to the design situation. The different forms of scenarios include role-playing, storyboarding, scripts/narratives, sketches, videos, and interactive works—however each form is enacted within the same physical and social context of the design situation in order to ensure that the scenario is designed 'in the world'. The design process begins with a scenario, yet subsequent scenarios are created whenever it is required. This occurs often since each subsequent scenario is revised and deconstructed through participatory design workshops. For example, in *ec(h)o* videos taped in various museums were produced as scenarios 'documenting' the visitor's experience and the system.

Participatory workshops

Workshops are another form of a 'frame experiment', however based on participatory design. Involving people in open but structured workshops allows for exploration of design responses to situations generated by scenarios. Workshops are a response to scenarios focusing on aspects of interaction that are enacted but not actively designed in a social or human context. Workshops can be in response to other workshops and are therefore only planned one at a time in an ad hoc and responsive fashion. Each workshop arises out of the previous design inquiry. Initially, in order to invite participation the workshops include prototyping as a participatory act alongside simple actions, typically adopting a low-resolution approach, such as paper prototypes. Over the course of the development of the design, the workshops and nature of the prototypes shift from generative to evaluative. As an example, in *ec(h)o* a participatory workshop explored movement, gesture and three-dimensional audio as a possible interaction model, by exploring ways of virtually 'catching butterflies'.

Prototypes and prototyped environments

Prototypes and technical workshops serve an enabling and evaluative function. Early in the process they act generatively, supporting design responses with technology or exploring them through 'Wizard of Oz' approaches. As the design outcomes emerge, components of the eventual system become prototyped and together are evaluated and help to evaluate the interaction through participatory workshops.

The method is purposely simple, involving the generative techniques of scenarios and participatory workshops, and enabling techniques of prototyping. Yet the resulting process is a complex non-linear structure that does not include separation of activities or inherent sequences. It does not privilege planning preceding action,
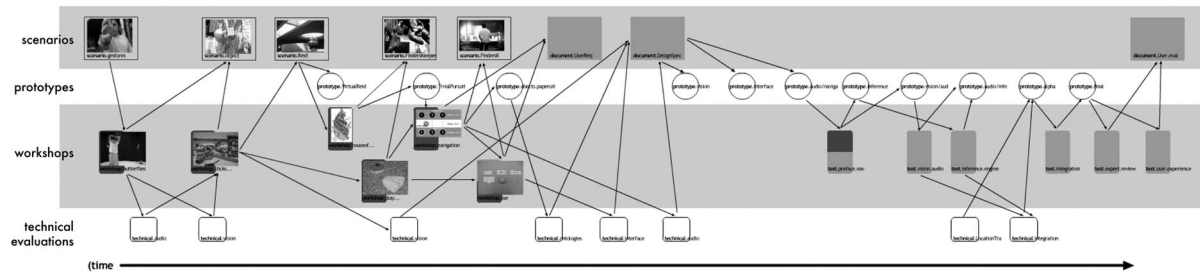
Figure 2. A retrospective map of the design method utilised in *ec(h)o*.

or decomposition and analysis as a pre-requisite for synthesis. The approach is a response to traditional methods in design, methods that simply lack in responsiveness to design situations. The exact sequence is not predictable but the overall pattern is. For example, while you may not know what workshop will follow it is clear that it will connect with 'parallel' workshops and eventually a scenario. The process is akin to dead reckoning approach to navigation—setting a general direction, and discovering the world as you go and marking each point in absolute reference to a previous point as you encounter them.

3.2 Description of the design practice in *ec(h)o*

The aim of the design activities was to develop a gesture-based interaction model, a navigation model, an audio display model and to prototype the required supporting interactive system. The team developed five scenarios excluding a number of storyboards and informal role-playing sessions, six participatory workshops, and a series of iterated prototypes and technical workshops. Preceding the scenarios and workshops we engaged in two ethnographic observation sessions and staff interviews at the Canadian Nature Museum. The project produced a publicly demonstrated prototype system, user testing and technical documentation.

The scenarios explored the visitor experience of *ec(h)o* from the visitor's perspective. In addition to video, the scenarios included storyboarding and interactive mock-ups. Each scenario responded to the conceptualising and outcomes of the participatory workshops. The scenarios evolved into documentations of the actual system since each re-direction and refinement was reflected in each scenario. All the videos were video-taped in museum environments.

In the workshops, the majority of participants for the workshops were drawn from our university campus. The ages of the participants ranged from 23–63, with the average age range being between 31–36. The backgrounds also varied, we were careful to include in equal numbers, students, faculty, staff, administrators and genders. Participants were screened based on past experiences with visiting museums and experience with museum technologies. The workshops were evenly split between group and individual activities. The later workshops required more specific problem testing and utilised more refined prototypes or models and so tended to be individual, while the earlier workshops were low resolution and required group input. Each workshop was videotaped, and followed by a structured interview, and each participant completed a questionnaire. Sample size for each workshop ranged from 8 to 12 participants.

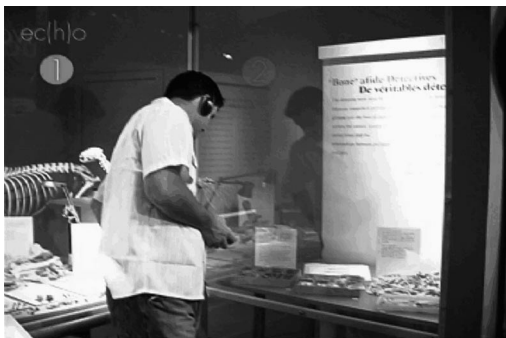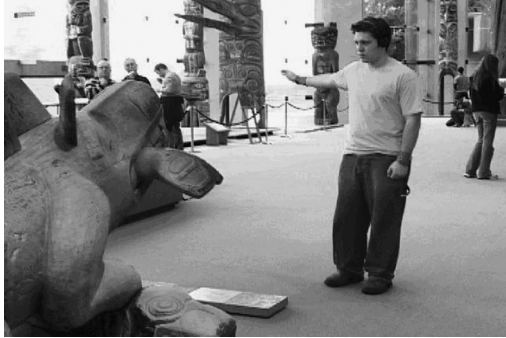Each workshop was given a name and an open call was made to the university. The

Figure 3. A series of frame stills from the various scenarios.

design team structured, planned, made the call, and performed each workshop within two weeks or so of deciding another workshop was required. Below are brief descriptions of each workshop.

Workshop 1: *How do you catch butterflies?*
The objective of this workshop was to begin

the development of an interaction model based on human gesture in response to spatial audio that was envisioned in the first scenario. The team initiated the co-designing by beginning with the metaphor 'catching butterflies'. In discussion, brainstorming and 'bodystorming' sessions, participants helped the design team come up with two alternate metaphors for considering gesture. They were asked to describe how they would act out these metaphors and to experiment with them. In the group discussion conducted at the end of the workshop the participants talked about the metaphors, resulting gestures and their responses to the constraints of the model.

Workshop 2: *Sticks and stones*
In response to workshop 1, workshop 2 was an exploration of movement with objects in response to the audio display. Participants were split into teams and asked to develop objects that would facilitate hand movements and could 'function' with a 'Wizard of Oz' audio display system. Participants were given toys, objects, and various materials to modify and construct. Each team was given a few minutes to explain their approach such that the other team could 'play/test' the objects. Discussion of these playtypes raised relevant issues such as limits and potential expansion of the playtypes, as well as critiques and responses to the models.

Workshop 3: *House of cards*
The workshop was designed to generate a conceptual model for navigation based on the developing gesture interaction model. *Trivial Pursuit*™ cards were modified to provide us with an extensive 'repository of objects'. Utilising an extreme variation of a card-sorting exercise, three models were generated including one that we ultimately incorporated in the final prototype without modification.

Workshop 4: *Serious play*
In response to the navigational model and

Figure 4. Images from workshops 1, 2 and 3.

initial interaction prototypes used in video scenarios, this workshop explored the physical and embodied implications of a physical interface. Participants worked together in groups with construction materials such as paper, card, *PlayDoh*, fabric, markers and various small objects (buttons, seeds) in order to individually create interaction objects. After the design stage, each team played, demonstrated and enacted with each other's concepts. A set of playtypes were selected as 'best' concepts to test with a 'Wizard of Oz' version of the responsive system.

Workshop 5: *No buttons*
The workshop was a response to outcomes of workshop 4 and 3. The aim was to individually evaluate the pairing of our evolved interaction object with the navigational model.

Workshop 6: *Preface*
The workshop explored and evaluated a series of approaches to the audio display and interaction based on the model of a conversation. We developed several approaches to the idea of a 'preface', and 'telling' components of a conversation for their effect on the turn-taking dynamics of the interaction model. We aimed to find a

range in the audio display that encouraged discovery and play in engaging with the audio information. Participants evaluated the approaches with a desktop prototype of the audio display engine.

3.3 Design outcomes and findings
The design outcome for an interaction model was a combined gesture and turn-taking approach based on a conversation model. In response to the workshops and scenarios we moved toward deictic gestures, such as pointing, or the gesture of a hand holding a glass. We employed a further constraint by introducing an object and thus achieving greater consistency of movement. This approach was suggested in an earlier workshop. Further workshops allowed us to develop the form of the object and mnemonic mapping of the navigation to the object and gesture. An interesting finding was that participants would tend to make device-like objects with analogue push-button or contact-based interfaces, while during 'testing' they would prefer the simpler non-device like objects and manipulations. This challenged our notion of what we may now consider a 'natural' interface.

The design outcome of a navigation

Figure 5. Images from workshops 4, 5 and 6.

model emerged from exploring paper prototyping within the emerging conditions of the interaction model, audio display and system. In large part, it was an integrally parallel set of design activities. The resulting model is a simple structure that we referred to as '1-2-4'. Based on our conversation model approach, visitors' would hear three different topics to choose from in the form of audio prefaces, lead-ins to longer narratives, and if a topic is chosen it is replaced with a new and related narrative, while the previous choices are replayed. In our workshops, we used modified *Trivial Pursuit™* cards to emulate the over eight-hundred audio objects within our repositories. Workshop participants felt the model, the '1-2-4' approach was more responsive and 'tailored' to their interests.

The audio display model was pragmatically based on the navigational model and the development of inference rules related to the reasoning engine, while theoretically based on a conversational model. The workshops and scenarios explored different approaches in the presentation of the audio with the aim of allowing visitors to effectively discern between thematically or conceptually different information objects. We also confirmed that the conversational approach was appropriate to maintaining a level of playful engagement and dialogue. Part of our findings related to the style of presenting artifact information. The outcome was audio prefaces written such that they had a 'teasing', humorous quality, and were recorded with a diverse range of voices. Other findings were consistent with the theoretical insights we had been discussing and researching. The preface or conversational approach clearly piqued curiosity, encouraged more exploration and continual turn-taking. Participants found it easy to understand, to use and more familiar. Comments included, they felt more 'focused', "it's nice to hear the 'emotion' in the voice", "it's not too dry and academic", and "it doesn't feel like an automated machine".

4 Discussion: the non-rational approach and limitations

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 analysing 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 characterised 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, the practice detailed in the case-story can be described as '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 in workshops or scenarios is like dead reckoning in navigation where one determines the next destination in absolute reference to the last. And the movement between workshops and scenarios 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.

In the case-story we can see design practice as asymmetrical and non-uniform. Each response has its own degree of exponential possibilities or divergences that are pragmatically explored until a set of relationships and a contingent form occurs that we understand to be the design outcome. In some sense, the described practice is a heterarchical form of networked relationships as opposed to the hierarchical form of traditional design methods.

However, certain limitations in the case-story are evident areas of further research in practice. This includes further research in the analysis and observation of design practice[5]. This would naturally entail work on the methodologies for documentation and analysis of design practice, including first-person methodologies and ethnography in action. It is by far more common to record interactions and real-time observations of 'users' but not practitioners. Secondly, in architecture, it is self-evident to build on site and in a sense the need to design *in situ* cannot be taken too far. The workshops in the case-story could have been enacted in the museum environment in many cases and therefore taken out of the lab and studio. Lastly, complexity in interaction is often in human to human relationships—*ec(h)o* is still very much an exploration of human to system interaction.

Another alternative to the rational approach in design methods is to consider methods as parts of loose toolkits that designers carry with them to be applied as they see fit (Löwgren and Stolterman 1999). Such 'second generation' of design methods has arisen with a focus on collaboration and creativity over the systematic formalising of design processes (Broadbent 1979), yet without a broader conceptual underpinning within design issues such as context, embodiment, or complexity this approach to design is compromised and minimal in its

impact in addressing the full range of design situations.

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 design. 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.

Limitations to current theories related to complexity are readily admitted. Aside from the inherent challenges of a theoretical rethinking, methodological concerns question the first-person narrative and or situated accounts of ethnographic or phenomenological approaches (Nardi 1996, Dourish 2004). Advocates of the contextual approaches based on activity theory are quick to point out that the theory is a research framework in psychology for understanding individual consciousness that, while having strong implications for better understanding the nature of human activity and interactive technologies (Nardi 1996, Gay and Hembrooke 2004), has proven far more challenging to mobilise into informed practice. The related ecological approaches have only begun to examine how to bridge the sociologically-based methods of ethnography and participatory design with emergent systems that characterise information ecologies (Nardi and O'Day 1999). Reflective practice has mostly remained a descriptive theory in design. And so the very idea of a theory of design and complexity is in reality a call for a new research agenda.

5 Conclusions

Both design and HCI offer theoretical frameworks as starting points for addressing complexity. The paper offers a beginning point for further synthesis, critique and analysis of these concepts in order to offer a clearer view of where we stand. The challenge of better understanding the role of complexity and the resulting implications is not a trivial pursuit, nor is there a singular or even delineable goal. Rather, it is a question of framing a broad research agenda. Yet it is reasonable to argue for a shift in design and design practice through the framing of complexity that will potentially address human and social experience, the reality of practice, and the need to design *in situ* in a physical, human and experiential sense.

Design is a human activity that addresses human and social experience. A re-orientation away from tasks and efficiency in design objectives is required to address the fuller aim of responding to complex human experience. Activities are characterised by simultaneous, diverse and cross-boundary tasks and aims. As a consequence, interpretation, contingency, exploration and negotiation are viewed as necessary and favourable attributes of design responses. A key challenge is to develop approaches to evaluation that can identify and incorporate these lesser quantifiable attributes.

Design methods create from within complex and situated actions that are unable to be modelled or represented fully. In turn, this requires methods that are situational and dynamically interact within changing contexts. Design methods do not need to predetermine the process or steps, rather there is a need to anticipate the dynamic nature of the action and responses that happen while designing. These responses are situated and embodied rather than abstracted and conceived as a mental model—they can be seen as non-rational. This calls for understanding design practice as emergent and interactive.

The integral relationship in design of activity and context is characterised by instability, contingency, and interrelatedness. It is not possible to fully model or reconstruct this dynamic or reduce it to primitives and essences. Since situations and contexts are not easily represented, design and analysis is performed *in situ*. The dynamic of interaction and context is seen in the world and not in the studio or lab.

We design for the activities of people in situations or situated participation, and require design methods to support this approach. In two respects, interaction is social rather than individual. Our actions are predominantly people to people in which technology can facilitate, mediate or intervene. Secondly, even as individuals acting with technology we are social in nature in that we are interwoven into a social context and history. We are social in the sense that our actions through technology are either mediations or interventions into our social world and it should be assumed that such actions involve diverse and simultaneous experiences that extend well beyond the definition of task or user.

Acknowledgements

Notes

[1] 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 (2003).

[2] 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 (2004). 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.

[3] Rittel argues for a hermeneutic approach to design, see Rittel and Webber (1973).

[4] For details of the qualitative and quantitative evaluation of *ec(h)o*, see *UMAI* (User Modeling and User-Adapted Interaction) forthcoming special issue on ubiquitous computing and user modeling.

[5] 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, Turns and Atman 2003).

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77

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