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# EXPERIENCING INTERACTION DESIGN: A PRAGMATIC THEORY

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# EXPERIENCING INTERACTION DESIGN: A PRAGMATIC THEORY

Volume 1

by

**RONALD LENGKONG WAKKARY**

A thesis submitted to the University of Plymouth  
in partial fulfillment for the degree of

**DOCTOR OF PHILOSOPHY**

School of Computing, Communications & Electronics  
Faculty of Technology

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## ABSTRACT

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### **Experiencing Interaction Design: A Pragmatic Theory**

Ronald Lengkong Wakkary

This thesis contributes a theory for the field of interaction design based on philosophical pragmatism. The theory frames interaction design as a pragmatic experience shaped by the inquiries of designers. The contributions of the theory are that it positions the designer at the centre of a theory, describes interaction design practice to be more than a collection of methods and strategies, and provides a sound basis for generating and verifying new knowledge through design. The thesis describes and analyzes two interaction design research projects through self-reflexive accounts that illustrate the proposed theory. The projects are a tangible museum guide and a responsive environment for physical play.

The thesis examines the value of understanding interaction design through pragmatism and how interaction design when viewed as experience opens the field up to a new theoretical framework. The two interaction design research projects are described as design inquiries constituted by a design inquirer, designer intentions, and design rationales. Further descriptions of the projects show interaction design to be comprised of design actions based on judgment and interpretation. Interaction design can be assessed by the degree to which there is integrity between the design inquiry and design actions, as well as by the transferability and discursiveness of the design inquiry findings that are relevant to the wider field of interaction design and related disciplines like human-computer interaction. The implications of the theory lead to new ways of mobilizing interaction design research and interaction design education. The pragmatic theory shows capacity for clear descriptions and analysis of interaction design inquiries in ways that extract and communicate new knowledge from interaction design practice and research. The theory shows interaction design to be a distinct and independent field of inquiry that generates knowledge through design.

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## AUTHOR'S DECLARATION

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At no time during the registration for the degree of Doctor of Philosophy has the author been registered for any other University award without prior agreement of the Graduate Committee.

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## CHAPTER 1: INTRODUCTION

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The term *interaction design* is now more commonly heard than ever before yet our current understanding of the field is incomplete. The aim of interaction design is to create and shape computationally interactive systems and artifacts for human use. Despite the term's growing popularity, our knowledge of the making of computational systems and artifacts is limited since our current understanding of interaction design is not sufficiently guiding research and education in the field. The simple reason for this is that current theories of interaction design have overlooked or ignored issues of *design* and the *designer* in conceptualizing the term. As a consequence, interaction design and especially interaction design research is under-defined. This minimizes our ability to understand how best to create interactive systems.

Interaction design is both a nascent field and an interdisciplinary one, and the field and research communities have yet to develop a mature research program. Having emerged from different disciplines, progress in the study of interaction design has been slowed by the disciplinary boundaries and differences in the epistemic cultures of design, science, and social sciences. Human-computer interaction (HCI) is particularly important in this regard, as it has had a great impact on theorizing interaction design. HCI has roots in psychology, computing science, and engineering, and these perspectives have dominated the study of

interactive systems and artifacts. HCI is commonly viewed as the study of interaction between people and computers, whereas interaction design can be seen as the practice of creating interactive computational artifacts for people. There is significant and beneficial overlap with the concerns of both HCI and interaction design. The influence of HCI has positively shaped interaction design in ways that other design disciplines may benefit, e.g. user-centered design. However I will later discuss how it has also eclipsed and obscured distinct interaction design contributions. Additionally, past design research traditions have the potential to contribute to theorizing interaction design, yet to date these traditions have had little influence on conceptualizing the field. It can be argued that while issues of interaction continually need to be debated and discussed, the picture will always be incomplete without a greater understanding of the role of design and designers in interaction design and by extension HCI.

The importance of contributing to a fuller understanding of interaction design is that this eventually leads to better design of computational artifacts and systems. The role that theory plays in a design discipline is that of a normative theory that informs new routines of practice, creativity and the fostering of environments that lead to beneficial design outcomes. Ideally, a design theory both informs human actions in design and articulates human values in design. In the context of interaction design, a theory helps to answer the questions of how we design, how we might design better, and what can we learn in the design of computational artifacts and systems?

This thesis will address these questions by way of a pragmatic inquiry of interaction design. Central to this approach is the framing of interaction design as a pragmatic experience, instances of which take the form of design inquiries. The underlying pragmatism shifts interaction design from a user-centric formulation to a designer-centric

formulation. The measure of the thesis will be the degree to which the theory provides a fuller account of interaction design and the knowledge it generates, creates a better understanding of interaction design's relationship to complementary fields like HCI, and constructively guides interaction design research and education.

The remainder of this chapter will introduce and describe the study. I will begin by discussing current (mis)formulations of interaction design that ultimately do not serve the discipline as theoretical positions. I then examine the role of theory in interaction design to help establish criteria to follow in the rest of the thesis. I conclude the chapter by providing an overview of the study, its research and disciplinary context, and a roadmap for the dissertation.

## **1.1 The visionary and status quo versions of interaction design**

This thesis asserts that interaction design is currently an under-defined concept, a fact obscured by current views of the field (Sharp et al., 2006 ; Kaptelinin et al., 2006 , Cooper et al., 2007). The result is an undervaluation of interaction design research that results in less published results and impact on interaction studies discourse. Some may well argue the contrary, however there is evident fragmentation and gaps in understanding interaction design with respect to teaching as well as research. In my own experience, as an educator and researcher in interaction design, I have found that the missing clarity is a pressing issue. One problem is the lack of conceptual coherency in the current understandings of interaction design. Earlier I noted the influence of human-computer interaction on theorizing interaction design and as we will see, HCI plays a prominent role in understanding interaction design. Another assumption of this thesis is that HCI and interaction design are distinct and in fact can be mutually beneficial - each addresses



different facets of the making and testing of interactive systems, as well as the study of the phenomenon of interaction.

Current views see interaction design as integral to and therefore part of HCI (Preece et al., 2002 , Kaptelinin et al., 2006), or conversely that interaction design is an entirely new field that subsumes HCI (Pirhonen, 2004 , Harrison et al., 2007). In both cases the argument currently fails to present a clear epistemological ground between interaction design and related fields, which would be more productive with respect to research and education. In effect, either HCI or interaction design is ascribed an overwhelming diversity of concepts and approaches. This creates confusion as a result of epistemological conflicts, i.e. tensions between ways of knowing. As a result, the conflicting range of rationales overwhelms students and practitioners such that mastery of the discipline is reduced to a selection of skills and methods with no conceptual anchors to explain their meaning and applicability.

In my own academic department, the School of Interactive Arts and Technology at Simon Fraser University, we have a broad-based design and computation major in our undergraduate program. Faculty often engage in discussion (and experimentation) as to what constitutes foundational knowledge and skills that are typically represented in the first and second year undergraduate courses. In our particular case, such courses range from graphic design, to spatial geometry, to object oriented programming. Students may learn diverse techniques from design critiques to statistical analysis, as well as disconnected concepts from human visual processing to cultural aesthetics. While as a faculty we make our compromises and settle on skills and narrow topics to develop further in more senior courses, there is the strong sense that students lack an overall conceptual grasp for connecting or relating the diverse skills and concepts.

### 1.1.1 The visionary view of interaction design

One view of interaction design that I label as *visionary* contends that the current disciplinary model of HCI is too narrow to address the challenges of ubiquitous applications and situations. It is visionary in that it looks forward to a complete reformulation of HCI and interaction design. For example, Pirhonen et al (Pirhonen, 2004) argue that HCI principles are a good starting point but are ultimately inadequate: “These [HCI] principles can even be used during the first steps in the creation of a new product concept or interaction concept, but their scope is limited to the current paradigm of HCI. New technologies and the growing awareness of their uses and of user needs require new types of paradigm, capable of integrating traditional empirical and analytic approaches as well as approaches that are novel though applicable to advanced artifacts in a human world” (Pirhonen, 2004, p.3). The authors argue for the subsumption of HCI within interaction design as the new approach to interaction: “Modern interaction research must do more than simply extend human-computer interaction...The prospect of ambient, ubiquitous and proactive computing and associated advances in services and service production necessitate the consideration of wider perspectives within interaction design” (Pirhonen, 2004, p.4).

However, the strong view of interaction design does little to address the issue of fragmentation, in fact it exacerbates it. Pirhonen et al argue that interaction design is multidisciplinary in nature and includes collaboration amongst engineers, designers, social scientists and humanists. Pedagogically, Pirhonen and his colleagues acknowledge the unlikelihood that such skills and knowledge could be integrated and found in a single individual: “it is hardly possible to be a highest-level engineer, designer, and psychologist at the same time” (Pirhonen, 2004, p.3). The authors stress skills of interdisciplinary

understanding, communication, and explicit goal-setting are necessary in order to overcome the challenges of the different disciplines working together. The authors make no claim for interaction design to be conceptually coherent or epistemologically grounded, and offer no promises of a practice nor a curriculum in which an understanding of an intellectual foundation would be integral to the necessary acquisition of skills and methods. Pirhonen and his co-authors argue: “it is unrealistic for such a collection of disciplines and expertise to be reflected in a unified field. Hence, future interaction studies will be characterised by the diversity of applicable skills and methods between which practitioners have to choose” (Pirhonen, 2004, p.4).

### **1.1.2 The status-quo view of interaction design**

John Carroll (Carroll, 2003), argues that HCI provides an overarching conceptual umbrella to a multi-disciplinary science. The field of HCI emerged as an application domain of cognitive science that integrated and extended systems thinking from human factors. The field of HCI first sought to apply cognitive science theory to software development. Drawing on this scientific foundation, HCI became a discipline in its own right, and broadened its focus to include scientific theories and methods on the use of technologies. Carroll suggests that HCI within the context of a multi-disciplinary science eventually incorporated relevant aspects of other traditions like the social sciences (Carroll, 2003, p.2). As such, subsequent influences of anthropology and sociology forged a scientific foundation in HCI that had become quite rich and as Carroll states: “HCI encompassed nearly all of social and behavioural sciences” (Carroll, 2003, p.5). The grounding of HCI in cognitive science, a natural science, formed the foundation upon which social sciences added diversity to the field and yet did not fundamentally alter the epistemological grounding of HCI in the natural sciences: “The tremendous range of

empirical methods and scientific concepts in routine use in HCI has been a source of strength as the field grew to address new problems and issues encompassing new technologies and new applications” (Carroll, 2003, p.5). Hence, in Carroll’s depiction, what I refer to as the *status-quo* view of interaction design, HCI is an ongoing emergent field that sufficiently grows in diversity to adapt to the changes of ubiquitous applications and situations in computing. However interaction design is weakly defined in this formulation since it is ultimately subsumed within a strong scientific realism orientation that lies at the foundations of HCI. Scientific realism, in short holds that knowledge is of independent phenomena that are discoverable, and justifiable by our observation of the phenomena. In practical terms, this means the discovery of observable facts verified by empirical and rational (i.e. scientific) methods.

This view of interaction design described by Carroll is a multi-disciplinary balancing act in which the epistemological traditions of science form ballast, stabilising the diverse approaches. Yet what are the limits to the degree of diversity that one epistemological viewpoint can hold? Carroll states that this very issue currently challenges HCI. As he phrases it, there is an “ironic downside” in which inclusiveness leads to fragmentation: “there are too many theories, too many methods, too many application domains, too many systems” (Carroll, 2003, p.6). Indeed, the challenge of there being such a range of diverse concepts and approaches can lead to some researchers isolating themselves in narrower niches, ignoring other aspects of activity and knowledge in the field. Understandably, Carroll sees such factional decamping as undermining the multidisciplinary science core of HCI. In addition, balancing the tensions of depth and breadth challenges HCI practitioners, especially students. The *status-quo* view holds that HCI is diverse yet sufficiently coherent. However, echoing my concerns previously stated

that students in my academic department lack the conceptual understanding to relate different skills, methods, and theories together, Carroll plaintively states that practitioners need to “understand the intellectual foundations of HCI, not merely how to manipulate the tools and methods constructed on those foundations” (Carroll, 2003, p.6). He continues to underscore the current challenge as he sees it: “Ironically, because HCI practice has diversified so rapidly and has incorporated so many new professionals, average expertise among practitioners has never been lower” (Carroll, 2003, p.6).

Interaction design within the *status quo* view is either synonymous with HCI or is an applied component of HCI. I’ve labelled it *status quo* since this conceptualization is the commonly held view among diverse and current theorists of interaction design, some of whom I will explore in depth in the following chapter. From an opposite perspective, in what I referred to as the *visionary* view, interaction design is seen as the next “wave” or “generation” of HCI. In other words, the tables are turned and HCI is present within this understanding but subsumed by a notion of interaction design.

In short, both formulations of interaction design suffer from a fragmented and superficial understanding of what is involved in designing interactive technologies. Researchers cope by pursuing depth, thereby foregoing a more holistic understanding of the field, and creating a sense of *progress* that masks the need for more resolved conceptualizations. Practitioners and students fail to acquire a coherency of knowledge and practice. Instead, they pragmatically skim the surface of the discipline, pursuing skills and methods separate from the intellectual traditions that provide the rationale for the skills and methods. Carroll sees the need “to continually synthesize a coherent methodological framework” (Carroll, 2003, p.7) as the way past the fragmentation. Methodology remains an integral aspect of the problem, yet the circumstance of methodological disarray (i.e., ‘too

many methods') is more symptomatic than causal. The critical issue is a matter of epistemological coherency or lack thereof, i.e. how we can agree that what we know is knowledge. Pirhonen and his colleagues do not rank conceptual unity high on the list of issues to resolve for interaction design yet they offer that the ongoing "solving of concrete interaction problems...effectively provides a unifying tacit discourse" (Pirhonen, 2004). In many respects this is what constitutes the traditional design approach to research, the building up of understandings case-by-case through exemplars. This represents the "long road" to discovery that risks no discoveries at all. As part of this thesis, I advocate a shorter route by way of a philosophical-theoretical approach that grounds interaction design in a clear and distinct epistemological orientation with the aims of greater coherence, and the demystifying of interaction design actions and interaction designers.

### **1.1.3 The shadows of user-centrism**

In addition to fragmentation, a second problem in the current confusion with interaction design and its relationship to HCI is missed opportunities in the research of interactive systems and artifacts. In particular, a design perspective on interaction research is invaluable if we are to understand how to successfully design interactive technologies. The ubiquity of interactive technology makes interaction design and HCI especially holistic, what Daniel Fallman (Fallman, 2003, p.231) states as "the act of trying to unfold a coherent whole." Unfortunately, interaction design is seen to lack validity in research methods and validation. The role of interaction design in the very processes of research is under-explored and perhaps even ignored, subject to measures of empirical and quantitative research methods in HCI that overwhelmingly focus on users. To underscore this point, many interaction design researchers find themselves caught between the fact that it is unrewarding to conform one's research to an HCI model and yet there is uncertainty as to

what constitutes a design research model. For example, by way of a personal anecdote, a paper I submitted to a major international HCI conference was rejected due in part to reviewers considering it a 'design paper'. In HCI reviewer parlance this means the paper lacked a quantifiable contribution, focused too much on design process, and its relevance to the HCI research community was not clear. I made some minor adjustments to the paper and in earnest submitted it to an international conference on designing interactive systems, a conference known for its sympathetic view of interaction design research. It too was rejected and in this instance, reviewers commented that the paper was too focused on HCI issues, lacked sufficient details on the design process, and did not contribute clearly to the design community. I do not recount this example to bemoan the fact the paper was not accepted or that the reviewers were incorrect. My point is that there is lack of clarity in regard to what constitutes interaction design research and what its relevance is to HCI.

Carroll remarks how in the early years when HCI was focused as an application domain of cognitive science, "there was a sense that there was wide tacit agreement as to the overarching research paradigm. And a lot got done" (Carroll, 2003, p.3). Pirhonen and his colleagues describe a wildly diverse group of specialists jointly engaged in the practice of interaction design including "education, sociology, philosophy, art, design, marketing, gerontology, demography and culture research" (Pirhonen, 2004, p.4). While not offering clues as to how to address research quality across the disciplines, Pirhonen et al do offer suggestions for practice. They argue for reshaping the organization of work and knowledge. Adding to their emphasis on interdisciplinary skills of breadth and communication, Pirhonen et al cite the design industries as having established "distinct practices and organization" in which creative thought is "central and intrinsic" (Pirhonen, 2004, p.4). Steve Harrison, Deborah Tater, and Phoebe Sengers (Harrison et al., 2007) suggest a third

paradigm of HCI that is phenomenology and design oriented, and equally catholic in respect to inclusion of diverse perspectives as Pirhonen et al's view of interaction design. In regard to research quality, Harrison and his colleagues see within their third paradigm a need for multiple interpretations that provide a rich description rather than a "single, objective" description (Harrison et al., 2007, p.8).

Harrison et al argue that the multiplicity approach of design research faces the challenge of being measured by the "gold standard" of behavioural sciences. This "gold standard" is central to what Harrison et al describe as the second paradigm of HCI, similar to the earlier described *visionary* view. For example, Harrison et al discuss the difficulties in the review process for submitted papers to the major international technical conference for HCI (similar to my own experience cited earlier), the Associated Computer Machinery (ACM) Conference on Human Factors and Computing known as CHI. Two main hurdles exist within the interaction research community: "(1) the legitimacy of only certain kinds of measures of success, (2) limited understanding of validity of methods outside a limited canon..." (Harrison et al., 2007, p.11). As such, an epistemological hold is in place that ignores the different strategies for claiming knowledge and ultimately, in their view, thwarts future development of a more diverse field. Design is overlooked in making a contribution since it is perceived to lack the exacting rigour of sanctioned methods. Fallman (Fallman, 2003, p.231) wryly comments in a mocking paraphrase, "Then we designed the prototype. Ugh...it took forever! Anyway, here are the results of our meticulous evaluation!" The point being that design is dismissed as opaque – a mysterious black box – and thus having no real research value, "concealed" according to Fallman (Fallman, 2003, p.231).



Yet what is the interaction design experience and how does interaction design contribute to research? In this respect we have at best only partial answers or in certain cases explicit polemics intended to open space for discussion and future engagement from which processes and a research paradigm may emerge. Harrison et al's arguments can be seen in this light. Their argument for a multiplicity of knowledge claims within a new paradigm of HCI is more a call to action than a research direction. Fallman (Fallman, 2003) makes the critical point that the question of how to address interaction design and research is unavoidable, for no other reason than the fact that no research contributions would have been claimed from studying interactive systems and artifacts if such items were not made actual by design. Fallman aptly observes within HCI the false notions that the design artifact either occurs by sheer chance or that a direct causality can be found between for example, fieldwork data and the design artifact (Fallman, 2003).

By way of review, I have been discussing two problems related to the lack of understanding of the field of interaction design and its relationship to HCI. The first problem is the lack of epistemological coherency that occurs because interaction design is overshadowed by HCI (the *status quo* view of interaction design) or because interaction design surpasses HCI (the *visionary* view of interaction design). Both cases fail to avoid fragmentation and to create a deep understanding between practice, knowledge, and education. The second problem is the missed opportunities in the research of interactive systems and artifacts. Interaction design is seen as lacking in research methods and validation. Further, the phenomenon of design and the role of the designer in interaction research are under-explored, subject to measures of empirical and quantitative research methods in HCI.

As discussed above, many of these problems are not unknown to researchers in the fields of HCI and interaction design. The perceived criticality of the issues varies, different strategies are invoked, and partial answers are given. For example, Carroll sees greater methodological coherency as a way to address fragmentation, yet I've identified the issues as epistemological in nature of which methodology is a key element but not at the root level. While Pirhonen and his colleagues do not see epistemological issues as critical, to some degree this is true of Harrison et al as well. Pirhonen sees the case-by-case descriptions of real design problems as a gradual unifying process, yet we can bootstrap the discussion by generating a theoretical view of interaction design. Lastly, some researchers offer strategic polemics launched with the intention of creating space for new discussions and the emergence of methods and research paradigms in interaction design but not a theory. I argue we need now to begin the process of developing a theory to support interaction design.

## **1.2 Role of theory in interaction design**

The preceding discussion shows the absence of a theory for interaction design. I will later discuss how design discourse, including emerging discussions on interaction design, has typically resisted the type of abstractions and formulizations that constitute theories. The limit of this approach is that the lack of theory generated from within interaction design leaves the field vulnerable to theorizing from other theoretical and disciplinary viewpoints like HCI or limits discussion to polemics. Further, trying to understand interaction design through design examples alone is too challenging and runs the risk of defining symptomatic views rather than explaining underlying relationships and processes.

In the following chapter I will discuss Victor Kaptelinin and Bonnie Nardi's *Acting with Technology* (Kaptelinin et al., 2006). These authors provide a good example of theory

that aims to be descriptive, explanatory, and generative. Kaptelinin and Nardi discuss activity theory as a basis for revisionary critique of HCI. They see in activity theory the descriptive capacity to provide a new set of key concepts and definitions, and the explanatory capacity to redefine relationships and processes within HCI. At the heart of the revisions that stem from activity theory is an epistemological critique of how the field defines the user, a concept central to HCI theory. Activity theory advocates a post-cognitive construction of the user over the traditional cognition-based formulations. As part of the shift toward a post-cognitive view for HCI, researchers and theorists see a greater role for invention and creativity in the making of interactive systems (Nardi, 1996 , Dourish, 2001). In this light, Kaptelinin and Nardi claim that activity theory also plays a generative role through its direct applicability to both HCI problems and further invention in a theoretical sense by contributing to the ongoing conceptual development of HCI. The authors draw on Ben Shneiderman's notion that generative theories (Shneiderman, 2002) facilitate creativity, invention, and discovery.

John McCarthy and Peter Wright in *Technology as Experience* (McCarthy and Wright, 2004) offer another revision of HCI theory by explaining our relationship to technology through experience. Similar to the approach of this thesis, the authors draw on the pragmatist ideas of Dewey in addition to the novelist Mikhail Bakhtin. McCarthy and Wright re-theorize the notion of user experience to include the emotional, intellectual, and sensual aspects of interactions with technology, arguing in the pragmatist sense that we live with technology rather than simply use it. From a pragmatist viewpoint, theory is by definition generative, in that it is seen as a systematic inquiry for imagining a possible future. For a pragmatist, theorizing is a necessary and practical consequence of living or approaching one's life such that theory changes one's world rather than represents it.

McCarthy and Wright discuss how Dewey criticized scientific theory as retrospective, concerned with describing and explaining the world as it is, rather than prospective, which is concerned with how the world might become. The authors argue that their generative view is “valued not so much for whether it provides a true or false representation of the world as for whether it helps us think through relationships between for example, people, technology, and design” (McCarthy and Wright, 2004, p.19).

Generative theory that supports creativity and discovery, as well as a prospective orientation which is aimed at shaping future outcomes, are both critical to any theory for interaction design. The reason is that interaction design is primarily concerned with the creation and development of interactive systems. Additionally, interaction design by nature has a future orientation since the goal is to understand what prospective design actions and outcomes will beneficially shape our environment. As such, the discoveries are both different in nature from intellectually-reasoned discovery and are reliant on the generative dynamics of design.

Participatory design (PD) is a good example of a generative theory or at least a well-elaborated set of generative strategies. Participatory design emerged from socio-technical concerns regarding the design and use of information systems in organizations (Ehn, 1989 , Schuler and Namioka, 1993 , Greenbaum and Kyng, 1991). In *Work-Oriented Design of Computer Artifacts* (Ehn, 1989), Pelle Ehn theorizes on the aim of participatory design to base design on embodied knowledge, mutual learning, and participation. The basis of Ehn’s notion of participation is a shared understanding of the design needs between designers and skilled workers. In order to create something new, designers must bridge the different languages, tacit knowledge, and past experiences that lie between them and stakeholders. Ehn phrased this as “the dialectics of tradition and transcendence – that is

what design is all about” (Ehn, 1989, p.7). Participatory design offers a set of theoretical tools for the practice of design and for the generation of design actions and outcomes. Participatory design stands out for the degree to which it is a relatively coherent and effective theory for design practice. Ehn in particular provides a theoretical context for PD based in Heidegger, Wittgenstein and Marx that offers a rationale and basis for further elaboration on techniques and principles incorporated into information systems design. The principles afford an articulation of techniques and goals for participatory design that mobilize the theory into a form serviceable in design practice. PD focuses on the relationship between designers and end-users, devoting a large degree of its efforts on articulating how designers interact with end-users. It does not revise core concepts in how design occurs or could be defined; rather it critiques scientific approaches to the user by offering a design perspective of the user. It falls short of offering a mode of validation or self-reflection that ultimately is the mechanism to critique and evolve theories. As a consequence, it articulates little about how to communicate research outcomes of PD and how PD interacts with other disciplines. Yet it is a powerful precursor to thinking in interaction design. I will show how PD serves as a critical theoretical antecedent for the theory I propose for interaction design.

Another powerful theory in design is Donald Schön’s reflective practice (Schön, 1983 , Schön, 1987). Reflective practice is well established as a critical crucible for conceptualizing fields of design. Schön sought to dispel the notion of designers and other professionals as implementers of received theoretical wisdom from elsewhere. Schooled in Dewey’s pragmatist inquiry (Dewey, 1938), Schön challenged the dualism of practice and theory and saw knowledge in doing, or as he phrased it, reflection in action (echoing Dewey’s dictum, learning by doing). His emphasis on the irreducible relationship between

action and knowing evolved into a hierarchy of knowing that leads from immediate actions to informed understandings of practice as a whole, i.e. reflection in action, reflection on action, reflection on practice (Schön, 1983). The formalization of the dynamic interaction of design and the forms of knowledge that are enacted by a designer actively designing are among Schön's most significant contributions. He shone a bright light in the "black box" of design in such a way that his theory continues to hold up to the scrutiny of the lived experience of designers. Schön reconstructed the design process from the failings of reductive and prescriptive design methods which were based on logic and the cognitive science of the early 1970s (Bayazit, 2004). The relevance at hand is that Schön's reflective practice offers a model for interaction design that is informed by pragmatism and avoids the logical abstractions and analytical empiricism of past approaches and HCI informed theories. The strength of what Schön offers is an applicable set of concrete formalizations and formal techniques grounded in the interactional and practice-based characteristics of design. Reflective practice offers a broad set of mechanisms for self-reflection on the field that has deeply influenced education in professional domains (Schön, 1987). Similar to PD, reflective practice serves as a starting point for the theory proposed in this thesis.

We can gather from the preceding discussion that an ideal theory for interaction design will describe critical concepts, principles and definitions, and provide an explanation of the relationships, actions, actors and processes within interaction design. In addition, an interaction design theory will facilitate the generation of new forms of practice, creativity, and discoveries with a prospective orientation grounded in the practice of making. A generative theory leads to an understanding of future possibilities or inventions in interaction design and guides us in determining the value of each possibility.

A positive consequence to interaction design's relationship with HCI is that HCI offers a clear counterpart that must be matched theoretically otherwise interaction design will continue to be eclipsed since it is under theorized. The strength of HCI theory is that it has theoretical depth. Underlying HCI is an epistemological grounding in scientific realism and phenomenon of study such that there is agreement on core concepts yet these concepts are open to revisions and subject to vigorous and critical debate that grows the field intellectually. This strength in focus and epistemology creates coherence around principles that in turn allow for flexibility and experimentation with methods of research, validation, and the means to verify claims. Further, HCI has mobilized a theoretical understanding through communication and flexibility of methods. In many respects, interaction design needs to match this standard in its own theory-making.

Given this, together with our discussion of related theories the following criteria can be used to establish the role of theory in interaction design:

- 1) Provide epistemological orientation: an underlying philosophical grounding that is appropriate to design that will guide the development of core concepts and defining principles;
- 2) Establish coherent principles to guide the development of research methods, design methods, and evaluation methods. This creates flexibility and experimentation in methods avoiding prescriptive approaches of the past;
- 3) Provide standards of validation that provide a means to credibly communicate and verify claims;
- 4) Mobilize the theoretical ideas and actions in a way that is accessible in practice and open to revision through practice.

## 1.3 Overview of the study

Contrary to the *visionary* and *status quo* formulations of interaction design discussed above (see 1.1 The visionary and status quo versions of interaction design), I claim that interaction design can be articulated as a coherent theory with a distinct epistemological foundation from HCI. I argue also that John Dewey's (1859-1952) philosophical pragmatism serves as a good and productive starting point for an epistemological framing of interaction design. I will show how pragmatism is relevant to interaction design and how the field can be seen as grounded in the pragmatist inquiries of traditions in design like participatory design, design ethnography, and criticism. The aim of the thesis is to develop a pragmatic theory for interaction design that describes critical concepts, principles and definitions, provides an explanation of the relationships, actions, actors and processes within interaction design, and articulates strategies for proving trustworthiness in the knowledge generated. Directly outside of the theory, I will explore how a revised interaction design bridges activities and outcomes with HCI, and how the theory points to practical directions in research and education.

In this section I explain how the structure of the argument is guided by several propositions. The resulting theory is further detailed and illustrated through analysis of two interaction design inquiries.

### 1.3.1 Propositions

I aim to develop a new understanding of interaction design in a theory built upon five propositions. I briefly discuss the propositions in order to provide an overview of the study and to provide initial orientation for the reader:



The first proposition is that current descriptions of interaction design are inadequate and there is a need for theorizing of interaction design in order to better value its role in the research and creation of interactive systems.

I stated earlier how the term interaction design is growing in use and yet there is little agreement on what it means. My aim is not to settle the “dispute” by providing the most definitive answer; rather my goal is to firstly understand how interaction design is currently understood and then to prospectively use theory to offer a more beneficial conceptualization of the field. Computing is increasingly more ubiquitous, relevant, and complex. It has moved past the narrow confines of experts to impact and influence everyday experiences. Hence, in addition to current interaction study approaches, new approaches are required to tackle the issues of design and computing in their fullness. The value of the theory proposed in this study is that it provides clear descriptions of key concepts and fundamental distinctions. It also aims to guide interaction design practice and to facilitate creativity, invention and discovery (Shneiderman, 2002). A proactive and pragmatist stance to theory is an effective way to construct a view of interaction design that measures its value in both research and practice.

The second proposition is that an epistemological home for interaction design lies in pragmatism. In pragmatists' terms, design is lived; it is an experience that it is bound up in ongoing interactions between the designer inquirer, matters of the inquiry, the environment, and stakeholders.

Pragmatism, in particular Dewey's pragmatism, elucidates the intellectual coherency of interaction design and reveals how the field contributes to knowing in the world. I will show how pragmatism weaves through design's intellectual history in ways relevant to a theory of interaction design. This approach provides an explicitly pragmatic explanation and description of design that substantiates knowledge creation inside and outside of the field. Pragmatism is concerned with the *here and now*, yet it continually asks what is the value of an understanding in terms of action and what future multiple possibilities can it uncover? To state the obvious, which is often overlooked, future experience is irreducible, which leaves little room for absolute knowing. And so in terms of design, multiple possible outcomes must be constantly negotiated and interpreted. Taking a view that design traditions are rooted in pragmatist philosophy leads to the third proposition.

The third proposition is that a revised interaction design productively draws on the intellectual histories of design. Arguments grounding interaction design in cognitive science and systems thinking have concealed the contribution of interaction design to interaction research and education. A clearer formulation of interaction design begins with grounding it in reflective practice, participatory design, design ethnography, and criticism.

It is truly surprising that few if any approaches locate interaction design in the traditions of design thinking. There is substantial value in this tack; above all it balances the intellectual attention on interaction from HCI with a complementary focus on design. The traditions of reflective practice, participatory design, design ethnography and criticism link to form a rich set of antecedents that help describe what interaction design is and might

become. For example, I will show how Ehn's (Ehn) understanding of participatory design shares with Schön's (Schön) reflective practice an inherent pragmatism that inquires at the level of descriptive action, disavows reliance on abstractions, and holds a dialogical view of design. To paraphrase Schön, interaction design is an explicit conversation between materials, end-users, and designers. I will show how the pragmatic inquiries of Ehn, and especially Schön, draw on Dewey's notion of *immediate empiricism* in which claims hold value or afford possibilities over time in the everyday and lived world. I will argue how criticism and design ethnography hold the potential to carry out the evaluation and shaping of the design claim, especially in understanding the ongoing and everyday existence of interactive artifacts and systems.

The fourth proposition is that a pragmatist view leads to the understanding of interaction design as experience and an interaction designer as an embodied inquirer that shapes the experience through experimentalism. Instances of interaction design experiences can be seen as inquiries in which judgment and interpretation are central actions.

Within a pragmatist view of interaction design we can describe designing as an *experience* (Dewey, 1934). We can see how an interaction designer's understanding of the experience of designing in the present is deeply informed by his or her own lived history with design. In addition, much of the skill in design is embodied and made evident through reflection; Schön referred to this as surprise on the part of designers whose prehension of change becomes reflection on an embodied difference in action (Schön, 1983). We can see that past experience, embodied reflection, and overall understanding of the experience of designing form an interaction designer's judgment. Professionally, judgment takes the form of a warrant on behalf of the designer, design team, or firm in relation to quality of the designing and design outcomes. In short, it is important *who* is designing. However,

judgment does not act alone. Rather it is subject to ongoing interpretation and feedback that helps negotiate the limits of that judgment. A commitment to explaining the designer inquirer's judgment and interpretation mediates the level of integrity and quality of the interaction design process.

The fifth proposition is that interaction design is guided by qualitative and interpretive orientations in validating new knowledge. The pluralism of pragmatism leads to the proposed theory promoting multiple strategies of validation that set out to be rigorous in interpretation and supportive of the practice of criticism, and inclusive of quantitative strategies where relevant.

It is important for interaction design to make its judgments and interpretations evident, communicable, and valid to others. This level of explicit reflection and agreed upon shared knowledge increases the interaction designer's capacity to make future design decisions. Reflection draws from the practice of interaction design, contributions that are important to the development of the field and to other fields. The trustworthiness and validity of findings in a revised understanding of interaction design is a qualitative question that is hinged upon interpretation and negotiation. Within this orientation, quantitative strategies can also support findings or guide research and practice. In parallel, a practice of criticism is a needed validation strategy that moves reflection on interaction design past specific inquiries and designers. Additionally, criticism mediates the values of interaction design inquires over time.

### 1.3.2 Interaction design inquiries

The propositions discussed above represent the theoretical framing of the research. I examine and illustrate the proposed theory in detail by using it to analyze two interaction design research projects. In both projects, I was the lead researcher working together with faculty researchers whose research foci included artificial intelligence, electro-acoustics, and games. In both instances the projects were complex and brought together multiple research agendas. My research interests and contributions were in the area of interaction design. With respect to this study, only aspects related to interaction design were analyzed. I hope to show how a first-person perspective is a critical and preferred stance in interaction design research given the dictates of pragmatism, the centrality of the interaction designer to the design experience, and the richness and credibility of the interaction design data.

The first of the cases is the research and design of an adaptive museum guide, known as ec(h)o. The interface for the prototype is a combined tangible user interface and audio display that utilized user modelling. The project is typical of an interaction design endeavour in that it is holistic in its approach and outcome. The aims of the project included the consideration of the museum setting as a significant aspect of the design process and outcome, the discovery of qualities of interaction that go beyond levels of efficiency in information delivery, and the testing of a dynamic approach to user modelling in support of a tangible interface. The project employed ethnography, participatory workshops, scenarios, prototyping, and mixed methods (quantitative and qualitative) for evaluation as part of its design process. Research focused on reflections on the design process (Wakkary, 2005 , Wakkary and Evernden, 2005), evaluation of the role of tangibility and play in user experience (Wakkary and Hatala, 2006 , Wakkary and Hatala, 2007), and evaluation of user modelling (Hatala and Wakkary, 2005 , Hatala et al., 2005).

The second case is a project known as *socio-ec(h)o*. The project comprised a prototype environment for group play whose goal was to explore the design of an ambient intelligent system, a method for composing group user models, and group interaction utilizing a game structure. Ambient intelligence (AmI) computing is the embedding of computer technologies and sensors in architectural environments that, combined with artificial intelligence and multi-modal displays, respond to and reason about human actions and behaviours within the environment. The main research goal from an interaction design perspective was to understand how to support groups of participants as they learn to manipulate an ambient intelligent space, as well as to understand and learn about designing ambient components of a responsive environment capable of providing this support. Similar to *ec(h)o*, the project employed as part of its design process ethnography, participatory workshops, scenarios, prototyping, and mixed methods (quantitative and qualitative) for evaluation, however with different emphasis on the importance of the each technique. Published research to date has focused on the technical platform (Wakkary 2005), interaction and gameplay (Wakkary et al, 2005; Wakkary et al 2007), group interaction (Wakkary et al 2008), audio display (Droumeva et al 2006; Droumeva et al 2007; Droumeva et al 2008), and the design of the audio display (Droumeva et al 2006; Droumeva et al 2007).

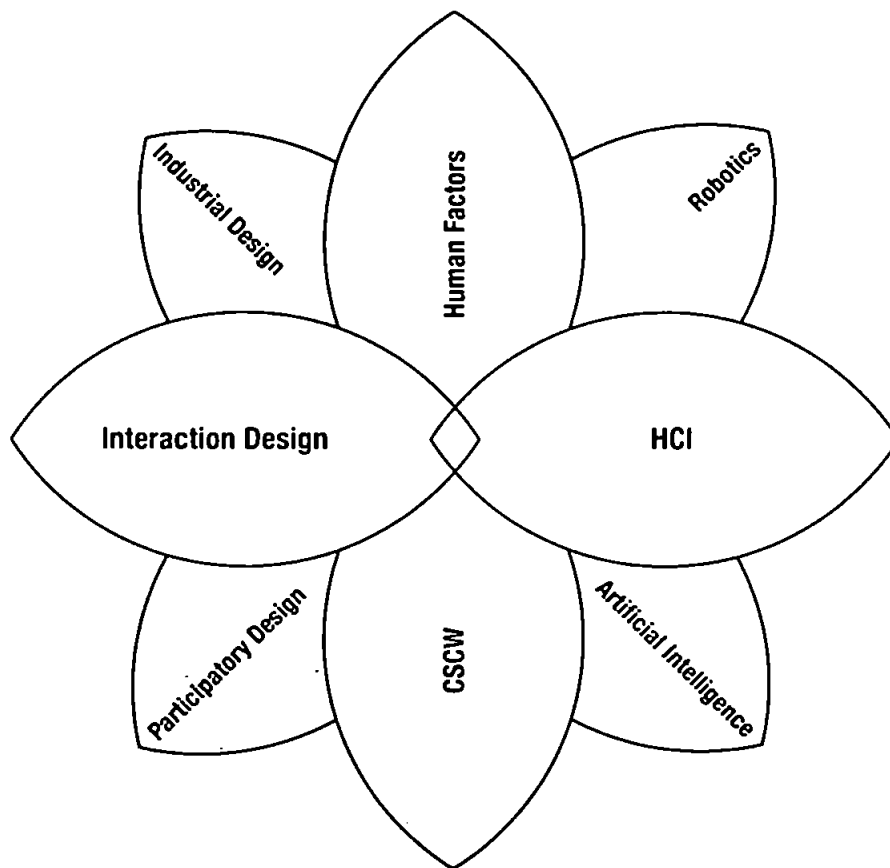
Some readers may wonder why the cases are exclusively research-focused rather than practice-oriented, i.e. a professional and commercial project. Firstly, as a design researcher, my projects offered the richest set of data available to me but more importantly, design research projects provide the degree of exploration, reflection and documentation that best support the questions of this thesis with respect to education and research. A design research project explicitly engages methods of research and interactions with fields

like HCI for the purpose of research. My aim in this thesis is to describe and improve upon these interactions to further design research. Similarly, the projects make explicit and also document design practice, in part as an object of study and in part in keeping with the goal of transparency in the research process. These reflections and documentation provide valuable data for a case study researcher, particularly with respect to education. A significant point that is particular to interaction design and HCI research is that the research requires the design of a functioning prototype. In many respects, it can be said that a design practice is embedded within the practice of design research, notwithstanding the absent roles of the client and market.

## **1.4 Context for the study**

I have discussed the broad outlines of HCI research as well as the historical progression from an application domain within cognitive science to human factors engineering to the inclusion of social sciences and other approaches (Carroll, 2003 , Grudin, 2005 , Cooper and Bowers, 1995 , Harrison et al., 2007). Given that there is confusion about interaction design within HCI research, while at the same time there is an acknowledgment of its relevancy, the aim of this study is to clarify interaction design and its role in relation to HCI. For the purpose of this study I will consider the larger context in which this relationship results in the labelling of the term interaction studies. The interaction studies term is a rubric to generously cover the various interrelated fields focused on human interaction with computational artifacts and systems. Within interaction studies we find interaction design and HCI. In Figure 1, these fields have been brought to the fore and highlighted since they are most relevant to this thesis. However, of equal prominence are Human Factors and Computer-Supported Cooperative Work (CSCW). Human Factors are concerned with human and systems performance, while the latter is

concerned with supporting technologies in collaborative work environments. Of a somewhat secondary order are fields that strongly relate, however they may have intellectual homes elsewhere, including Participatory Design, Industrial Design, Robotics, and Artificial Intelligence. The notion of interaction studies is not the focus of this study, and is presented here as an operational term and should be considered provisional, as such one could imagine many other fields within this schema.



**Figure 1 Schema for interaction studies, an operational rubric for interaction related research**

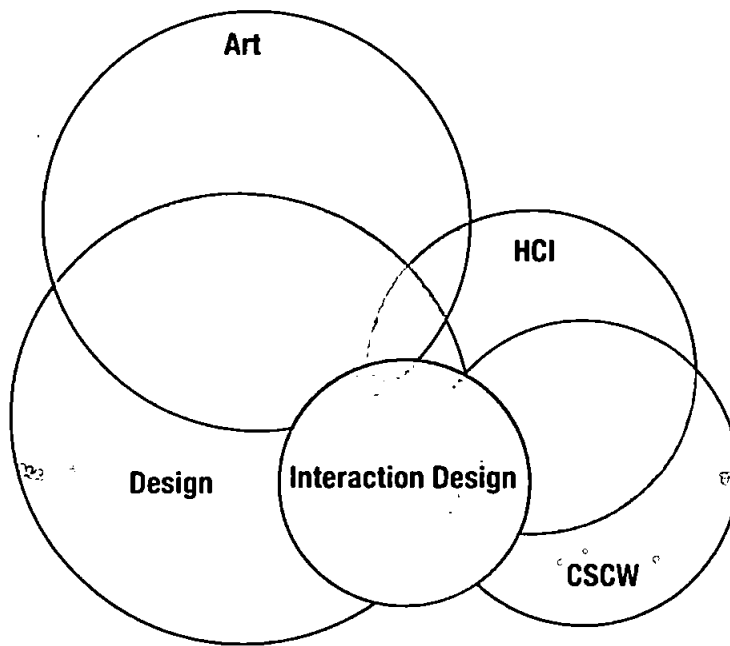
Design research also has its origins in rational and systems thinking schools of thought that are still prevalent in design research today. Early design research focused on applying logical and systematic approaches to methods for design that were inspired by operations and management research during World War II in which scientific principles



were applied to logistics and management (Cross, 2007 , Gedenryd, 1998 , Bayazit, 2004). Despite later disavowals from design method research pioneers Christopher Alexander and Chris Jones (Bayazit, 2004), design method has been a continuing focus in design research. Design method has shifted away from the abstraction of logic and systems to a more empirical based approach or what has been referred to as the “second generation” design methods (Rittel, 1972) brought about by the realization of the complexity of design as characterized by Horst Rittel and Melvin Webber’s description of *wicked problems* (Rittel and Webber, 1973). Interestingly, an avenue opened that intersected cognitive science and the study of *design thinking* (Lawson, 1997 , Rowe, 1987 , Cross et al., 1992) that incorporated analytical empirical methods such as *talk aloud* and *protocol analysis*. These methods were applied to designers as means of studying expert behaviour on the part of cognitive scientists, and designer thinking on the part of design researchers. Significant breaks with the rationalist approach to design research occurred periodically such as Alexander’s *pattern language* (Alexander et al., 1977), a design formalization grounded in a social evolutionary understanding of design, Victor Papanek’s *Design in the Real World* (Papanek, 1972) that advocated a holistic and ecological approach aimed at sustainability in design, and Schön’s *Reflective Practice* (Schön, 1983). Schön’s reconceptualization of design against the “technical rationality” that dominated professions like design offered paradigmatic change. While reflective practice is often held up as an exemplar for understanding design, its critical challenge to a rational understanding of design in favour of a pragmatic approach is generally overlooked.

Since this investigation crosses interaction studies and design it is helpful to situate interaction design in relation to other disciplines. Figure 2 is also a provisional mapping that positions interaction design between but overlapping with design and HCI. I’ve taken

the liberty of leaving design unspecified but one can consider the practices of industrial design, visual communications, engineering and so on within the circle of design. In addition, and equally general, art including performance, installation, sculpture, media art and so on are overlapping with design, interaction design and HCI. CSCW, given its attention to design of collaborative and cooperative work environments and ethnography, overlaps with HCI, design, and interaction design.



**Figure 2 Situating interaction design in relation to other disciplinary fields**

The main audience for this thesis is the interaction design researcher who may come to interaction design from either tradition of design or HCI. The study is also relevant to the HCI researcher who wants to better understand the role of design in HCI and the design researcher who is interested in the emergence of interaction design as a design phenomenon and may want to consider its impact on design as a whole or on other design disciplines. This thesis also offers a critique of current theory in interaction design and a focus on

revising theory based on interaction design research practice that is relevant to practitioners and students.

## **1.5 A roadmap of the thesis**

In this introduction I have sketched the broad outlines of the dissertation and the issues it plans to tackle and why. I will in detail present the case for this revised understanding of interaction design in the chapters that follow. The plan for the remaining chapters is as follows.

Chapter 2 will review and address the current formulations of interaction design. The review groups the literature into HCI dominant views that tend to overshadow design, and interaction design views rooted in design discourse. Chapter 3 discusses the proposed theoretical framework for interaction design. The chapter establishes a philosophical basis for interaction design founded on Dewey's pragmatism. It firmly pivots the discussion of pragmatism and a basis for the theory on aspects of design's intellectual history. In particular the theory draws upon reflective practice, participatory design, design ethnography, and design criticism. Chapters 4 and 5 divide into two parts the analysis of the two interaction design research projects using the theory. The first project is the design of an ambient intelligent and adaptive museum guide known as ec(h)o; the second is an ambient intelligent physical game for multi-players known as socio-ec(h)o.

Chapter 4 begins with an analysis of the two projects in what is referred to as the design inquiry that describes the designer inquirer, designer intentions, and rationales. The chapter continues with a detailed account of the actions of judgment and interpretation in ec(h)o in what is referred to as actions. Chapter 5 is the second part of the project level analysis. It includes an analysis of the actions of socio-ec(h)o and concludes with a holistic

account and analysis of the entirety of each project at what is referred to as the experience view.

Chapter 6 investigates the validation strategies in the theory and provides examples of how they are operationalized within the theory. Chapter 7 looks at the implications of the theory in relation to HCI, and interaction design research and education. A discussion of the theory in relation to the emerging interaction design theories and interpretive approaches in HCI sets out to critically examine the theory in a wider context. The chapter concludes with a discussion of the limits of the study and theory. Chapter 8 is the concluding chapter of the dissertation. In it I summarize how the theory offers a revision of interaction design that addresses the theoretical gaps in the field. In Appendices 1 and 2 are the lists of sources and abbreviations for data from the interaction design inquiries analyzed Chapters 4 and 5. Appendix 3 is the list of contents for the accompanying DVD that includes videos from the interaction design inquiries.

## CHAPTER 2: THE CURRENT STATE OF INTERACTION DESIGN THEORY

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In this chapter I will discuss the current theoretical uses of the term ‘interaction design.’ We will find that the term is elastic, which will be demonstrated by the descriptions of interaction design as synonymous with HCI to interaction design as a new discipline. I first look at how HCI researchers have theorized the term interaction design. Secondly, I examine design-oriented views of the concept and I will show how the issue is framed less theoretically. Interaction design is approached as a question of multiple design strategies that ultimately focus on design stances and methods. In tracking the shifting contours and intellectual premises in relation to interaction design, a clear difference emerges in the capacity and limits of theorizing between HCI and design. This poses two very distinct (almost inverted) problems with respect to understanding the field. HCI theory operates from a strong philosophical centre that affords HCI researchers with a stable theoretical purchase. Yet the same strength creates an intellectual constraint of viewing interaction and design exclusively through the lenses of user-centrism (the user is the object of study) and science. On the other hand, design lacks a strong philosophical orientation and design researchers tend to be wary of theoretical views of design. This limits the discussion to descriptions of practice. However, in the absence of theory there is an unconscious idealism for explaining what is left unexplained.

A number of edited collections of essays on interaction design have recently been published that provide a representative range of views of theory and practice (Pirhonen, 2004 , Bagnara and Smith, 2005 , Moggridge, 2007 , Kolko, 2007). However, I have considered only monographs that can be said to make explicit theoretical claims on behalf of interaction design. I've taken this approach since a full manuscript is where people generally turn to first in understanding a field, and secondly because it is in the space of a book those authors' theses are allowed full expression. The exception to this is a book chapter by Terry Winograd (Winograd, 1997), which is pioneering in the way it outlines a possible direction for interaction design.

## **2.1 Beyond human-computer interaction?**

Terry Winograd was among the first computer science researchers to argue for a shift from considering the computational device to considering the experience of computation and how it shapes us (Winograd and Flores, 1986). He eventually saw the need for a discipline in parallel to computer science to address these emerging concerns that he labelled "interaction design" (Winograd, 1997). The key movement he identified in computing science was the move away from concentrating on machinery to concentrating on people:

Over the next fifty years, the increasing importance of designing spaces for human communication and interaction will lead to expansion in those aspects of computing that are focused on people, rather than machinery. The methods, skills, and techniques concerning these human aspects are generally foreign to those of mainstream computer science, and it is likely that they will detach (at least partially) from their historical roots to create a new field of "interaction design" (Winograd, 1997, p.157).

Winograd had long been an advocate for the need for a design orientation in tackling the larger and deeper issues raised by computing: "The use of technology in turn leads to fundamental changes in what we do, and ultimately in what it is to be human. We

encounter the deep questions of design when we recognize that in designing tools we are designing ways of being” (Winograd and Flores, 1986, p.6). In his seminal book, *Understanding Computers and Cognition* in 1986 (Winograd and Flores, 1986), Winograd together with Fernando Flores set out to radically reconsider HCI, computing and cognition. Flores’ background was not in computing but in social and political organizations where he applied cybernetic theories to management of large-scale projects. This in part accounts for the intellectual diversity of their approach. Another factor was Winograd’s own experiences with the limits of thinking in artificial intelligence (AI) at the time. The radical rethinking of *Understanding Computers and Cognition* is founded on a critique of rationalist tradition in HCI and computing. Winograd and Flores turn from scientific realism described as a “mathematico-logical paradigm” to philosophical positions of Heidegger, Gadamer, Maturana, and Austin (Winograd and Flores, 1986). They were well aware that philosophical investigations rooted in biology, hermeneutics and phenomenology drew them far afield from traditional thinking in computer science, yet they argued that “theories about the nature of biological existence, about language, and about the nature of human action have a profound influence on the shape of what we build and how we use it” (Winograd and Flores, 1986, p.xii). Winograd and Flores laid out the touchstone critique of scientific realism and rationality in computing that allowed for further critiques based on issues of embodied cognition, context, interpretation and the role of design.

In 1997, Winograd spoke directly to the notion of interaction design. Winograd’s observations were from a relatively short article titled “From Computing Machinery to Interaction Design” included in *Beyond Calculation: The Next Fifty Years of Computing* (Winograd, 1997). In the article, Winograd describes three trajectories he observed as

emergent at the time: 1) Computation to communication; 2) Machinery to habitat, 3) Aliens to agents.

The first trajectory, “computation to communication” minimizes the core computational abilities of computing in favour of less complicated but more influential communication capabilities of computing. The shift from computation is marked by the industry emphasis and the “excitement” over applications such as the Internet, email, chat and the communication applications and tools including word processing, email, file sharing and so on. It is further signalled by the economic commoditization of computation related hardware and software.

The second trajectory, “machinery to habitat” aligns the perspective of computing with the user. The user does not see machine qualities in a computer such as the processor, architecture or operating system. Winograd observes that the experience is not of machine or application; it is of accessing “cyberspace” through networking or immersion in low-resolution virtual realities current at the time, including MUDs (Multi-User Dungeon), MOOs (MUD Object-Oriented), and IRC (Internet Relay Chat). In noting the shift away from the machine to the virtual he asserts the important reconsideration of space as a medium for personal experiences, actions and living. Winograd offers the neologism, *interspace*, marking the outdateding of the traditional concept of interface, a new space “inhabited by multiple people” and machinery “in a complex web of interactions” where computing is “media for the creation of virtualities: the worlds in which users of the software perceive, act, and respond to experiences” (Winograd, 1997, p.154).

The last trajectory is “Aliens to Agent” in which the argument is part lament of the failures of ‘good old fashioned artificial intelligence’ (GOFAI) as heralded in science fiction. The trajectory acknowledges that the goals of AI have become more modest,



focusing on simpler software brokers and intermediaries acting on behalf of users in applications and on the web. The super intelligent computer robots or aliens as Winograd phrases it, have given way and continue to give way to the simple software servants of the web – the software agent. The lesson in the failings of AI is the need to re-examine the foundational assumptions (an argument pursued in *Understandings Computers and Cognition*) and start over from “new footings” (Winograd, 1997, p.157).

A result of the combined trajectories is that a need for a new discipline of interaction design arises. The emerging innovations and problems would be in communication, interaction and experience. Computing hardware, software, and related skills would become commodities. The shifting boundaries of computing would favour interaction design over traditional computer science:

Many of the most exciting new research and development in computing will not be in traditional areas of hardware and software but will be aimed at enhancing our ability to understand, analyze, and create interaction spaces. The work will be rooted in disciplines that focus on people and communication, such as psychology, communications, graphic design, and linguistics, as well as disciplines that support computing and communication technologies (Winograd, 1997, p.156).

This expansive notion of computing paradoxically plays out on a broader social level but in effect narrows the focus of computing science as an academic discipline. Anticipating Carroll’s problem of fragmentation (Carroll, 2003), a convergence of art and science in the pursuit of complex interaction is not the direction that Winograd sees: “Will it [computing science] extend outward to include graphic design, linguistics, and psychology? What would it even mean to have a science of that breadth? (Winograd, 1997)” Winograd predicts that computing science will contract its boundaries and concentrate on deepening its roots and gaining greater intellectual coherence and depth that will enable it to focus on fewer but more significant technical advances. In many respects,

Winograd implies that the epistemological difference between computing science and interaction design is simply too great. Similarly, while HCI is related to interaction design, it is at the same time very different.

In the midst of this interdisciplinary collision, we can see the beginnings of a new profession, which might be called “interaction design.” While drawing from many of the older disciplines, it has a distinct set of concerns and methods. It draws on elements of graphic design, information design, and concepts of human-computer interaction as a basis for designing interaction with (and habitation within) computer –based systems. Although computers are at the centre of interaction design, it is not a subfield of computer science (Winograd, 1997, p.159).

Winograd outlines a new direction for interaction studies that includes the emergence of a new discipline of interaction design that draws on the traditions of design and the concepts of HCI. The field has computing at its core but it is epistemologically distinct from computer science. Its importance is that it addresses the need to design spaces for human communication and interaction. In relation to this study, the question asked was how does this blueprint for interaction design play out in the discourse of HCI (and design)? As I will show, the question largely fell on deaf ears. From the field of HCI, the new field of interaction design is either interpreted or constructed solely within the terms of HCI, i.e. a subfield of computing science, or HCI researchers ignore the proposed substantive and new nature of interaction design by viewing it as synonymous with HCI.

In contrast to Winograd, *Interaction Design: Beyond Human-Computer Interaction* by Jenny Preece, Yvonne Rogers, and Helen Sharp (Preece et al., 2002) best reflects the view that interaction design is a subset of computing science. The text has widely been used as a textbook in HCI and interaction design classes; recently a second edition was released (Sharp et al., 2006). As a textbook, it is written to be accessible rather than theoretical. However, the approach rests on an underlying theoretical view and the authors advance two theoretical claims: as a textbook on interaction design it promises a definitive description of

the field; and secondly it claims that interaction design is “beyond human-computer interaction.”

The authors define interaction design as: “designing interactive products to support people in their everyday and working lives” (Preece et al., 2002, p.6). Preece et al view interaction design as a progression from the multi-disciplinarity of HCI (psychologists, computer programmers, educational technologists), to the incorporation of a wider array of diverse disciplines including graphic design, industrial design, film, narrative, sociology, anthropology and dramaturgy (Preece et al., 2002, pp.8-9). This progression is in response to a context of new emergent hardware capacities including location awareness, large displays, and information appliances. In short, this is an aggregation of academic disciplines, interdisciplinary fields, and design practices. On the surface, this is similar to the visionary view of interaction design discussed in Chapter 1. However the authors theorize very little if at all as to how these divergent disciplines, fields and practices interact within a concept of interaction design. In reality, the authors conceive of interaction design similarly to the *status quo view* described in Chapter 1 (see 1.1.2 The status-quo view of interaction design), which is that interaction design is indistinguishable from what is commonly understood to be HCI.

The authors describe interaction design in three parts: 1) the user and usability, 2) design process, 3) evaluation. The authors begin with a caution against approaching interaction design from the “nuts and bolts” level of design, such as interaction styles. Rather, central to the problem space of interaction design is user experience and usability. The user is constituted within the conceptual framework of cognition. That is the user is conceived of as an individual operating within the world from a set of mental models (logical representations of how the world works), managing and processing information

(memory and data), and relying on artifacts and representations to supplement and aid cognitive processes (memory and computational aids). Interaction designers aim to map interface metaphors to a cognitive understanding of users for a particular routine and setting. Optimization of the mapping is key and this is achieved by determining the requirements and psychological effects critical to an efficient relationship between user, the system design, and the actions. The authors view design and the user as an optimization problem: “we consider what humans are good and bad at and show how this knowledge can be used to inform the design of technologies that both extend human capabilities and compensate for their weaknesses” (Preece et al., 2002, p.73).

The second part of Preece et al’s description of interaction design is design process. In the authors’ view, the design process is dictated by the needs of users, and as a consequence is largely comprised of identifying needs and establishing design aims to address those needs or requirements. Design in this context is seen as empirical data gathering and analysis resulting in representations of tasks that conceptualize how a design system might support the tasks. Designers rely on a process of iteration or going back and forth between assessing needs and creating representations. The authors discuss formal techniques for task description, task analysis, task representations, and forms of prototyping. In terms of methodology, the authors offer examples of software engineering lifecycles and an introduction to user-centred design theory and techniques.

Evaluation is the third part and completes the description of interaction design. While evaluation is discussed separately, it is tied to the design process. In particular, its aim is to assess the fulfilment of design requirements and for this it relies on empirical observation for validation. Four primary methods are discussed: direct observation of users, interviewing users, experimental studies, and expert reviews. Analysis of the data is

discussed introducing readers to quantitative and qualitative analysis, heuristic accounts, and predictive theories like GOMS (Goals, Operators, Methods, and Selection Rules) and Fitts Law.

By many measures, Preece et al's account of interaction design is not different from HCI. The authors' description does not vary from HCI conceptions of the user. For example, users are at the centre of the discussions on models whether the models be behavioural, social, perceptual or cognitive, or emotional. Users participate in the design process as either people to observe, collect data from, and/or to involve through user-centred-design. Systems are assessed through evaluation of the users' performance through means of observation, direct questioning or by comparison or simulation of predictive models of behaviour. Additionally, the authors adhere to the underlying scientific realism of HCI whereby observable phenomena constitute the design problem in the testable form of requirements and the resulting outcome can be put to the test and establish empirically verifiable claims.

The core ideas of design as presented in *Interaction Design: Beyond Human-Computer Interaction* were already part of the HCI discussion. Preece and her colleagues have brought design issues into focus and made simple and operational the description yet conceptually they have not moved from current accounts of HCI. Ultimately, many concepts in *Interaction Design: Beyond Human-Computer Interaction* can be found in earlier HCI textbooks like *Designing the User Interface: Strategies for Effective Human-Computer Interaction* (Shneiderman, 1997) such as GOMS, task analysis, Fitts' Law, mental models, information processing, observational fieldwork, scenarios, user-centred design, expert review, usability, experiments and so on.

In many respects, Preece et al have written a solid and accessible introductory HCI textbook; unfortunately it says little about interaction design. In a review by Sri Hastuti Kurniawan in the *SIGCHI Bulletin* (Kurniawan, 2003), Kurniawan applauds the book for its richness in approach to the topics. Kurniawan commends the authors for a pedagogically sound contribution and she strongly recommends its use in HCI classes. However, she is confused by the contradictions in defining interaction design: “although its title indicates that it is about interaction design, this term is never clearly defined...more terminological rigour is needed to help the readers clearly understand the various nuances of meaning...given the lack of rigour in defining the discipline of interaction design, it is perhaps premature to call it an interaction design book” (Kurniawan, 2003, p.15). In addition, she wonders how the authors go beyond HCI. Austin Henderson, in his review in *ACM Ubiquity* (Henderson, 2002) finds the text praiseworthy with only one reservation in agreement with Kurniawan:

I do find myself quibbling a bit with the subtitle of the book ("Beyond Human-Computer Interaction"). The phrase "human-computer interaction" can be taken to point fairly narrowly at the design of the user interface; however, its meaning, particularly as applied to the discipline ("HCI"), has broadened over the years, and now addresses most of the material covered by the book. So I see the book going beyond user interface, but not beyond HCI (Henderson, 2002).

Theoretically the book does not demonstrate the claims it makes more in title than in substance. An alternate and perhaps more applicable framing would be similar to Steve Heim's recent interface design textbook, *The Resonant Interface: HCI Foundations for Interaction Design* (Heim, 2008). Here Heim makes no greater claims than to argue for the importance of HCI concepts to be understood by interaction designers, and sets out to make a designer's handbook on HCI. Jon Kolko's *Thoughts on Interaction Design* is similar in this regard (Kolko, 2007).

Evident in *Interaction Design: Beyond Human-Computer Interaction* is the strength of the theoretical foundation of HCI. HCI has reached a theoretical maturity where debates about better and evolving conceptual formulations are productive contributions to the field. Such is the case with Kaptelinin and Nardi's *Acting with Technology: Activity Theory and Interaction Design*, which I introduced in Chapter 1 (see 1.2 Role of theory in interaction design). The authors set out to comprehensively explain activity theory and offer it as better theory for advancing HCI. Activity theory has its roots in applied psychology dating back to the 1920's in the work of Leont'ev, Vygotsky and Engeström in the 1980's (Nardi, 1996). The aim of activity theory is to understand consciousness within human activities in a way that reveals motivations in actions (Nardi, 1996). Human experience is seen as mediated through artifacts and signs within an activity system. For HCI, an activity system provides a broader and more ecologically valid unit of analysis than tasks. For example, the theory provides HCI a set of conceptual tools for understanding the complexities of multi-user activity, development over time, and expertise (Bertelsen and Bødker, 2003).

Kaptelinin and Nardi have different aims than Preece et al yet both texts use the term interaction design indistinguishably in meaning from HCI. In *Acting with Technology* interaction design is quite incidental despite its inclusion in the subtitle: "HCI, CSCW [computer supported cooperative work], and CSCL [computer supported collaborative learning] comprise a set of related fields. In the past HCI was often shorthand for the whole collection, but it appears that 'interaction design' and more recently 'informatics' are increasingly used as general references including these fields as well as others such as digital design" (Kaptelinin et al., 2006). Despite the fact that claims for interaction design are merely nominal in *Acting with Technology*, the authors' critique of HCI is relevant to this thesis.

Kaptelinin and Nardi identify with Cooper and Bowers' distinctions within HCI (Cooper and Bowers, 1995, p.61): "between 'first-wave HCI' and 'second-wave HCI' ... we position activity theory as a second-wave theory, a representative of a group of interaction design theories that encompasses postcognitivist approaches" (Kaptelinin et al., 2006, p.16). While Cooper and Bowers do not give a definitive description of second wave HCI, they stress that the "'second wave' is highly varied and fragmented in comparison with early HCI" (Cooper and Bowers, 1995, p.61). Second wave HCI generally denotes a shift away from the early cognitive psychology formulation of HCI that has been referred to in varying forms in the discussion so far. In *Acting with Technology* this description is further detailed as a focus on situated and contextualized issues. Since activity theory is generally applicable and used in many contexts, the subtitle (*Activity Theory and Interaction Design*) is intended to signal that the discussion of activity theory is within an HCI context. The literature Kaptelinin and Nardi reference was published in the historical context of HCI, and so for the sake of clarity and in the context of this study, I will revert to using the term HCI (in its broadest sense) where the authors use interaction design.

Kaptelinin and Nardi's discussion on the role of theory, particularly postcognitive theories, is relevant to this study since interaction design operates in and responds to the same discourse of embodiment and commitment to practice that I will elaborate on in Chapter 3. The authors observe that HCI is in need of theory because of critical challenges to its origins in cognitive psychology. The challenge grew from the situated action perspective of ethnomethodology, in particular Lucy Suchman's pivotal text *Plans Situated Actions: The Problem of Human-Machine Communication* (Suchman, 1987). Ethnomethodology is an alternative to ethnography developed by Harold Garfinkel (Garfinkel, 1967) in which observations are made without commitments to social theory in



analysis or generation. Graham Button writes, “it [ethnomethodology] shifts the emphasis away from the production of sociological accounts and theories of social doings to an emphasis upon the description of the accountable practices involved in the production of naturally organised phenomena” (Button, 2000, p.325). As such, ethnomethodology is committed to uncovering actual practice in as rich a detail as possible without recourse to external framing such as theoretical work. It is on this count that Kaptelinin and Nardi are critical of ethnomethodology. The first reason is due to its untenable resistance to any form of abstract representation or theory in expressing lived experience: “The actions and practices have come and gone with the passage of time. We have only representations, which of necessity are abstractions. We fashion these representations to the best of our ability, but inescapably shape them with our viewpoints, perspectives, constructs, and theories in doing so” (Kaptelinin et al., 2006, p.20). Secondly, and perhaps more importantly to the authors, a postcognitive conception of HCI cannot be without a strong theoretical foundation, indeed they argue that is the role of activity theory. The authors cite the pragmatist stance of the philosopher Richard Rorty who argues for a proactive understanding of theory that it is not a perfect account of reality rather it is the theory’s ability to create actions to cope with reality that is important (Kaptelinin et al., 2006, p.24). The text goes a long way toward fleshing out the nuances of second wave or postcognitivist or even third paradigm (Harrison et al., 2007) conceptions of HCI. More generally even, it is applicable to interaction studies as a whole. It asks for a full account of the design of interactive technology in its multiplicity of actions, contexts, people and experiences. In doing so, Kaptelinin and Nardi provide a sound critique of cognitive based HCI.

Activity theory with respect to HCI argues for a revised formulation of the user beyond cognition and therefore radically changes the way systems are conceptualized and

understood. In fact, what we can say to be knowledge is formulated differently in the context of activity theory. What is clear is the theoretical need to address the critique and the theoretical revision at the epistemological level. Particular to this thesis, Kaptelinin and Nardi provide a clear example of the value of theoretical revisionism. In their case the authors argue within HCI, while in this thesis the argument is parallel to HCI and focuses on a distinct field of interaction design.

In summary, I began with Terry Winograd's outline for a shift in computing science and HCI, and the emergence of interaction design as a movement beyond HCI. Winograd stretches the term to include a new discipline, 'interaction design'; the premise of which is that it will be distinct from the intellectual foundations of computer science and HCI. I discussed how Preece et al's *Interaction Design* contributes a solid account of HCI but does not contribute to an understanding of interaction design. If anything, it illustrates the inherent difficulty in attempting to describe interaction design from within the limits of the intellectual foundations of HCI: the centrality of the user and the underpinnings of scientific realism. I found in Kaptelinin and Nardi's *Acting with Technology* an incidental and unconsidered use of the term interaction design which is endemic in the field of HCI. In both cases, the elasticity of the term interaction design contrasts considerably with Winograd, returning in essence to the assumptions and limits of HCI. However, in the case of *Acting with Technology*, there is a clear critique of HCI that offers a model for theoretical debate either within or outside of HCI with respect to the design of technology. Additionally, the authors laid out shared theoretical needs with interaction design in the ideas of second wave or postcognitivist HCI that reveal a commitment to practice and a broadened notion of cognition.

## 2.2 Strategies in interaction design

Winograd in an interview in Preece et al's *Interaction Design* provided a designer's perspective of interaction design. He discussed the inherent challenge of interaction design as academic research given its tacit knowledge and experiential nature: "Its not the kind of thing that you can set down easily as, say, you can scientific formulas. A lot of design tends to be methodological. It is not about design per se but it is more about how you go about design..." (Preece et al., 2002, p.71). Much of design discourse is rooted in a methodological exploration and a similar approach is extended to interaction design. I've characterized the approaches discussed in this section as a discussion of strategies, where methodological concerns are evident and never far, yet there is a guarded exploration at a level beyond techniques and routines. Guarded in the sense that design theorists have shied away from theoretical formulations, instead seeing design as practice-based and therefore too contingent and dynamic for theoretical formulations; or wary of theory from past importation of theories from other disciplines (e.g. math, physics, engineering, behavioural sciences, etc) that view design as an application domain. Strategies as a result are articulated positions and principles intended to guide designers through the various relationships with materials, clients, audience, and stakeholders that constitute the various forms of design.

Alan Cooper and Robert M. Reimann in *About Face 3: The Essentials of Interaction Design* (Cooper et al., 2007 , Cooper and Reimann, 2003) describe tactics as ways of designing or creating particulars like menus and dialog boxes. Strategy, in Cooper and Reimann's case is considering the interaction between users and interfaces. Cooper and Reimann define interaction design as "the definition and design of the behavior of artifacts, environment, and systems, as well as the formal elements that communicate that behavior"

(Cooper et al., 2007, p.16). The authors emphasize the shift from the focus on form in traditional design to creating things that behave in interaction design.

*About Face 3* is similar to Preece et al's *Interaction Design* in that it aims to deliver practical and accessible concepts and tools to practitioners and students, however it differs in that it is not a textbook. Cooper and Reimann at times giving low level critiques of particular software and at other times offering design principles (they refer to these as axioms) and practical tips.

*About Face 3* is divided into three sections. The first section concentrates on design process and how to achieve a systematic understanding of the user. In this section Cooper and Reimann elaborate on what they refer to as *Goal-Directed Design* process, modeling users and personas. The second section marks the narrowing of the book's focus to interface design. It covers a high level but detailed sequence of critiques, remedies, and principles to common interface design concepts and pitfalls such as *undo*, *user input*, *dialogue*, *smart software*, and *interaction models*. The final section of the book dives into the low-level interface design issues, what the authors refer to as tactics. The authors cover *mouse controls*, *manipulation*, *controls*, *errors* and the application to the web and beyond the desktop including mobile devices, appliances, and telephony.

One problematic aspect of the book is the degree of disconnect between the early discussion on process and conceptualization of designing, and the progressively more detailed set of principles meant to address particular interface issues in the latter parts of the text (the authors never clarify the relationship they see between interface design and interaction design). It would have been helpful to have an in-depth case-study or discussion of how the process-oriented issues can operationalize the latter interface design principles, as this remains unclear. The interface design discussion does not contribute significantly to

our study since the realm of interface design is not the focus. I will limit my discussion to the early section of the book covering methods and modeling the user, and in particular Cooper and Reimann's use of narrative, and especially their innovation of *personas*, which has had the greatest impact on the field (Pruitt and Grudin, 2003 , Blomquist and Arvola, 2002).

The centrality of the user continues from HCI to interaction design. Cooper and Reimann's unwavering premise is that the design of the behaviour of software must exclusively be understood and validated by the user's perspective. The authors argue for the separation of design from the software engineering process. The reason for their position is that programmers and engineers design from an implementation model of computing that is concerned with the functional logic of a computer, whereas people understand computers from a mental model that is based on past experiences with everyday objects and routines. For example, most people understand documents like physical documents in the world, typically they have only one copy and that copy belongs to them. The software developed using the implementation model violates the mental model understanding by creating at least two copies (one saved to a hard drive, the other not saved but stored in dynamic RAM) and both copies belong to the program (another program cannot open it). This creates untold confusion and common errors with simple functions like saving, opening, and renaming files. Further, implementation models lead to a conception of users based on tasks. The virtue of tasks is that they can be mapped to a single or set of discrete executable routines on a computer, i.e. saving a file to the hard drive. Mental models are guided by goals and not tasks. Cooper and Reimann provide the example of getting to work in the morning where the goal is to get there as quickly and safely as possible regardless of

whether the tasks are braving traffic in a car, taking public transport, or walking part of the way.

Based on this the authors discuss innovations to existing design methods in what they have synthesized as *Goal-Directed Design*, which describes the following: separate design from programming and design first, then program; focus on user goals established by creating personas that are archetypal representations of potential users; derive the behaviours of the product from the personas; and lastly apply design principles to behaviours. *Goal-Directed Design* is a process of modeling users and their domains through observational fieldwork, then defining requirements from these models, and translating the knowledge captured in the models and requirements into a design framework that reflects the goals and needs of users. The method combines techniques of ethnography, stakeholder interviews, market research, product/literature reviews, detailed user models, scenario-based design, and a core set of interaction principles and patterns. The authors divide the process into five phases: research, modeling, requirements definition, framework definition, and refinement.

The method can be seen to be an incremental variation of human-centred approaches to design such as *Contextual Inquiry* (Beyer and Holtzblatt, 1998) or even the *usability engineering lifecycle* (Mayhew, 1999) with acknowledgments of the admonitions of focusing on goals over tasks and principles over style guides. *Goal-Directed Design* augments the latter process in part by incorporating the ethnographic commitment of *Contextual Inquiry*, however the main distinctions lie in its assertions of goals and its use of narrative to represent the goals in a contextual manner, as well as the innovation of personas, a story-based user model.

In the research phase, as discussed above, the authors draw on the ethnographic fieldwork and analysis of Hugh Beyer and Karen Holtzblatt's *Contextual Inquiry* (Beyer and Holtzblatt, 1998). The authors do suggest some improvements such as using a shortened discount version of the interviewing process that lessens the contact hours and relies on samplings of key individuals, reduces the size of design teams for greater efficiency, shifts to a goal orientation over task analysis, and looks beyond the business context to separate end-user from client needs. From the analysis of the fieldwork, designers construct a user model in the form of a persona: "a precise descriptive model of the user, what he wishes to accomplish, and why" (Cooper et al., 2007). Personas are composite representations based on "behavioural" data collected from the fieldwork and interviews of a range of people. The personas are used as archetypal representations that "stand in" for the user throughout the design process and help to address potential behaviours and motivations of potential users. Well developed personas guard against the conception of the user needs stretching or contracting in the development process along with the changes in the software (elastic user), or the focusing on the marginal or exotic features as the central issue (design edge cases). They also guard against the possibility that the designer designs for themselves (self-referential design).

Constructing the personas involve analyzing gathered data to map "behavioural variables" of participants, analyzing for patterns and synthesizing characteristics into a number of different persona types. These types can be tested against narratives that designers create to "test" the actionable qualities of the personas. Cooper and Reimann see narratives as a "powerful tool" to generate and validate design ideas. Here narratives validate personas, which in turn are utilized in scenarios to generate requirements and design frameworks. The authors cite Carroll's description of scenarios in which designers

make use of particular stories to construct and illustrate design possibilities (Carroll, 2000). The strength of scenarios is their depiction of concrete actions and the ease in which the scenarios can be created and modified. Scenarios describe an environmental setting, agents and actors with particular roles, typically engaged in one or more activities. Cooper and Reimann suggest minor improvements to Carroll's description of scenarios for their use with *Goal-Directed Design*, such as making scenarios less abstract and more concrete, and keeping actors on the level of goals rather than too quickly depicting tasks. Nevertheless, the authors show a commitment to narrative throughout the process they describe.

In summary, *About Face 3* discusses a method for interaction design that overlaps with other human-centred approaches, however it is distinct in its emphasis on goals over tasks. The text falls short of operationalizing the methodological explorations in relation to the interface design principles that consume much of the book yet the basic techniques are applicable to interaction design beyond user interface issues and have been adopted as such. Ironically, the design process they describe is highly appropriate for a broader understanding of interaction than graphical user interfaces, yet the authors' view of interaction design is more constrained than Preece et al.'s understanding in *Interaction Design* (Preece et al., 2002). The authors provide an accessible text that synthesizes a range of HCI and usability innovations and concepts into a design method. While Cooper offers a strategic discussion of the position of the designer in shaping the relationship between the user and the design artifact, the greater effort and contribution to interaction design is methodological. *Goal-Directed Design* is a series of sequenced techniques, i.e. scenarios, discount ethnography, personas, etc. that form a methodological whole.

The limits of the contribution to interaction design theory result from the coherency of the method. This all-encompassing approach makes it difficult to substitute or modify



techniques. This in itself would not be a problem however the lack of underlying theory provides little guidance in how a designer might modify techniques. For example, what are the design tradeoffs between combining deeper ethnography with discount personas rather than the other way around? The weakness of the strategic discussion is evident in the contradictions and the lack of clarity of the guiding principles. For example, the commitment to ethnographic accounts of users is at odds with the analysis of “behavioural variables,” which assumes a reductive view of the narrative account that is in conflict with ethnography. The limits of Cooper and Reimann’s contribution is not that it is methodological but that at a strategic level it is insufficiently explained or theorized in order to provide guidance for use of techniques or to resolve epistemological contradictions. Additionally, Cooper and Reimann adhere to a user-centred model for design that, though in many respects may be beneficial; its exclusive focus limits the fuller understanding of interaction design.

*In Thoughtful Interaction Design: A Design Perspective on Information Technology*, Jonas Löwgren and Erik Stolterman take on the notion of strategy and push the idea to its limits (Löwgren and Stolterman, 2004). Their focus is on a conceptual reconsideration of the role and attributes of the designer in relation to the responsibilities of interaction design. The authors see interaction design strategies as decision-making shaped by the difficulties of designing a *material without qualities* (Löwgren and Stolterman, 2004, p.5) i.e. the virtuality of the digital. Whereas other authors attempt to describe the contours of the discipline and practice of interaction design, Löwgren and Stolterman argue from the perspective of the designer who they position at the centre of the discipline. To those familiar with design theory this will not be a surprise but in the context of HCI-influenced theories of interaction design this is a radical step.

The theoretical strategy proposed by Löwgren and Stolterman is for the interaction designer to understand his or her role within design as a *thoughtful designer*. The authors describe design as a “knowledge construction system” whereby a designer embodies the craft of design through a sensibility and language (articulation), knows of the qualities of digital material, and possesses design ability. The craft itself is expressed in paradigmatic examples, digital artifact genres, and external criticism (role of critics).

The authors relate the idea of a thoughtful designer to that of an articulate craftsman (Löwgren, 2008). As such, the existential identity of the designer is bound within one’s design ability, one’s understanding of use qualities, and historical awareness of interaction design. The latter refers to a designer’s knowledge of design history and especially past exemplars in interaction design, and the emergence of interaction design genres or styles. The notion of historical awareness is straightforward whereas the ideas of designer ability and use qualities require further explanation.

Despite the centrality of the designer, the explanation of a designer’s abilities is at times opaque and difficult to follow. Further, the authors are reluctant to provide more than “inspiration” or an “introduction” to explain design abilities. They argue that each “person [designer] is unique” and “it is ultimately a question of *designing* oneself as a designer” [original italics] (Löwgren and Stolterman, 2004). Nevertheless, it can be said that design ability is composed of skills and knowledge. Skills operate at the level of craft and are dependant on the design domain. Knowledge is at a higher level and applicable across design disciplines. The higher level attributes include the ability to reason and communicate about design, and the ability to be creative and analytical about design process and outcomes. Equally important and often overlooked in technology related design is aesthetic sensibility. The designer understands and shapes the dynamic gestalt experience

of the designed artifact in ways that are often unique to the designer. Gestalt is the overall impression or experience that dynamically emerges over time (or through interaction). Further, designers make judgments that require an ethical sensibility that aligns the diverse and sometimes conflicting values and ideals of the designer, client and other stakeholders.

Löwgren and Stolterman see designer judgment as critical to interaction design. Design is viewed as dependant on judgment since design situations are complex, dynamic and require action with incomplete information. As a primary act in design, designers set provisional limits and constraints based on their judgment for what constitutes the design situation. Judgment in another form balances the fullness of the design situation by composing all aspects including the technical, functional, ethical, and aesthetic. The authors detail a third form of judgment characterized as navigational judgment, in which designers decide among many alternatives in the design process throughout the making of a design artifact.

Löwgren and Stolterman are indebted to Schön's ideas of design and the reflective practitioner (Schön, 1983). Schön describes the design process as complex, dynamic and uncertain, in which a designer navigates and creates by reflection on his or her actions. Schön's ideas were a critique of the technical rationality of design and other professions where rationalist theories were imposed. Like Schön, Löwgren and Stolterman see in design a resistance to such theories and the impossibility for design to be encapsulated in rational descriptions. The authors purposely aim to provide descriptions of design over logical formulations. This in some respects is a targeted response to the HCI-influenced theories of interaction design (Löwgren, 2002). Designers make judgments with practical considerations of the situation at hand and with an eye to a future situation that does not yet exist, and as such design, unlike HCI, is not concerned with truth in the scientific sense that

underlies HCI. Further, the HCI description of design process is one of optimization or problem solving that is a matter of method and technique in which designers are interchangeable. Löwgren and Stolterman scornfully reject the notion of a designer as a “methods operator” and in doing so offer up their richer descriptions of the characteristics of unique competencies of designers.

In addition to design ability there is a language acquired by designers that expresses a sense of artifacts and their use qualities. Again, the authors shy away from strict formulations but provide “tools-for-thought” that assist in the developing of a sense of interaction design products and their qualities. While rigid definitions do not serve anyone, such hedging is weak theorization. There is the need to explain the role of interpretation in a practice that is inherently resistant to formalization. The authors argue that dialogue takes place in the act of designing and reflection yet it is fair to ask what constitutes reflection. The “tools for thought” are a set of suggested, use-oriented qualities for digital artifacts that are not general but are applicable across individual examples. The qualities are described in five groups: users’ motivations; immediate sensation; social outcomes of interaction; structural features of the artifacts; and users’ created meanings.

There is a holistic quality to the attributes in that it is their combination, or what Löwgren and Stolterman refer to as the dynamic gestalt that designers understand and shape as the experience of the digital artifact. The authors describe the dynamic gestalt of a digital artifact as the overall character that is experienced almost at once. To designers the attributes are independently discernible and assessed through dialogue, elaborations, and rearticulated into new formulations through an internal process of critique.

*Thoughtful Interaction Design* advances many key issues with respect to theorizing interaction design independently from HCI. Löwgren and Stolterman adopt a revisionary

approach that draws on the traditions of design discourse in their account of interaction design. The authors reformulate interaction design practice with an emphasis on the unique qualities of designers and design artifacts, which are no small steps in the context of HCI informed theories. The authors place the designer at the centre of designing interactive systems rather than the user. The designer is constituted as an embodiment of design language, sensibilities of digital artifacts and materials, and design abilities. Additionally, the authors articulate design as a practice rather than a science. They offer a rich description of design practice within a digital context and detail a range of qualities of digital artifacts.

The value of the authors' contributions to this thesis is great. The authors illustrate the epistemological differences between interaction design and HCI. They demonstrate the rewards of understanding interaction design through the lens of design discourse. And they establish the theoretical particularities of design, namely the understanding of practice, the singular role of the designer, and the challenges of formalization. Nevertheless, particularly on the last point, there are clear limits to understanding interaction design as a set of strategic positions that are ultimately under theorized. The authors referred to their descriptive qualities of digital artifacts as "tools for thought." The authors' assertion of the resistance to theory in design has them adopting a "toolkit" approach to reasoning. Tools in this sense have precedent in design. The notion, encapsulated in the idea of a "toolkit" arose within the "second generation" design methods movement as characterized by Hans Rittel (Rittel, 1972) in which design theorists became wary of prescriptive and overly rational approaches to design methods: the idea of a designer as a "methods operator." The toolkit represents an open-ended approach to techniques where designers can pick and choose techniques at their discretion depending on their view of the design situation.

Bravely, Löwgren and Stolterman apply this model to design knowing and thinking. The coherency of the different tools selected rests with the designer:

A thoughtful designer, equipped with appropriate tools for reasoning, will be more able to sort out what is important, make necessary judgment calls, distinguish true needs for more information from better-safe-than-sorry approaches, and identify fruitful directions in the exploration of possible futures that is called design. The ideas we have presented in this book are intended to serve as such tools for reasoning (Löwgren and Stolterman, 2004, p.171).

Putting aside the significant question of what separates thoughtfulness from tools for thought, what is the underlying basis in thinking and knowing that motivates a selection of one tool over another? In other words, how does a designer know if the toolkit is “equipped with appropriate tools for reasoning” or not? How did a particular tool come to be part of the toolkit? And how does a designer know if a selection of a “tool for reasoning” is good or not? The problem with the “toolkit” model is that it offers no reasoning or context for the tools it contains, i.e. it offers no guidance to designers for selecting one tool from another. It in fact is not a model at all but rather a repository or list that makes no claims for its contents whatsoever. In this sense, the idea of a “toolkit” is meaningless and questionable in value. It provides no useful explanation of the thinking actions of design.

Henrik Gedenryd (Gedenryd, 1998) wrote of how “iteration” in design, the repeating of the design process or reversal of sequencing within the process is not the solution for flexible design methods that it is often heralded as being. In fact, Gedenryd argues that iteration in design is a poor fix for the underlying problem of viewing design as a linearly sequenced set of discrete operations. He explains how in the case of the waterfall model, the traditional design management model of tasks flowing sequentially into later tasks, iteration is not an improvement but an erasure of the underlying rationale for a model at all:

Adding iteration to a model means that you allow for the included phases to be repeated;...[Iteration is] an ill-considered added feature that handles a certain condition, but which in doing so goes against the original idea, and is therefore incompatible with it—thereby, in reality it constitutes no solution at all.

By allowing for iteration, a stage model comes to saying that you can do anything, in any order, as many or as few times as you like. By allowing for everything, it no longer says anything about their order. But if you do that, you have given up what was the purpose of these models in the first place: to specify what things to do, when to do them, and in what order, so as to guide the designer. The only substance that remains is a list of the activities that are included (Gedenryd, 1998, pp.97-98).

And so iteration as an ad hoc extension undermines the model it is intended to support. The same applies to the ad hoc extension of a toolkit to either design methodology or in the case of Löwgren and Stolterman, design thinking. The “toolkit” model does not provide an underlying rationale. It does not answer the questions of what makes a “reasoning tool” appropriate and how a designer assesses one tool over another.

Some may answer that the appeal of the toolkit is that it does not impose a rationale and logic on the different design or reasoning techniques, thus avoiding the errors of past design methods and theories. Yet rather than dismantle the prescriptions of the past methods and theories, toolkits perpetuate the notion that a designer is separate from thinking and actions in design. In other words, design reasoning and techniques can be categorized as discrete operations that can either be assembled as a tightly related group of interdependent tools or assembled as a loose set of tools with no relations among them. In either case, a designer can be reduced to a “methods operator.” Toolkits address only the organizing principles behind discrete operations in design not whether discrete operations themselves are a valid way of understanding design.

Toolkits separate design thinking and actions from the designer and tend to reduce the actions of a designer to a selection and implementation of tools. In order to mitigate the

problems of toolkits, Löwgren and Stolterman assert the role of a “thoughtful designer.”

We can presume that the coherency and selection of tools rests with the thoughtful designer. Any separation of the thoughtfulness and tools for thought are resolved by the reflection and actions of the designer. And so what makes a thoughtful designer? How is a designer thoughtful? How does a designer become thoughtful? Löwgren and Stolterman suggest it is through preparedness:

We have emphasized the importance and responsibility of interaction design. To handle this responsibility, our recommendation to interaction designers is to be prepared: prepared to act in a design process, encounter new design situations, learn and develop as designer, and understand historical developments and future technological trajectories (Löwgren and Stolterman, 2004, p.171).

The authors imply an ethical commitment to interaction design is sufficient to mobilize a designer in *designing oneself as a designer*. What motivates this commitment? Preparedness speaks to a reasonable state of readiness a designer must have, but how does a designer become prepared and how do they know they are sufficiently prepared? How is a designer to learn to exercise design judgment and how do they know if their judgments are good or not? The passage above describes designers who are left to their own devices and rely on their own encounters with design and their reflective vigilance of that history. The critical point that is left unexplained is what enables designers to make the right judgments that lead to better design outcomes?

As stated earlier, Kaptelinin and Nardi in *Acting with Technology* (Kaptelinin et al., 2006) criticize ethnomethodology for what they characterize as holding a “radical antitheory position.” Ethnomethodology, a variant discipline of ethnography within sociology, rejects “sociological theorizing” and actively resists generalizations and abstractions choosing instead to rest its understanding on “actual” and “real-worldly sources:”



Antitheory such as ethnomethodology struggles with its own contradictions. The very idea of the orderliness of human conduct is itself an abstraction. The work of studying orderly conduct through the empirical investigation of specific instances amounts to the development of a theoretical principle, much as investigating instances of species diversity is part of the work of developing a theory of biological evolution. That human conduct is "orderly" is not itself a foregone conclusion. Human conduct might be studied as chaotic, or as swinging between order and disorder, or as order within chaos. The assumption that specific instances of organized action can be studied theory-free is without ground. All observation is a view from somewhere (Kaptelinin et al., 2006, p.18).

It may be an exaggeration to label Löwgren and Stolterman and other design theorists as anti-theory however as we've discussed, design discourse has a long practice of resisting formalizations and theoretical abstractions. This is in part historical; based on past theoretical incursions from other disciplines and design theorists' own early failings with methodological studies (Alexander, 1971 , Jones, 1977). Nevertheless, the criticisms Kaptelinin and Nardi raise with ethnomethodology are applicable to design. The implicit notion that design could be theory-free is ultimately an argument for an absolute idea of design that eludes us, "this is just the way design is" or a randomness that is surprisingly and incredibly coherent despite its complexity. Or as in the case of Löwgren and Stolterman, the learning and knowledge construction of a thoughtful designer occurs through existing as a designer in a manner that is every bit real but cannot be formalized. In either case, the assumption is of a reality beyond our grasp or our ability to articulate in theory. The assumption is idealist and leaves the impression that designers and design are mysterious black boxes. Despite the avoidance of theory we cannot avoid a philosophical understanding that may be problematic, an absolute view of design or an idealist view of design that ultimately sells short interaction design research inside and outside the interaction design communities, and limits design education to a guild model of one-on-one mentorship.

In summary, I have shown the limits of articulating interaction design as a strategic formulation that remains shy of the depth and commitment of theorizing. In the case of Cooper and Reimann's *About Face 3* the insufficient theorizing undermines the methodological contribution. The coherency of the method can be inexplicably rigid since the lack of deeper explanation provides little guidance in modifying the techniques of personas and scenarios, for example. Additionally, the discussion supporting the method overlooks epistemological contradictions like the reduction of observations in ethnography to analytical variables. Löwgren and Stolterman's under-theorizing is a product of resisting formalizations and generalizations of the things they richly describe, namely the practice of interaction design. The result is an informative and nuanced set of digital artifact qualities, design abilities, and design language that are put forward as parts of a reasoning toolkit reliant on the designer's judgment for coherency and productive reasoning. The weakness lies in the black-box description of the designer. Left unexplained is what guides the designer to make judgments and how a designer learns to exercise design judgments and make assessments of their decisions. Lastly, Cooper and Reimann adhere to a user-centred description of interaction design, whereas Löwgren and Stolterman adopt a revisionary approach, drawing on the traditions of design discourse, and reformulate interaction design by emphasising the uniqueness of the designer and design artifact.

## **2.3 Next steps**

I stated at the beginning of the chapter that there is an inversion between HCI views and design views of interaction design. HCI theory is mature whereas design-oriented conceptualizations of interaction design are at a less theorized level that I referred to as strategy. I also discussed at the outset of the chapter how the term interaction design endures a degree of elasticity in its definitions and use. Figure 3 represents in matrix form

our review of current theories and viewpoints related to interaction design discussed in this chapter. The current conceptualizations have been plotted on a horizontal axis that shifts from theory to strategy, and a vertical axis that shifts from descriptive/explanatory theories and viewpoints to revisionary ones. This axis represents the traditional requirements of a theory to explain and define concepts reliant on logical abstractions and a potentially conflicting revisionary view that is unique to design practices and relies on embodied descriptions of practice. In addition, the matrix is divided into four disciplinary foci that the conceptualizations intersect: HCI, Post-Cognitive HCI, Design, and Interaction Design.

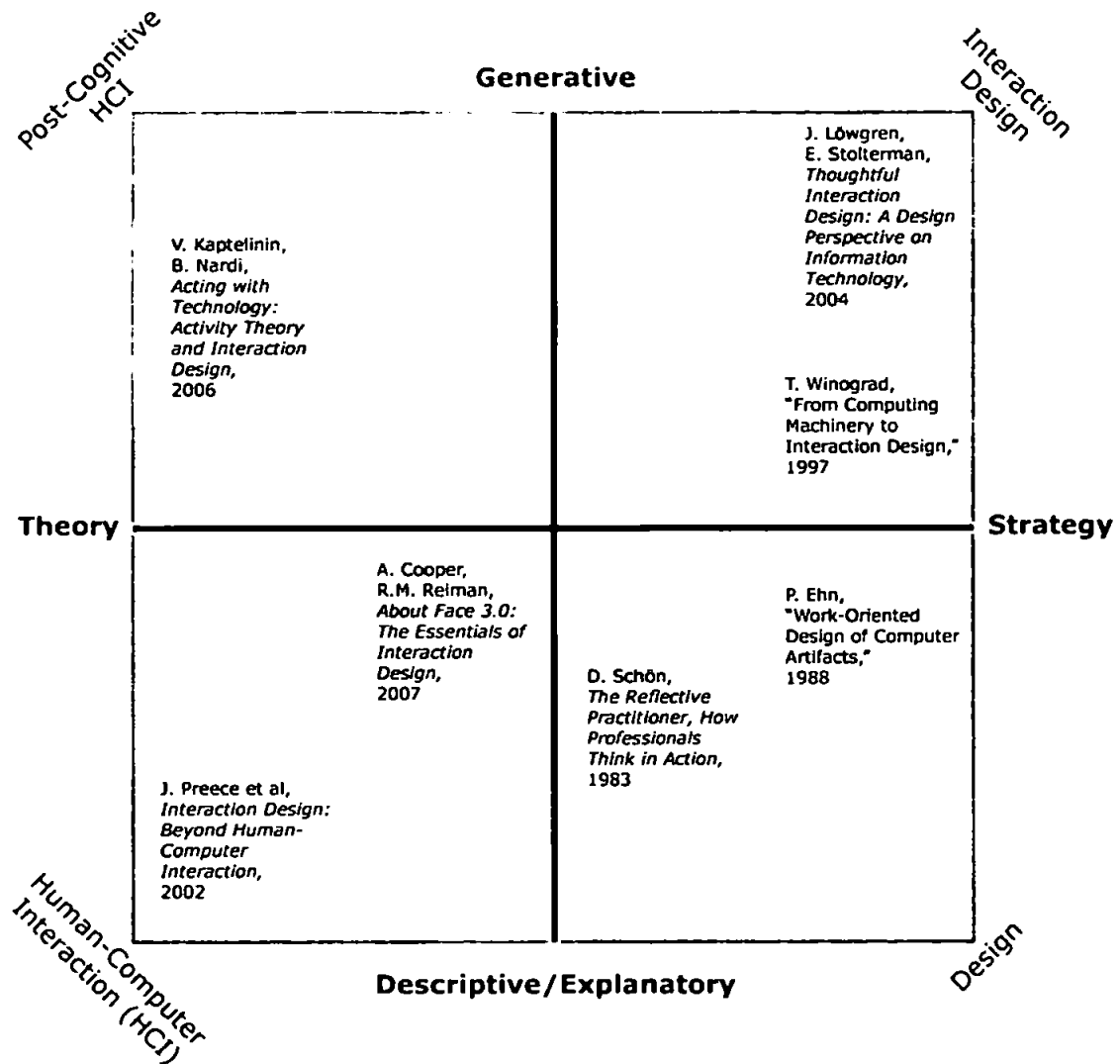


Figure 3 Literature reviewed in this chapter is plotted in a matrix of two dimensions: descriptive/explanatory to revisionary, and theory to strategy. The grey shaded area indicates the literature and theory gap in interaction design.

In HCI theory, Preece et al's *Interaction Design: Beyond Human-Computer Interaction* (Preece et al., 2002) is not a theoretical text, however it rests on a strong theoretical foundation of HCI. In Figure 3, *Interaction Design: Beyond Human-Computer Interaction* occupies the most theoretical and descriptive/explanatory view in our review. As a reflection of the theoretical maturity in HCI, Kaptelinin and Nardi's *Acting with Technology: Activity Theory and Interaction Design* (Kaptelinin et al., 2006) offer a balance of approaches between descriptive through to revisionary theory of HCI. The

theory critiques the behavioural and cognitive sciences in favour of a post-cognitive HCI. Kaptelinin and Nardi's text occupies the most theoretical and revisionary position in respect to HCI and post-cognitive HCI in Figure 3.

By contrast, the texts reviewed in this chapter that point to a notion of interaction design independent of HCI are under-theorized and defined here as strategies. In Figure 3, Löwgren and Stolterman's *Thoughtful Interaction Design* (Löwgren and Stolterman, 2004) is placed in the interaction design quadrant and toward the strategy and revisionary ends of the spectra. Winograd's "From Computing Machinery to Interaction Design" (Winograd, 1997) was published as a polemical article, arguing for a clear break from computing science for interaction design. Key challenges in building an interaction design theory from these texts is that they are either emergent positions stated as polemics or descriptions without underlying theoretical structure or they are bound within or reactive to HCI theory. As mentioned earlier, Ehn's participatory design (Ehn, 1989) and Schön's reflective (Schön, 1983) practice offer clear starting points for a theory of interaction design. These theories are located in the design quadrant in Figure 3.

The depth of the debate between HCI and post-cognitive HCI demonstrates the maturity and robustness of theories for HCI. At the core of the theories are two notions: user-centrism in which the user is the primary focus of study or rhetorical claim (Cooper and Bowers, 1995); and scientific realism. The debate between HCI and post-cognitive HCI advocates is not over the centrality of these two notions of HCI; rather it is around the theoretical construction of the user as based on behavioural and cognitive sciences or non-cognition views like activity theory. Theoretical depth is demonstrated by the ability to probe beyond descriptions, in this case cognitively or contextually defined users, to the underlying concept, in this case the user. While the question of what constitutes a user may

be up for intense discussion, the theoretical principle of user-centrism is not, which demonstrates the maturity of the theory. Additionally, the theory provides coherence for the methods of HCI. In Preece et al's descriptions of methods the user-centric principle is clearly evident. The basis for the design process is user needs and the basis for evaluation is user performance. The logic and rationale for the use and combination of techniques rests with the principle of scientific realism. HCI design method is founded on the empirical data gathering and analysis of users that results in representations of tasks and situations of use. In effect, any techniques used for gathering requirements that are in line with the principles of scientific realism adhere to the idea that user needs are empirically observable, discoverable and testable. The strength of this is that it allows for wide experimentation and selection on behalf of system designers with respect to techniques for requirements gathering as long as the experimentation addresses the principles involved. This is evident in the range of methods from interviews, to conversation analysis, to cultural probes used for requirements gathering. Additionally, the principle of scientific realism rationalizes the relationship between evaluation and design, where observable phenomena constitute the design problem in the form of requirements and the resulting system, assuming it has been implemented in accordance with the requirements, can be empirically tested. Any claims for users, design of the system, or interactive systems use can be verified. The verifiability of claims rests in the use of techniques that afford measurability of the phenomena and independence, assessed by the nature of evidence separate from theory and by the minimizing of subjective interpretations. Again, the virtue of this approach for an HCI practitioner is the guidance and degree of freedom with respect to use and selection of evaluation methods.

There is considerable virtue in the way in which scientific realism is operationalized in HCI theory and mobilized for discoveries about users and systems while at the same time incorporating the making of computer systems. The requirements and resulting design plans represent hypothesizing the user and system design. The designed system embodies the relationship between user and system by implementing the requirements. As such the hypothesis can be tested in the form of evaluating user and system performance. Shortcomings in the resulting design can be attributed to requirements gathering, design representations in system plans, or implementation, i.e. the making of the system. Notwithstanding the critical drawback that scientific realism does not help HCI account for implementation, the actual design and making of the interactive system, the advantage of this position is it provides a better justification than existing interaction design theory for the methods employed in developing a digital artifact.

However, the same strength that affords HCI researchers a stable theoretical purchase also forms an intellectual constraint that prevents the full understanding of interaction design. In other words, the underlying theoretical precepts of HCI act as a gravitational pull distorting views of interaction design in ways that mimic HCI, i.e. basing interaction design on the principles of user-centrism and scientific realism. Yet why should interaction design be considered user-centric? Löwgren and Stolterman's *Thoughtful Interaction Design* favour a designer-centric view of interaction design over a user-centric view. What is the applicability of scientific realism if interaction design is not a science? Design discourse has resisted abstractions and formalizations in favour of irreducible descriptions of experience and practice. The totality of design artifacts and especially designer judgments are not measured by empirical discovery and verification. While interaction design may not adhere to principles of user-centrism and scientific realism, this

does not however mean that it should be non-theoretical or theory-free. The downfall to the approach of strategies is that interaction design is under-theorized, leaving the field to be defined by others outside of the field or leaving it perpetually under-developed since building theoretical discourse on little supported descriptions or underlying contradictions is simply too challenging.

The first proposition is that current descriptions of interaction design are inadequate and there is a need for theorizing of interaction design in order to better value its role in the research and creation of interactive systems.

This chapter aimed to address the first proposition that interaction design is insufficiently theorized. In Figure 3, the striped area within the interaction design quadrant represents the absence of a theorized notion of interaction design and the gap that the theory here aims to fill. Based on our discussion, the broad outlines of an interaction design theory would be similar to Schön's reflective practice and Kaptelinin and Nardi's theory of post-cognitive HCI in that the theory would balance a descriptive/explanatory theoretical outlook with a revisionary one.



## **CHAPTER 3: PRAGMATISM, INTERACTION DESIGN AND A THEORETICAL FRAMEWORK**

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This chapter discusses the theoretical foundation for a pragmatic theory of interaction design. The philosophical starting point is with Dewey's pragmatism and the pragmatic understandings of experience, judgment and interpretation. These concepts form the building blocks for the theory. I will also discuss the pragmatic threads in design theories like the influences of Ehn's participatory design and Schön's reflective practice. The chapter concludes with a framework for a new theory of interaction design.

### **3.1 Dewey, pragmatism and design**

In this section, I will provide a brief background of Dewey and pragmatism. The particular concepts of experimentalism, judgment and interpretation will be discussed in greater detail in subsequent sections. I will also aim to answer the question of what motivates the connection between pragmatism and interaction design, and discuss the parallels between pragmatic experience and descriptions of design.

#### **3.1.1 Background to pragmatism**

John Dewey (1859-1952) along with Charles Sanders Peirce and William James were the founders of philosophical pragmatism. The contributions of Dewey's pragmatism extend beyond the borders of philosophy. They influenced the social, political and

educational developments of his time through to today. His philosophical views anticipated aspects of Wittgenstein and re-emerged in later thinkers like Richard Rorty and Hans Joas.

In the early twentieth century, pragmatism re-examined foundational questions about how we know and the representations we make of the world through science and knowledge. In the questioning of existing metaphysical truths, pragmatists sought not to simply replace old philosophical truths with new philosophical truths. The aim of pragmatism was to look to science and philosophy for the opportunities they afforded individuals to find meaning in their lives. Pragmatism's disavowal of metaphysics leaves no room for absolutes and certainties. Dewey committed to the non-metaphysical notion that human knowledge is provisional, incomplete, and probabilistic. Dewey saw such a commitment as neither a reason for despair nor false comfort but as a practical matter of philosophically engaging with human experience as fully as possible without recourse to underlying absolutes or transcendental truths. In many respects, Dewey's concerns were with the actions of knowing as opposed to the objects of knowing. This orientation to process combined with the social and ethical views of the world and knowledge that pragmatism presents is what makes it relevant today. The emphatic lack of a foundational approach to thought and reason was made explicit decades before postmodernism. Dewey asserted the need to abandon the dualisms of truth and falsehood, subject and object, and mind and body that dominated prior metaphysical philosophies.

Metaphysics aside, Dewey's greatest charge against certain philosophies centred around the denigrations of the everyday practicality of inquiry and experience: "the most serious indictment to be brought against non-empirical philosophies is that that they have cast a cloud over the things of ordinary experience. They have not been content to rectify them. They have discredited them at large" (Dewey, 1929a, p.40). Pragmatists saw a gap

between sciences, philosophical knowledge and the everyday experiences of living and acting in the world. Dewey's own philosophical starting point was with the here and now of lived experience. Dewey observed that we often experience life as routine coping with familiar situations, however some situations are problematic. His notion of inquiry flowed from the idea of the problematic everyday experience in which a situation is confusing, unresolved, disturbing and lacking in clear possibilities of action. He states, "we must begin with things in their complex entanglements rather than with simplifications made for the purpose of effective judgment and action" (Dewey, 1958, p.387). Truly valuable judgments and actions arise from complexities, not simplifications. Boisvert, a Dewey biographer, describes Dewey's challenge that "the philosopher must become once again an ordinary human being who lives, enjoys, undergoes, suffers, imagines, hopes, struggles, loves, and plans for the future" (Boisvert, 1998, p.16).

Experience is the starting point for philosophic thought in pragmatism. Dewey speaks of experience in its most radical and genuine form describing it as having an "inclusive integrity" (Dewey, 1985). As Boisvert describes it, "on this level, 'experience' weaves together the environment, memory, reactions to physical conditions, interests, limitations, and projects envisioned" (Boisvert, 1998, pp.16-17). Dewey describes experience as interactional. It is the result of interaction between a person and aspects of the world she lives in – or in pragmatist terms entities-in-interaction. Experience resides in neither the person nor the situation but in the interaction between them. In this sense experience is not of the mind or a product of subjective perceptions. Metaphysical dualisms have little place here.

Pragmatic inquiry is the response to the complexities or problematic everyday experiences we encounter. For Dewey, inquiry is a practical tool that transforms

experiences into comprehensible situations, in which possible successful actions are made clear. Pragmatism as such is a generative philosophy; it both uncovers the multiple possibilities through knowledge of an experience and simultaneously offers the more fulfilling and ethical pathways through the possibilities. Yet pragmatism is not a system of thought without people. It is people who are the pragmatists who animate the philosophy, and who do so at different levels of expertise as they develop. Dewey's pragmatism speaks more to how one knows than what one knows. Knowledge is developed through a growing awareness and sensitivity that comes with time or in the prosaic sense, experience. Knowledge may reveal possibilities, but it is evolving judgment and interpretation that determine the value of the possibilities.

### **3.1.2 Why pragmatism and interaction design?**

Pragmatism, in particular Dewey's pragmatism, has the potential to elucidate the intellectual coherency of interaction design that is born out of practice, experience, and human interaction. Equally it provides methods for revealing how the field contributes to knowing in the world. The main pragmatist concepts of experience, judgment and interpretation will serve as the building blocks for the foundation of the theory proposed in this thesis.

Many past theories support a pragmatist view of design. McCarthy and Wright see in pragmatism a revisionary approach to HCI in arguing for the need to understand technology through experience (McCarthy and Wright, 2004). Richard Coyne saw pragmatism as having a supporting role in adopting postmodern theories in information technology design (Coyne, 1995). In addition, the design theorist Richard Buchanan has discussed Dewey as a touchstone in his view of design as a liberal art (Buchanan, 1995). Henrik Gedenryd relied on pragmatism in design as a basis for an interactive cognition

view of design thinking (Gedenryd, 1998). In this chapter I will discuss how Ehn's participatory design via Heidegger and Wittgenstein held a pragmatist position and how Schön's reflective practice is deeply indebted to pragmatism. Perhaps with the exception of Schön, who acknowledged Dewey's influence, no design theories have incorporated pragmatism as a foundation, and especially not with respect to interaction design.

The threads of pragmatism in design thinking are important in showing a natural relationship between the philosophy and design. Yet, it is the very way in which Dewey's pragmatism formulates inquiry that is of utmost relevancy and need in interaction design. Pragmatism's commitments to inquiry through the lived world of experience and the role of the inquirer are critical to design. This is because of design's own commitment to the lived world of practice, and also because design is a human act driven by human actors, namely designers. Additionally, pragmatist notions of experience encapsulate the holistic dynamics of design. Dewey's emphasis on everyday life strikes a chord within design given its often mundane and ubiquitous role in our lives. As discussed above, experience is interactional where "interconnection and interdependency are the rule" (Boisvert, 1998, p.24), and as such, temporality and change are continuous and cannot be abstracted away. This is an apt framing for design experience and accounts for the underlying reasons for design theory's past resistance to abstraction. Dewey accounts for the lack of representation in experience yet argues for its substantiation through inquiry; a tack that design theory can productively follow.

### **3.1.3 Design and experience**

The dynamics of design are the very problematic experiences from which Dewey's inquiries begin. This is echoed in Schön's own well-known characterization of designers engaging situations of uncertainty, instability, uniqueness and value conflict (Schön, 1983).

Traditionally, design theorists have described the vagaries of design in similar fashion. For example, Herbert Simon (Simon, 1973) characterized a class of problems as ill-structured, meaning that in contrast to structured problems, ill-structured problems were undetermined, crossed several domains of knowledge, lacked clear goals, and came with incomplete information. Equally there is the notion of design as “wicked problems” by the design theorist and planner Horst Rittel and Melvin Weber (Rittel and Webber, 1973). Rittel saw in design planning ill-defined problems that could be characterized as “wicked”: such problems are messy, circular, incomplete, contradictory, often changing and rife with complex interdependencies. Rittel enumerated ten properties of “wicked problems” (Rittel and Webber, 1973):

1. There is no definitive formulation of a wicked problem.
2. Wicked problems have no stopping rule.
3. Solutions to wicked problems are not true-or-false, but better or worse.
4. There is no immediate and no ultimate test of a solution to a wicked problem.
5. Every solution to a wicked problem is a "one-shot operation"; because there is no opportunity to learn by trial-and-error, every attempt counts significantly.
6. Wicked problems do not have an enumerable (or an exhaustively describable) set of potential solutions, nor is there a well-described set of permissible operations that may be incorporated into the plan.
7. Every wicked problem is essentially unique.
8. Every wicked problem can be considered to be a symptom of another problem.
9. The existence of a discrepancy representing a wicked problem can be explained in numerous ways. The choice of explanation determines the nature of the problem's resolution.
10. The planner has no right to be wrong (planners are liable for the consequences of the actions they generate).

Among these ten properties we find many parallels to pragmatism's understanding of experience. For example, there is concreteness to these problems such that “every

wicked problem is essentially unique” and that every attempted solution “counts significantly.” Wicked problems consist of dynamic interrelationships or, in pragmatist terms, entities-in-interaction such that the “problem can be considered to be a symptom of another problem” and there is no definitive endpoint or “stopping rule.” Multiplicity can be assumed such that wicked problems “do not have an enumerable (or an exhaustively describable) set of potential solutions” and “are not true-or-false, but better or worse.” Lastly, the planner or designer is present within a wicked problem such that it is the designer’s “choice of explanation” that “determines the nature of the problem’s resolution” and that a designer is responsible and is liable with respect to the problem, “the planner has no right to be wrong.”

I previously cited Schön’s characterization of the situation designers encounter as engaging uncertainty, instability, uniqueness and value conflict (Schön, 1983). Schön’s theories echoed Dewey by addressing the gap between the abstract knowing of philosophers and scientists that he referred to as “technical rationality” and the practice-based knowing of professionals that he called reflective practice (Schön, 1983). Designers are embodied within the theory as reflective practitioners who generate knowing by doing. Schön generally referred to design experience as “design situations.” Like Rittel’s “wicked problems,” reflective practice accounts for the dynamic, contingent, and unfolding nature of design. Yet Schön was also careful to detail and elucidate the actions and reflections of the designer embodied within design situations. The designer functions by going back and forth between construction and reflection of the situation as a means to understand the situation the designer is creating.

Interaction design can be understood as a prospective action animated by a proactive and embodied inquirer who experiments within a present moment in order to

consider future actions and contingencies. For example, Schön views design as a conversation (Schön, 1983). Rittel understands design as argumentation (Rittel and Webber, 1973). In either case, each analogy explicitly describes 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 for further prospective actions. We can view design in pragmatist terms as the interactions between an inquirer or designer, subject-matters or possibilities within the lived world, and actions.

### **3.1.4 Key aspects of pragmatism and design**

So far in this chapter, I've introduced pragmatism as a philosophical starting point for a theory in interaction design. Key philosophical principles set pragmatism apart from other philosophies and hold affinities with interaction design practice, namely pragmatism disavows absolutes, seeing knowledge as provisional, incomplete, and probabilistic. Furthermore pragmatism holds a generative view that looks prospectively toward actions that create value and knowledge. Lastly, I also discussed how pragmatism has a natural relationship to design and how a pragmatist lens fits with past descriptions of the design experience, namely “wicked problems” and “design situations”.

## **3.2 Interaction design as experience**

In this section of the chapter, I will show how a pragmatist formulation of experience and inquiry directly informs an understanding of interaction design by emphasizing how the interactional nature of inquiry and experience makes clear the role of a designer as an embodied inquirer, and that the experience of designing can be articulated by the dimensions of experience that include concreteness, multiplicity, and entities-in-interaction. Lastly, I will discuss how past design thinkers offer clear starting points for



such a theory in line with pragmatism, including reflective practice, ethnography and participatory design.

### 3.2.1 Concreteness

A pragmatist begins thinking and knowing with experience, and assumes that it is only through experience that we interact with the world. In deceptively simple terms, Dewey states that the meaning of experience is experience itself. In *Experience and Nature* (Dewey, 1958), Dewey describes a surprising and fearful sound heard in a darkened house during a storm. The sound turned out to be the knocking of a window shade against glass. Dewey explains that the experience of the sound was unexpected and haunting. Learning the source of the sound does not alter the experience and to hear the sound again would make for a new and different experience altogether. A pragmatist grounded in ordinary experience simultaneously accepts its concreteness and the existential integrity of contingency, responsibility and the possibility of not knowing or failing. These are the conditions of experience and any inquiry of the experience.

As I've discussed, experience is interactional between entities that include the inquirer:

The outline of the common pattern is set by the fact that every experience is the result of interaction between a live creature and some aspect of the world in which he lives. A man does something; he lifts, let us say a stone. In consequence he undergoes, suffers, something: the weight, strain, texture of the surface of the thing lifted. The properties thus undergone determine further doing. The stone is too heavy or too angular, not solid enough; or else the properties undergone show it is fit for the use for which it is intended. The process continues until a mutual adaptation of the self and the object emerges and that particular experience comes to a close (Dewey, 1934, p.45).

This example by Dewey from *Art as Experience* (Dewey, 1934) prefigures Schön's description of a design situation (Schön, 1983), and moreover describes again the

concreteness of the experience, i.e. it is as it can be described and is without some other purpose or meaning. Further dimensions detailed in this example include the interactional nature between “a live creature and some aspect of the world,” and the multiplicity of experience as an indefinite set of unknowns, possibilities and adaptations. Additionally, Dewey’s passage makes clear the embodied presence of the inquirer. The “man” is not an observing spectator; rather he is an experimenter trying out different actions in a continuum between knowing and doing.

I’d like now to turn to a personal account of a visit to a natural history museum that was part of a research project that I later use as a case study in this thesis. The example is of a museum for which our team was researching and developing an adaptive museum guide. A visit to a museum reveals an everyday yet dynamic 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, the visitor’s learning style, and the dynamics of friends, family and strangers around them. 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. In museum studies literature, the experience has been 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 (Lehn et al., 2001a). Instead, the museum experience is subject to multiple influences and results in multiple outcomes (Leinhardt and Crowley, 1998).

From the perspective of an interaction designer, grappling with understanding a museum visit, the experience can be both elusive and at times self-evident. It was elusive

given the multiplicity of qualities. It was self-evident at times given my own history of having worked in museums as a preparator, having visited innumerable natural history and science museums, and having experience and knowledge of designing with interactive technology in museums and similar contexts. After my first visit to the museum we were working with I left with a number of reflections. The exhibit displays were like a series of small theatrettes set along a slightly curving path, the exhibit design was repetitive but playful. I found that the playful quality was accentuated by a large mastodon display that punctuated the centre of the curving path. Each display, like a tiny theatre for one, enveloped you as you moved in closer to view the artifacts. Like a theatre set, the oversized structures were made of inexpensive materials, brightly painted wood, large signage, and Plexiglas. The overall quality of the exhibit displays was of temporary structures that had been in use too long, and as a result there was some wear and tear. As it was, the museum was about to be closed for major renovations and the exhibits completely redone. Nevertheless, I found that the wear and other aspects of the building, such as worn carpeting and cool interior temperatures (I kept a sweater on) undercut the light heartedness of the look and feel of the exhibit. On the other hand, the acoustics were not very good since the ceilings were high, however I liked how they added a raucous and joyful aspect, especially when children visited. The trailing and echoing sounds created an acoustic shape accentuating the curvy pathway. A simple wooden puzzle game created a noisy racket of wooden puzzle pieces falling into a wooden chute. This noise drew people into the space since it was often accompanied by surprise and laughter. And so the space felt contradictory in that it was both upbeat and downbeat at the same time. Adding to this was the fact that the natural history artifacts were themselves interesting, however each display was so crammed full of objects that the net result was fatigue and frustration, which ultimately led me to boredom when trying to figure out the significance of each artifact. To

make matters worse, the previous day I visited the museum's research facilities and collections storage. In a word the visit was exciting. The facilities literally housed the equivalent of two to three football fields of artifacts and data. Seeing the artifacts in the context of active research and having researchers on hand to contextualize the data and bring to the discussion personal anecdotes of the experience of collecting them or working with them brought the collection alive in a way the museum exhibit did not.

These impressions of my first visit to the exhibit show the concreteness of the experience that I felt. There is no single priority in representing a museum visit as an experience, and the voice or presence of the inquirer of that experience is evident. With respect to interaction design we can say that the experience does not readily give over to a single problem to solve nor can it be viewed as a whole easily reducible to salient factors. In design, first-person accounts are critical, yet a view that incorporates the multiplicity of perspectives and possibilities may make the most of the concreteness of experience. The emerging practice of design ethnography suits this need well. Ethnographic methods provide an integrated and contextually descriptive approach, better suited to engaging experience in everyday contexts. Ethnography involves both a set of methods for doing fieldwork and an analytic approach for making sense of the data collected during the fieldwork (Button, 2000). Ethnographic studies conducted throughout the design work provide crucial details about the specific situation and practices, yielding both designed artifacts and systems that are a better fit and more sustainable within their context (Randall et al., 2007), and create new knowledge about interaction design (Wakkary et al., 2007). In fact, field studies in design have a long history that is parallel to ethnography and can distinctly be considered as design ethnography (Randall et al., 2007).

### 3.2.2 Designer as inquirer

Throughout and subsequent to Dewey's time, the inclusion of memory, affect, somatics and actions of the inquirer in the formulation of experience led to criticisms of subjectivity. Dewey's critique of objectivity, namely reductionism and rational abstraction, is misconstrued as a call for subjectivity:

Whether a certain term, say "experience," has subjectivistic or objectivistic implications, we might have to consider whether, taken without specific qualifications, it was not rather a neutral term, a term to be used "without prejudice."... In contrast with this conceivable meaning of the term neutral, which might be called the logical, stands another term which might be called the metaphysical or ontological, namely there is a certain sort of stuff which is, intrinsically, neutral (Dewey, 1980, pp.49-50)

Dewey's rebuttal is to challenge the dualism of objectivity and subjectivity and the underlying metaphysical claims such as the idea of intrinsic neutrality in inquiry. Dewey's experience was not fashioned in metaphysical terms. He later lamented the inability for philosophy to understand experience as anything other than an individual perspective.

The appeal to "experience" was a thoroughly wholesome appeal to liberate philosophy from desiccated abstractions. But I failed to appreciate the fact that ... philosophy had corrupted and destroyed the wholesomeness of the appeal – that "experience" had become effectively identified with experiencing in the sense of the psychological, and the psychological had become established as that which is intrinsically psychical, mental, private (Dewey, 1929a, p.362).

Dewey's claim is that experience is things as they are, i.e. experience is its concreteness. He argued that inquirers always begin and constantly return to the concreteness of the experience and the embodied inquirer. The non-linearity of the experience, for example the shift from emotion to bodily state or the simultaneous multiple and heterogeneous possibilities are part of the "inclusive integrity" of experience. Inter-subjectivity, or the sharing of subjective states by others, is part of that inclusiveness. In my own example of the museum visit, the subject-matters of the inquiry included my own

perceptions as a visitor and design researcher together with inquiries of other states like other members of the team, the other museum visitors, the curator, the natural history researchers, and the museum administration. Dewey argued for the fullness (including the somatic and embodied) of the participation of inquirers in order to understand experience.

### **3.2.3 Multiplicity**

Descriptions of experience fold and unfold, often in different and even contradictory trajectories, despite being of the same experience. It would be incorrect to consider these as attempts at exhaustive accounts. Pragmatic experiences are inexhaustible. Dewey referred to this as the “infinitely other and more” in human experience, yet at the same time there is completeness or an “inclusive integrity” rendered by the inquirer. The “infinitely other” is expressed as a multiplicity, “sense data” that is saturated with memory, affect, somatic awareness, and history. In my example of the museum, boredom, playfulness, the need to wear a sweater, and memories of visits to the storage facilities mixed and intermingled. The multiplicity or multivariate (Lehn et al., 2001b) challenge a single meaning or purpose to the experience.

Multiplicity at its most evident is expressed in social and cooperative endeavours. Interaction design is collaborative and interdisciplinary within the design team and participatory with respect to the stakeholders and end users. It is a highly social and cooperative discipline. Boisvert (Boisvert, 1998) makes this point with an example of a community wanting to know if a particular water source provides potable water. Some may want to identify the chemical makeup of the water, others may wish to examine the history of water use by communities, and others may be interested in the religious symbolism or irrigation potential for crops. The point Boisvert makes is that both the context and the material of the inquiry, in this case water, and what Dewey refers to as subject-matters, is

not one-dimensional to be viewed in one correct way. Boisvert explains that subject-matters are “repositories of multiple possibilities, many of which remain latent until the activities of inquirers help bring them out” (Boisvert, 1998, p.37). This further elaborates on the pragmatic formulation of the interaction between an inquirer, subject-matters, and actions. Returning to the example of the museum visit, the multiplicity of possibilities within the inquiry from a design researcher perspective included the questions of the design of play in interaction and content, the role of tangibility in an interface supportive of play and learning, the role of user model and adaptive reasoning in supporting a tangible interface, and the potential of acoustic ecologies and displays. Each is a possible research question that is simultaneously embodied in the situation.

### **3.2.4 Entities-in-interaction**

As one might expect it is a challenging and questionable task to isolate and explain dimensions of pragmatic experience. The qualities of experience are intertwined and thus I’ve already discussed the dynamic interrelationships or entities-in-interaction in explaining multiplicity and concreteness. This is unavoidable. However there is a primacy given to entities-in-interaction in Dewey’s formulation that must be clearly stated. Experience is constituted by the dynamic interaction between entities in the lived world. It neither resides in the person nor in the world but in the interaction between them. Yet the comprehensibility of experience depends on the fully present and interacting inquirer.

Schön’s articulation of reflective practice goes a long way toward manifesting the idea of entities-in-interaction in design and professional practice. Schön sought to dispel the idea that design is an inexplicable black box. Hence, he focused considerable energy on carefully formalizing the actions of doing in design by naming different design actions such as design moves, reframing, backtalk, etc (Schön, 1983). A central concept is that designers

are in constant conversation with materials, and the design artifact's emergent forms. This dialogic model for design exemplifies the notion of entities-in-interaction.

The technique of design games in participatory design (Ehn, 1989) is another example of entities-in-interaction in the formalized practice of design. Theoretically based on Wittgenstein's idea of language games and Heidegger's idea of embodiment, design games are a manifestation of the comprehensibility of design through interaction. Design games incorporate an inter-subjective approach between designers and end-users in which the aim is mutual learning between designers and end-users. As an example, Ehn cites the making of cardboard props of computer and networking equipment and a design game aimed at experimenting with possible configurations of workspace and a new system (Ehn and Kyng, 1991a). Design games adhere to the principle of "design by doing" by allowing users to enact their practical skills while participating in the design process. It is important to point out that the design games target the phenomenological aspects of designing and the embodiment of skills through role-playing and physical re-enactments.

### **3.2.5 Key aspects of interaction design as experience**

Dewey's pragmatism has taken our formulation of interaction design some distance from the traditional empirical approach that is at the heart of an HCI view of interaction design. The traditional approach would call for a reduction of the design phenomenon into hierarchical elements that could be isolated and compared as variables. Additionally, traditional empiricism calls for an "objective" inquirer who minimizes his or her presence within the inquiry. HCI in its various flavours tempers this strict notion of empirical studies yet adheres to the central tenets of an objective viewer and a distant phenomenon. In HCI, understandings of interaction design are further eclipsed by the view that the user is the phenomenon of study; the focus being on the interactions of a user. This leaves a gap in the



understanding of what design of interactive technologies is and how it is performed. Current interaction design theory makes little attempt to explain the field at the epistemological level, avoiding “what is interaction design” questions or simply adopting HCI concepts in place of asking the questions. Where current interaction design theory does weigh in, the theory focuses on how interaction design is performed. Methodological discussions are less clear on their scientific and research value (in the context of HCI) and hence the position of the researcher is ambiguous. However, interaction design methods tend to hold onto the notion of the user as a distant phenomenon and the object of study. As a consequence, whereas HCI focuses on the interaction *of* a user, interaction design methods tend to focus on interactions *with* a user, i.e. how to incorporate the idea of the user into the design process. In contrast, our discussions have led us to an understanding of interaction design in which the experience of design is the phenomenon of study, in which the designer is directly involved in shaping the phenomenon and rendering it meaningful.

What I have been discussing in this chapter is a vastly different formulation for thought and knowing in interaction design. Pragmatism does not separate the phenomenon from the experience but argues that the phenomenon emerges in the form of experience through interaction with an inquirer. As Schön makes clear, the designer shapes the design situation, and Dewey’s pragmatist interacts and resolves experiences through an embodied inquiry. The epistemological assumption underlying this pragmatist view is that experience is concrete and indivisible except as a simultaneous multiplicity of possibilities that can only be known through the interactions and actions of a present inquirer.

From our discussion so far on inquiry and experience in interaction design, I draw the following:

- Pragmatism's formulation of experience (concreteness, multiplicity, and entities-in-interaction) directly informs and illuminates interaction design;
- An interaction designer is an inquirer of the design experience, acting as an active agent in the knowing and comprehensibility of interaction design through an embodied and proactive presence in the inquiry;
- Several departure points in past design thinking exist for a mobilization of pragmatism in interaction design including ethnography, participatory design, and reflective practice.

### **3.3 Interaction design as inquiry**

If we consider interaction design as experience, then instances of interaction design in both practice and research can be seen as inquiries. In a pragmatist view, the differences in actions of interaction design between research and practice are less of a concern since the two approaches are subsumed under the idea of an inquiry. I will focus on three aspects that describe the nature of inquiry in interaction design and the idea that a designer is an inquirer: experimentalism, judgment, and interpretation.

#### **3.3.1 Experimentalism**

Dewey advocated for inquiry as a hands-on interaction with the world in which an inquirer shapes, tests, and explores an experience while simultaneously constructing the experience. In design and in most other human experiences, clear separations or borders between thinking and doing are non-existent. The embodied inquirer simultaneously acts and reflects with the situation as a way of knowing. While Dewey was critical of philosophy aping science in a reductionism of things known, he lauded the acts of knowing in science, namely experimentation. Dewey directly contrasted “experimentalism” with “empiricism,” seeing the latter as outdated and insufficient. Earlier in the discussion on concreteness (see 3.2.1 Concreteness), I cited a passage by Dewey from *Art as Experience*

(Dewey, 1934) to explain the interaction between an inquirer and entities. In the passage, a man lifts a stone and through a series of interactions he explores the properties until a “mutual adaptation” emerges between him and the object thus resolving the experience. At the heart is an experimentalism that rests on embodiment, imagination, and future possibilities.

Dewey’s experimentalism is premised on the embodiment and presence of the experimenter. He argued against the distant observer and the precepts of the disembodied mind or objectivity. Dewey commented on how traditional philosophy was akin to “a spectator viewing a finished painting rather than after that of the artist producing a painting” (Boisvert, 1998, p.37). An inquirer is one who manipulates the subject-matter and introduces changes for intended and unintended effect thus directly participating in the act of knowing. Earlier (see section 3.2.4 Entities-in-interaction), I discussed how Schön’s reflective practice rests on a dialogic relationship between designers and design processes and materials reliant on action and reflection. Reflection-in-action captures the qualities of Dewey’s embodied inquirer exceptionally well:

When someone reflects-in-action, he becomes a researcher in the practice context. He is not dependent on the categories of established theory and technique, but constructs a new theory of the unique case. His inquiry is not limited to a deliberation about means, which depends on a prior agreement about ends. He does not keep means and ends separate, but defines them interactively as he frames a problematic situation. He does not separate thinking from doing, ratiocinating his way to a decision, which he must later convert to action. Because his experimenting is a kind of action, implementation is built into his inquiry (Schön, 1983, p.69).

Evidently influenced by Dewey’s inquirer, Schön’s reflective practitioner “does not separate thinking from doing.” The practitioner experiments in ways that simultaneously integrate reflection, action, and implementation. Further, experimentation is not “limited to a deliberation of means” and so is more independent of predetermined goals; in fact the

experimentation shapes both the process and the goals together into descriptions of the problem from which may emerge a more productive possibility. This strongly echoes Dewey's entities-in-interaction and the premise that the experience is shaped by the inquirer's interaction with the aim of creating possibilities for future good. In more detail, shaping the problem is what Schön refers to as a frame experiment:

When the phenomenon at hand eludes the ordinary categories of knowledge-in-practice, presenting itself as unique or unstable, the practitioner may surface and criticize his initial understanding of the new phenomenon, construct the new description by an on-the-spot experiment... he may construct a new way of setting the problem—a new frame which, in what I shall call a 'frame experiment', he tries to impose on the situation" (Schön, 1983, p.63).

Schön has mobilized Dewey's inquirer into modes of practice like design. As the inquirer engages problematic experiences, the practitioner invokes an inquiring experimentalism with new phenomena or problems in practice. The frame experiment is explicitly the type of shaping of subject-matters expressed by Dewey. Further, the frame experiments are possible descriptions of the problem and outcomes. An inquirer explores and creates multiple and even contradictory experiments as part of the overall inquiry. In this mode of pragmatic inclusivity and multiplicity, such descriptions are simultaneous representations of the situation at hand and elicitation of possible future outcomes. It is imagination that motivates experiments and descriptions of the present problem and future possibilities. Dewey argues that past traditions of philosophy drove a sharp wedge between artists and scientists (Boisvert, 1998). The imaginative constructions of the artists were minimized as fanciful flights of subjectivity. The identity of the scientist as objective stripped him or her of any imaginative capacity. Dewey of course argued that both scientists and artists fuelled their experimental inquiries with imagination. Schön captured this shared approach between

practitioners of art and science in his characterization of “virtual worlds” or experimental spaces for creativity:

The therapist’s use of the transference and the architect’s sketchpad are examples of the variety of virtual worlds on which all the professions are dependent. A sculptor learns to infer from the feel of a maquette in his hand the qualities of a monumental figure will be built from it. Engineers become adept at the uses of scale models, wind tunnels, and computer simulations. In an orchestra rehearsal, conductors experiment with tempo, phrasing, and instrumental balance...Virtual worlds are contexts for experiment within which practitioners can suspend or control some of the everyday impediments to rigorous reflection-in-action. They are representative worlds of practice in the double sense of “practice”. And practice in construction, maintenance, and use of virtual worlds develops the capacity for reflection-in-action which we call artistry” (Schön, 1983, p.162).

The virtual world is an experimental space that is to be understood in its many forms of imaginary constructs including the ephemeral (therapist’s transference), provisional (architect’s sketchpad), and concrete (sculptor’s maquette, engineer’s scale model or a musical rehearsal). These experimental “spaces” allow for imaginary representations of what is and what could be. Schön’s allusion to the double meaning of practice grounds imagination and experimentation in two different ways. Firstly, the more imaginative descriptions are concrete or make the present or future situation experiential, i.e. the experience can be brought into practice more readily. Secondly, imagination is itself a skill that is practiced and increases in ability and quality to the level of “artistry”.

Our discussion so far has focused on the material and procedural nature of design, yet the subject-matters of inquiry include the social. For example, Schön expands on the idea of experimental space in a discussion of role-playing and the exploration of interpersonal situations:

A role-play is an improvised game in which the participants learn to discover properties of an interpersonal situation and to reflect-in-action on their intuitive responses to it. In improvisation, musical or dramatic, participants can conduct on-the-spot experiments in which, as improvisation tends

towards performance, the boundaries between virtual and real worlds may become blurred (Schön, 1983, p.162).

The formulation of social embodiment, improvisation, and experimentalism took on its clearest form in Ehn's description of design games in participatory design (Ehn, 1989). As discussed previously (see 3.2.4 Entities-in-interaction), in design games, imagination underpins the social and embodied inquiry. Imagination drives the inquiry and the need for the social knowledge exchange and collaboration. Imagination answers the exploration of future possibilities as in the design games exploring possible design outcomes. Ehn articulates an embodied participation through social interaction in design that is theoretically based in Wittgenstein's language games. Ehn saw design and other skills as essentially languages. Both design and skills could be bridged in a generative and participatory fashion through the structure of games based on improvisation and role-playing. Ehn extended the idea of language games to include embodied interactions in order to highlight and make explicit the tacit and practice-based knowledge of design and other forms of knowledge embodied in skills and practices. Interaction in the sense of participatory design is mutual learning that is firstly descriptive and ultimately generative. Design games allowed designers and users to enact together activities that imaginatively explored and played with future possibilities. The collaborative and social exchange was cemented by the shared embodiment of the design exploration. This social embodiment allowed users to enact their longstanding practical skills and share these with designers, meanwhile participating in a creative design process. Participatory designers structured design games as an embodied exchange of knowledge, collaborative knowledge creation, and shared experimentation.

A designer as a pragmatic inquirer is at the heart of experimentalism. First and foremost this establishes the active and participatory presence of the designer within the

creation of design and knowledge. The disavowal of the observant spectator for the proactive and hands-on inquirer puts a particular emphasis on the first-hand accounts of experience. In addition, pragmatic experimentalism is not the result of planned experimental design but rather is a consequence of emergent interaction. This type of experimentalism can best be accounted for in ethnographic and auto-ethnographic terms. Ehn provides first-hand descriptions of actions of the systems he helped shape as a designer (Ehn, 1989), and Schön relied heavily on ethnographic vignettes or case stories as a tool to advance his theories (Schön, 1983). Earlier, in section 3.2.1 Concreteness, I discussed ethnography in design and its role in respect to the concreteness of experience. We can know from this that the notion of the designer as an inquirer is well served by ethnographic commitments on the part of the designer, including participant observation, views of the participants, analysis, and reciprocity. Ethnography serves as a tool of inquiry, for example in the realm of social embodiment in participatory design, as well as the critical need to provide transferable accounts of the design experience itself. In many respects, Schön's idea of reflecting back on practice requires the material and the descriptions of design to facilitate the reflections within interaction design, and also requires the communication to fields outside of interaction design.

In summary, experimentalism in interaction design incorporates the following principles:

- Design inquiry requires embodied participation of the designer with matters that are social, material, and procedural;
- Design inquiry involves multiple constructions and representations of present and future possibilities motivated by imagination and experimentation;
- Design inquiry is a first-hand experience that for inquiry and valid accounting requires ethnographic commitments to adequately relate the concreteness and multiplicity of the design experience.

### **3.3.2 Experimental actions of the inquirer**

In our discussions so far I have shown that an inquiring interaction designer simultaneously reflects, acts and implements through experimentation. The experimentation is not a hands-off affair; rather the designer directly shapes the design experience in order to create productive possibilities. I discussed how pragmatism describes embodiment, imagination, and multiple possibilities as intertwined within experimentation and as such form the basis for inquiry in interaction design. The designer has an embodied presence in the inquiry and the design experience is constituted through his or her interactions. The experimentation shapes present and future possibilities emergent in the experience. And lastly, as part of the inquiry, a clear account of the design experience and the role of the designer are given. These accounts of the design experience provide the designer and others with the opportunity to understand and interpret the judgments exercised as part of the inquiry. Central to experimentalism is the back and forth between judgment and interpretation.

The simultaneity of thinking and action in interaction design requires the integration of judgment into the process of inquiry. Judgment in design is integral to the on-the-spot experimentation of inquiry. It is often formative, in the moment of design as well as summative, an evaluation of an outcome. This is not an arbitrary matter but rather ongoing decision-making is one of the mechanisms of inquiry that keeps it progressing and enables it. In returning to Dewey's example of the man and the stone, judgment fuels the experimentation and prods the imagination to attempt one framing and reframing after another.

The actions of the designer in the face of indeterminate situations are to move and shape the situation into a greater and greater determinacy. As Schön states it,



“experimentation is a kind of action, implementation is built into the inquiry” (Schön, 1983, p.69). The connection of means to ends in the immediacy of both comprehension of the situation and action within the situation is an act of judgment and interpretation that is served by what Dewey refers to as “somatic intelligence” (Dewey, 1929b). Somatic intelligence can be understood as *thoughtful manipulation* (Boisvert, 1998). Judgment together with interpretation makes certain that experimentation is not unconsidered or haphazard. The reflective shaping of the interaction designer toward particular outcomes is what moves the situation from multiple possibilities toward a set of actual possibilities.

Löwgren and Stolterman in *Thoughtful Interaction Design* (Löwgren and Stolterman, 2004) emphasize that design is an ethical activity. They argue that interaction designers need to reconcile as best they can their own ideals and values with the design outcomes they produce. It is a designer who motivates knowing in the experience of interaction design and a designer who is responsible for the actions resulting from that knowledge. The experience of interaction design, its concreteness and entities-in-interaction, makes it difficult to avoid the responsibility. Designer inquirers are embodied in the design situation and cannot retreat from the ordinary experience of their design actions. Design is not solely an “intellectual” exercise; it is an embodied and felt experience that does not elude the designer. Participation in the experience through somatic intelligence acknowledges the responsibility and supports the exercising of judgment and interpretation to shape the conditions that bring along with them good and bad consequences. And so careful reflective action is needed to determine which ends should be achieved and which should be discouraged. To paraphrase Boisvert, progress in interaction design “is neither inevitable as the optimist would hold, nor hopeless as would hold the pessimist. A world where possibilities are ever-present is a world in which intelligent

participants have to gauge carefully the consequences of their actions” (Boisvert, 1998, p.25).

Judgments are actions in interaction design; in other words they are design decisions that create representations of possible outcomes, design activities that help reflectively progress the inquiry, provisional and final design outcomes, and evaluations of those outcomes and other judgments. The designer inquirer’s judgment is a response to the pluralism of the situation and is motivated by responsibility and supported by somatic intelligence. However judgments alone cannot address the multiplicity; rather the actions of inquiry are characterized as a back and forth between judgment and interpretation. Multiplicity of the design situation must be negotiated and is therefore critically dependant on interpretation.

In the sciences, formative knowledge is seen as speculative or conjectural at best. Dewey’s pragmatism however makes no such commitment to absolute knowing, and rests on the understandings that we act without certitude and that knowing wrestles with the fullness of the lived world that is temporal and changing. Critical understanding of experience is an ongoing opening of that fullness. This does not mean that claims of knowing go untested, rather pragmatic inquiries are subject to the test of the concrete experience from which they are derived and are also subject to the remit that the claims hold value or afford possibilities over time. In experimentation, interpretations carry out this evaluation and shaping of the claims, especially in understanding the development and existence of interactive artifacts and systems.

In design, this call for constant reflection and analysis of conditions on the part of the designer has multiple dimensions. These include the different perspectives of the designer inquirer, design team members, and views of stakeholders in the design situation.

Additionally there is a temporal dimension that interprets results summatively as findings and seeks ongoing interpretations over time through criticism

### **3.4 Theoretical framework**

In Chapter 1 (see 1.2 Role of theory in interaction design), I discussed the role of theory in interaction design. I concluded that theory that served interaction design would ideally describe critical concepts, principles and definitions, and provide an explanation of the relationships, actions, actors and processes within interaction design. The theory would facilitate new forms of practice, creativity, and discoveries with a prospective orientation grounded in the practice of making that leads to an understanding of future possibilities. And the theory would guide interaction designers in determining the value of each possibility. The novelty of this type of theory is in the acknowledgment of the practice of design and the role of the designer. I have to this point discussed at length the philosophical framework of pragmatism for interaction design. The further uniqueness of the theory is in its details. This section is devoted to articulation of a pragmatist view of interaction design in a mobilized form that supports the putting into action the views discussed. And by doing so, articulating and uncovering the details that make the theory unique to interaction design.

The vehicle for this is a theoretical framework that shapes the discussions above into a more explicit form. The framework is comprised of three components: 1) experience view; 2) design inquiry; 3) actions. The experience view is the setting out of core concepts and definitions shaped by the culmination of design inquiries. The design inquiry addresses the design experience or a given design situation. Actions express the design acts within each inquiry that results in an interaction design artifact(s) or system.

### 3.4.1 Experience view

The experience view describes epistemological assumptions and the basic thinking underlying interaction design. The aim is to define concepts that are core to interaction design. The experience view is a high level understanding of the field that frames reflection on disciplinary concepts and definitions and generates meta-level or epistemological accounts of experiences of interaction design, i.e. what lies within and without our understanding of the field. In many respects this is the philosophical view of the field, in and of itself it is not very helpful for inquiring about particular design situations or design practice, but without it we would lack the theoretical foundation and tools to best understand interaction design and have principles by which we validate and interpret the newness of knowledge created and the success of our activities.

Here we find two overarching concepts. The first is that interaction design is understood as experience. In this chapter, I have discussed the match between interaction design and the pragmatist formulation of experience. The experience of interaction design can be articulated by the dimensions of concreteness, multiplicity, and entities-in-interaction:

- *Concreteness*: experience is as it can be described, without some other purpose or meaning. There is no single priority within an experience and as such it does not readily give over to a single problem to be solved nor is it easily viewed as a whole reducible to salient factors. Concreteness describes experience as contradictory, irrefutably present and accessible, yet contingent and open to not knowing.
- *Multiplicity*: experience is inexhaustible, being saturated with intellect, memory, affect, somatic awareness, and history, yet there is an “inclusive integrity” to an experience that can be rendered explicit by inquiry. Experience as such is a repository of multiple possibilities to be drawn out by an inquirer.

- *Entities-in-interaction*: experience is constituted by the dynamic interaction between entities in the lived world. It neither resides in the person nor in the world but in the interaction between them. The comprehensibility of experience is reliant on inquiry.

The second concept is that an interaction designer is an inquirer of that experience.

These two concepts, interaction design as experience, and an interaction designer as inquirer, are interdependent. The attributes of experience rely on an inquirer for comprehensibility and imagination to uncover its possibilities. This is explicit in the idea of entities-in-interaction. In a sense, an interaction designer as inquirer constructs the experience of design and therefore cannot be separated from the experience. Key attributes to an interaction design inquirer are embodiment and proactiveness:

- *Embodiment*: design experience is both constituted by the interactions of the designer and the world, and is simultaneously rendered comprehensible by the inquiring interactions of a designer. Experience and inquiry is felt, somatic, and interactive. Given this, a designer is not a distant observer in design experience but rather is an embodied presence in both the experience and the inquiry.
- *Proactiveness*: an interaction designer actively shapes the experience to imaginatively render the multiple possibilities latent in the experience.

Each part of the framework holds a distinct set of outcomes, some of which are theoretical and others practical yet all satisfy a theoretical need. The experience view is in essence epistemological, and so outcomes are theoretically reflexive on the core thinking underlying the theory and field. The outcomes are:

- *Theoretical reflections* on the experience of interaction design, including critical inquiry of design experience, the nature of design inquiry, and methodological discussion of design actions.

- *Descriptive accounts* of what constitutes interaction design as a measure of the borderlines of the field.

This outlines a level of the theory for researchers and practitioners to address and discuss aspects of what constitutes the field of interaction design.

### **3.4.2 Design inquiry**

The next component of the framework is the design inquiry. This part addresses design inquiries of a given design experience. For example, individual design projects can be considered inquiries. This allows us to better understand the research and knowledge contributions of individual projects and is one part of the framework that articulates how interaction design is conducted at the project level.

At the centre of interaction design as inquiry is the idea of experimentalism. As discussed earlier in this chapter (see 3.3.1 Experimentalism), the practitioner invokes an inquiring experimentalism with new phenomena in practice. Design inquiry is a hands-on interaction with the world in which the designer shapes, tests, and explores an experience. Simultaneously, the designer constructs the experience as a result of the experimentation and as such, the designer simultaneously acts and reflects with the situation as a way of knowing. Earlier in the discussion on concreteness (see 3.2.1 Concreteness), I referred to design inquiry as a “mutual adaptation” between the designer and entities in the world as a means to resolving the experience.

Experimentalism in interaction design requires embodiment, imagination, and future possibilities. These are manifest in what I call the outcomes or products of inquiry. The embodiment of the inquirer, i.e. who is the inquirer, shapes the inquiry. The designer

inquirer's imagination and prospective thinking brings intention, motivation, and ultimately a rationale for the unfolding of the inquiry. These aspects animate the inquiry:

- *Designer inquirer*: who is (are) the inquirer(s)? What past experience is relevant to the particular inquiry?
- *Designer intentions*: explicit statement of the intent or intents of the inquirer with respect to the design inquiry. How will the shaping of the experience be guided and what are imagined outcomes?
- *Design rationale*: explicit reflection on the whys and hows of the inquiry. Rationales support the designers' intentions.

At the conclusion of the section in this chapter discussing experimentation (see 3.3.1 Experimentalism) I discussed how the experimentalism, which is first-hand, can be accounted for through ethnographic and self-reflective approaches. Explicit accounts of what transpires over the course of the inquiry provided valuable communication of design knowledge through action and open the process to critique and validation.

### **3.4.3 Actions**

Actions describe the acts and outcomes of interaction design. In a sense, actions describe the practice level of design, the detailed acts and actual outcomes, yet it should be viewed in light of the overall framework. The results of decision-making and the actualities of design become visible. Actions are defined by the key concepts of judgment and interpretation, and the recurring need for accounting of the process and outcomes.

Two concepts determine the interaction design actions, judgment and interpretation. As discussed earlier in the chapter (see 3.3.2 ), judgment in interaction design is integral with the on-the-spot experimentation of inquiry. Judgment comes in two forms, formative in the moment of design actions as well as summative in the evaluation of outcomes. This ongoing decision-making and constant judgment is the mechanism that keeps the inquiry

progressing, enabling it. The second concept is interpretation. The multiplicity of the inquiry is irreducible. This requires that the pluralism of the situation be negotiated and interpreted. In design, this calls for the constant reflection and analysis of conditions on the part of the designers and critics.

The actions and outcomes are bound within each of the two concepts. In the case of judgment, the products of judgment range from representation of design decisions to results. They include:

- *Representations*: externalizations of design decisions and imagined possibilities such as sketches, storyboards, scenarios, models, and prototypes;
- *Activities*: externalizations of processes to aid or model design judgment like workshops, role-playing, and design games;
- *Models, artifacts, and systems*: results of judgment and design actions that are final products;
- *Evaluations*: range of formative and summative evaluations from expert reviews, informal evaluations to formalized user testing.

In the case of interpretation, this concept is manifest in engagement with end-users and stakeholders, findings, and criticisms:

- *Stakeholder views*: formative engagement in design through co-designing or assessment in for example, participatory design workshops or user-centered focus groups;
- *Findings*: formative and summative conclusions based on interpretations of actions and results of evaluations;
- *Criticism*: formative and ongoing critique of design decisions and outcomes during the design process in the form of critiques to ongoing formal criticism from external critics.

Similar to the ethnographic and other accounts of process, in the design inquiry, the actions require a similar descriptive documentation of the process. Explicit accounts of



what transpires over the course of the inquiry provided valuable communication of design knowledge through action and open the process to critique and validation.

#### **3.4.4 The framework**

In Figure 4, the holistic nature of the framework is evident. The framework is a set of integral concepts (see Figure 4). The experience view encompasses all parts of the framework. It can be seen as a result of a limitless numbers of design inquiries, with each inquiry made up of actions.

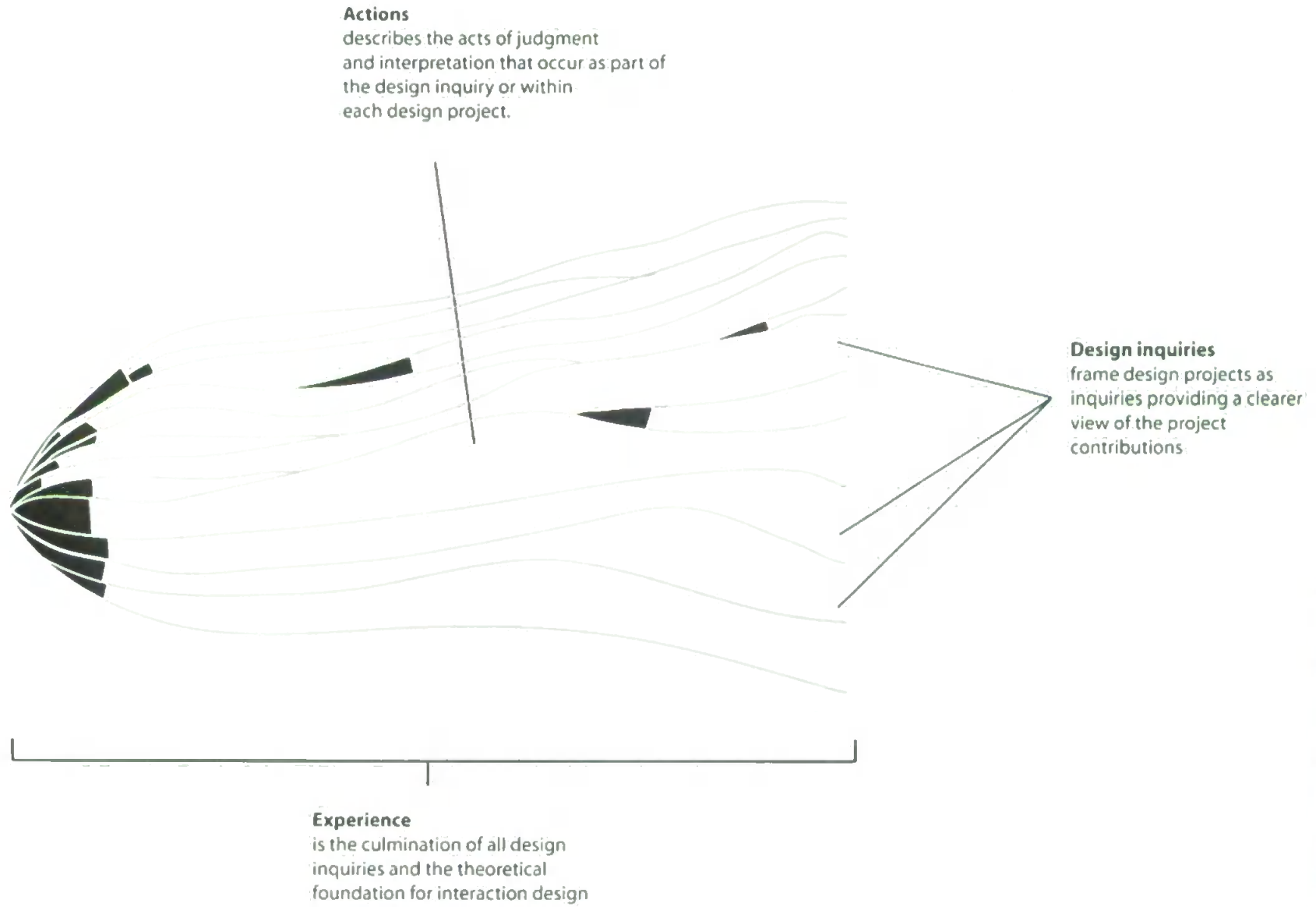


Figure 4 The complete framework

### 3.5 Reflexive account of the framework

So far in this chapter I have discussed the philosophical ideas of pragmatism as a basis for a theory of interaction design. I arrived at a formal framework intended to represent the theoretical dimensions and possibilities of a pragmatist view. The framework, as described in detail in the preceding section, includes experience, inquiry and actions. This formal articulation is a scaffold that uses pragmatist concepts of concreteness, designer as inquirer, multiplicity, and entities-in-interaction as supporting structures for illuminating the practice of interaction design. The framework is not an end in itself but a supporting structure for engaging interaction design theoretically. What is proposed is only a starting point that will and should be subject to revisions, changes and ongoing rethinking.

This chapter has been structured to provide a rational argument for the pragmatist theoretical position on interaction design. While this type of account provides the intellectual argumentation and logic for the move to pragmatism – it may appear top-down and dispassionate in its reasoning. The descriptive strengths of the rational account are that it provides the intellectual connections and details from a broad viewpoint. However, this account alone misses the deeper and felt understanding that motivated the evolution of thinking that led to me to a pragmatist position. Additionally, an exclusively rational account is at odds with the experiential and practice orientation of design. And so I turn now to a reflexive account of the felt experience that led to a pragmatist understanding and accounts for my own deeper motivations and ownership behind the theory proposed in this dissertation.

The pragmatist idea of knowing through an inquiry of experience holds a strong appeal to me as a designer, whether the understanding is formalized or intuited. The

understanding that ‘practice’ is a form of knowing of the world is very powerful. By practice, I mean the understanding that emerges from continual and accrued experiences of making whether in design, visual arts, or other fields of creative practice. I came to see that my understanding of practice is almost synonymous with the idea of ‘pragmatist experience’ in its fullest sense. I will discuss this in more detail later on. Suffice to say that practice is knowledge about making informed by constant acts of doing that are embodied, hands-on, and interactive. Practice, as such, is central to design however my own understanding of practice and the experience of making began with painting. My own career path to interaction design was through visual arts and painting.

I found that in painting, the sense of practice emerges through interactions with materials, the navigation of innumerable possibilities through decision-making, the cultivation of chance to work in your favour, the ongoing self and external critiques of analysis, and the pure pleasure of taking risks for unknown but novel rewards.

Practitioners, like painters hone their practice in making through constant experimentation and risk-taking, acquiring new skills and tempering all of this through the assessment of interpretation and the cumulative evolution of judgment. Practice holds a richness and depth that speaks to the complexity of making things. The experience of practice, where knowledge is simultaneously enacted and produced is bound in complexities that are often felt if not articulated well. Rationalized reflections tend to be disembodied and logical whereas practice is embodied and realizations emerge from interaction rather than deduced by intellectual reasoning alone.

Simply put, it is not possible to understand the practice of painting without having experienced painting. Additionally, the experience extends over time and deepens with the accrual of months, years, and decades of painting that includes ongoing reflections on

painting whether that is thinking about painting, or discussing and critiquing painting with others. The language and awareness of the practice or experience of painting is intrinsic to the act of painting. There are no external rules that govern how to paint nor is there an external language by which painters talk about painting. In my view, the language of reflection for painting is organic and has many variants but this does not mean it lacks coherency. Its coherency arises from constant referencing back to act of painting.

Other painters and I shared and resolved issues about painting by talking about our experiences. These experiences ranged from the smallest things like the feel and “painterly effect” of particular colours from certain brands or the mixing of our own paint, to grander issues around what to paint, to philosophical questions about why paint at all. The language and descriptive examples used in discussions with other painters were “calibrated” by constantly referencing practice and experiences of painting to the point of optimal sharing of ideas. That is our organic language was supported by concrete experiences that were like scaffolds that shaped the terms and referents we used. Sure enough our own instances of painting were unique, yet there was enough commonality that transferred knowledge and shared understandings readily occurred.

Studio critiques in painting are a good example of the need for constant reference to the acts of painting in creating a shared sense of practice. Studio critiques involve critical discussions, typically between painters, in a painter’s studio. Ostensibly, studio critiques are the easiest way to see a collection of paintings without having to wait for a gallery exhibition. There are however, many more substantial benefits to critiques in a studio that are relevant to our discussion. The studio contains an “archaeological” record of the decisions, experiments, risks and failures that go into a final collection of paintings. The studio is often full of process artifacts like sketches, in-progress works, experiments, and

“failed” works that openly deconstructs the decision-making and judgement process. These artifacts serve as examples and support the “calibration” of language I discussed earlier, and ultimately support the critical dialogue of the critique. For example, a painter can readily demonstrate a failed exploration in a sketch, or as a result of a critique possible alternative paths to the decision taken can emerge. The “archaeological map” of practice in most studios contains invaluable knowledge and wisdom of making.

One compelling personal example that informed my practice as a painter deeply was time I spent living in the studio of the well-known German painter, Gerhard Richter, with whom I was studying under in my senior undergraduate year. At the time I was moving between cities in Germany and Richter graciously offered his guest room in his studio. The time I spent immersed in the artifacts and history of his practice was more illuminating to me than any text on his work or single discussion we had outside of the studio. Additionally, the studio visit offers insights into the technical set-up of a painter’s work space that adds to ones practice and one’s own studio set-up. This was very true of my time in Richter’s studio. Lastly, the studio visit allows for ready enactments and re-enactments of the actions of painting. Live demonstrations and shared experiments can take place during studio visits in which the language of practice becomes explicitly embodied.

Through being a painter I saw that painting practice binds a complex array and range of entities that are experienced as a whole synthesized in the actions of painting. Practice in this sense resonates strongly with the notion of pragmatist experience. Practice both manifests and creates knowledge about painting – what painting is and how one paints become blurred in the singular experience of practice much like the intrinsic connection between means and ends in pragmatism. Reflections on practice in painting is not reducible to language or reductivist thinking, it relies on organic, agreed upon, and embodied

communication that references the concreteness of acts in order to achieve coherency and shared meaning. The embodied practice of painting and its importance to the development of one's own painting practice is evident in the studio critique in which among other valuable insights, painters can negotiate an archaeological map of practice that spurs on and facilitates a reflective understanding.

Some may argue that the practice of painting is not exclusively an internally negotiated dialogue rather there is shared understandings in the form of techniques and methods. For example, methods exist for encaustic painting or other painting media like oil and acrylics, and techniques exist for stretching and preparing canvases. Of course painters restlessly experiment with and try to innovate with the most accepted approaches yet the basic principles behind the techniques and methods remain. And so some might argue that the practice of painting is well represented in the collection of known methods and techniques. Another case can be made that the works of art stand outside of process and are an ultimate class of artifacts that best represents practice. The argument is that the value and knowledge of practice is embedded, manifest in the final artworks. These arguments are quite credible but alone they do not represent a whole picture of practice.

In many respects the same arguments play out in design. For example, in design, the final object holds sway over any discussions of the reasons and descriptions of how the object came into being in the first place. The professional critics, especially in architecture and industrial design, similar to art criticism, give untethered attention to the design object. With respect to methods, interaction design methods and techniques hold the promise of a rationalized descriptions of practice that are testable and open to optimization. Other articulations of practice are seen as black box or subjective descriptions with little rational merit. I raise these issues not to question the importance of critical interpretation of made

objects or the value of accepted methods but rather to point out that these are only two dimensions to practice that on their own are insufficient for understanding practice.

Another dimension brings a fuller picture, what I've been discussing as my felt experience of practice as a painter and designer. That is the knowledge about making and knowledge about how to make, informed by constant acts of doing that are embodied, hands-on, and interactive.

Despite the differences in making between painting and interaction design my own transition from an artist to an interaction designer was nearly seamless. The ease in shifting from one discipline to another came from the deep familiarity with an embodied and complex practice with the making of things. In a sense, there is a shared understanding of making things and an ethos of inquiring of the world through creativity that binds these practices together. There is clear value in reflecting on the object, methods, and techniques that result from or inform practice. Yet a more complete and powerful picture is formed when the embodied language of process is given form and incorporated into theoretical awareness. As a practitioner, I've always felt that the combined dimensions of practice has a value that goes beyond improving how we make things to creating deep knowledge about how we make things that in turn reflects on how we make the world around us.

Carrying forward my experience of practice as a painter was as I've been saying critically important. There are obvious differences between painting and design that include the symbolic realm of painting versus the utilitarianism of design. The utility of design brings with it constraints, clients, reliability, safety, the immediacy and ubiquity of impacts, collaboration, and industrial scale production. Ironically, while painting distills the embodied and enacted practice more clearly, the necessity to give this communicable form and mobilize it theoretically as part of the field of design is greater. Painting practice is



invariably a single author practice in which the proprietary nature of how one paints is critical to maintaining a painter's originality – critical marker of a successful career in painting. Interaction design on the other hand, is typically collaborative and interdisciplinary and so cannot afford the same degree of proprietary culture. In fact, the potential immediacy, ubiquity, and scale of the impact of interaction design creates some urgency in fully articulating interaction design practice on a theoretical level. I devoted Chapter 2 of the dissertation to make this point. My own sense of theoretical direction for interaction design is to illuminate the experience of the designer, articulated in terms that can build a wider and more transparent view of design grounded in practice.

And so, pragmatism, which up until now has largely been intuited rather than supported by a stated philosophical position helps to ground my own experience of practice with an intellectual coherency that acknowledges the felt and embodied dimensions of process and practice. The framework introduced in this chapter is a disambiguation of the felt experience into a language that aims to resonate with an experiential view of the practice of interaction design. The framework reflects the holistic idea of practice in describing it as a continuum from the smallest scale of actions and judgment of actions that animates the overall design project as an inquiry. On a higher level, practice is viewed as an ongoing series of inquiries that in the pragmatist sense encapsulates the experience of interaction design. The idea of the framework began with the idea of representing the archaeological map of practice and to motivate an interpretive inquiry through critical reflection that may uncover a language of interaction design embodied within practice.

### **3.6 Summary**

This chapter is pivotal in the dissertation and covered extensive ground, so it merits a brief summary. The chapter introduced Dewey's pragmatism. I showed that there are

pragmatist threads in previous design theories, which led to discussing how pragmatism is relevant to interaction design. I explained how pragmatism's notion of experience relates to existing descriptions of design like "wicked problems" and "design situations". This demonstrated the productive potential of viewing interaction design as a pragmatist experience. The chapter followed with a detailed description of important pragmatist terms and how they could relate to interaction design. These include concreteness, designer as inquirer, multiplicity, and entities-in-interaction. The pragmatist approach to knowing is through an inquiry of experience. This frames the practice of interaction design to be an inquiry. An inquiry in design is constituted by experimentalism and interaction designer actions of judgment and interpretation. As a result, I propose a theoretical framework to mobilize the theory discussed in the chapter. The framework is comprised of integral components of experience, inquiry and actions. In concluding the chapter, I offer a reflexive account of how I arrived at a pragmatist position as an interaction designer. This chapter introduced the philosophical basis for the theory, analysed its applicability to interaction design, and concluded with a theoretical framework intended to mobilize the theoretical conclusions.

## CHAPTER 4: PART ONE: TWO INTERACTION DESIGN INQUIRIES

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In the next two chapters I apply the theoretical framework introduced in Chapter 3 to two interaction design research projects. The aim is to firstly show how the theory provides clear and useful descriptions of the design projects. These descriptions aim to make sense of the design experience, and to reveal the dynamics and critical relationships among the aspects or entities of the inquiries. The theory also reveals how findings or knowledge establishes immediate and prospective insights into the design process that are specific to the particular inquiry thus mobilizing it and progressing it forward. Simultaneously, the theory uncovers findings in the traditional sense that can be generalized across the field and into other domains (I explore this further in Chapter 6). In summary, the theory provides a framework and a vehicle for understanding the research value in interaction design.

The first design inquiry is known as ec(h)o, an ambient intelligent museum guide. The prototype is an integrated audio, vision and location tracking system installed as an augmentation of an existing exhibition installation. ec(h)o is designed to create a museum experience that consists of a physical installation and an interactive layer of three-dimensional soundscapes physically mapped to museum displays and the exhibition

installation. Through a tangible interface that is a wooden cube, the visitor can interact with a single artifact or multiple artifacts in order to listen to related audio information. The audio delivery is dynamic and generated by agent-assisted searches inferred by past interactions, histories and individual interests. The prototype was installed and tested at the Canadian Museum of Nature in Ottawa.

The second interaction design inquiry is known as socio-ec(h)o. In socio-ec(h)o we explored the design of sensing and display, user modelling, and interaction in an embedded interaction system utilizing a game structure. The prototype involves interaction of multiple participants (four at one time) in a cooperative puzzle game that is solved by coordinated physical actions of the group. The environment is responsive to the participants' actions through ambient audio and light. Both design projects discussed are research-oriented yet they each hold specified design and system goals allowing them to be illustrative of both design research and practice.

It is important to note that the accounts of the design projects are self-reflexive. The designer-centric premise of the theory makes reliance on a self-reflexive designer both inevitable and vital. The inquiry data or what Dewey refers to as the subject matter is primarily a result of first person accounts of the projects. I am the design inquirer in each project since it is my making of the experiences that established each as a design inquiry. Accountability or what Dewey refers to as responsibility, is critical to understanding value and knowledge generation in interaction design, in other words it does matter who is designing. And so in collaborative efforts, design and research teams typically have a lead. This leading role is where accountability lies and it is this role that is understood as the designer inquirer. Having said that, the subject matter of the experience is externalized at almost every step. In other words, the embodied and proactive shaping of the design inquiry

continually generates externalized outcomes like written reports, published accounts, activity descriptions, scenarios, prototypes, evaluations etc. It is this externalized “data” or subject matter that is more than not reflectively classified and made sense of through use of the theory. In addition, these outcomes are collaborative efforts and so incorporate the perspectives of other design team members through design actions.

Chapters 4 and 5 describe and analyze ec(h)o and socio-ec(h)o interaction design inquiries according to the theoretical framework. This chapter is part one. It discusses the importance and role of the design inquiry in the theory through the examples of the two projects. The chapter continues with a detailed description of the actions of ec(h)o based on the theory. Chapter 5 is part two. It begins with a detailed description of the actions of the second project, socio-ec(h)o. The chapter then analyzes the two projects as an overall experience within the experience view.

#### **4.1 The design inquiries of ec(h)o and socio-ec(h)o**

In this chapter I firstly examined the projects as design inquiries. An interaction design inquiry is constituted in the knowing of or assurance that four questions can be reasonably answered: what is the inquiry, who is the designer inquirer, what are the designer intentions, and what are the design rationales? The first question of what is the inquiry is a result of answering the latter three. A design project comes into existence when designers decide that he or she can in fact constructively shape an experience through a design inquiry. This decision may be arrived at after much exploration, faltering, and false starts. Essentially, the designer is looking to be satisfied that there is traction for his or her design experimentalism and that he or she is ultimately convinced of the potential for positive outcomes. The theoretical framework helps define when such a point is reached and what therefore constitutes a design inquiry.

The point when a designer constitutes a design inquiry is when he or she is satisfied with the level of awareness, articulation or possibility of the four aspects of the inquiry. This decision occurs at the outset of the design experience when much of the understanding is prospective. The inquiry is extant throughout the process so it is not a matter of strict sequencing. For example, I will describe the inquiry retrospectively with a level of completeness that was simply not possible at the beginning of the project. The design inquiry is fully operational at the formative stage when it is speculative (nothing is yet designed or created) but able to be articulated as a prospective outcome. It continues to be refined throughout the life of the experience and rests in a summative account at the end.

The theoretical value of describing and analyzing interaction design at the inquiry level is to describe what constitutes an interaction design inquiry. A design inquiry must have a designer inquirer, designer intentions, and design rationales that together answer the question of what is the design inquiry. In addition, the theory helps to understand the relative quality of the inquiry by revealing the integrity of the relationships between the designer, the intentions, and the rationales.

#### **4.1.1 Designer inquirer**

In both projects, I am the designer inquirer. In my own design history, I've had many past engagements with museums and interactive technologies. I first worked with museums as an interactive artist. Educated as a painter and a visual artist I incorporated computer technology in artistic collaborations with other artists through an online art web site I co-developed in 1999 known as Stadium ([www.stadiumweb.com](http://www.stadiumweb.com)). The projects ranged from revisionary investigations of conceptual art in light of computer technologies, to rich media productions, and telematic installations. In addition to Stadium, I collaborated with a range of museums in design and art projects as part of a digital design company I

founded named oo-design. My interests in interactive technologies shifted from art practice to design, when I became more interested in interactivity over expression. As a designer the project clients widened beyond art museums to private and public sector clients. In addition, I was a member of the digital design faculty at Parsons School of Design and later the Technical University of British Columbia and lastly Simon Fraser University. My decision to become an academic was led by the goal of exploring interaction design from research perspectives. In my view, research offered a platform for design-focused investigations of new technologies and the exploration of how interactive technologies challenged existing ideas of design.

I recount these experiences to help illustrate how my view of interaction design research is shaped by my previous experiences in interactive arts, visual arts, and academic research. I see at least three distinct tendencies that frame my role as a designer inquirer:

- *Focus*: In research projects I tend to focus on goals or outcomes that have social and cultural affects. For example, an early research project known as re-gossip investigated how a social network text-based game on mobile phones could explore mobile communities and sociality through text-messaging (Wakkary et al., 2001b , Wakkary et al., 2001a). We found that designing with the mechanics of gossip in mind was more compelling than investigating principles of user-interface design for mobile screens.
- *Experimentalism*: In a prosaic sense or in the pragmatist sense, experimentalism is a familiar concept to those with visual arts training. The practice of art making requires hands-on exploration that often progresses through impromptu and chance experimentations. An evolved sense-making involving material, procedural, and intellectual play is critical to the success of a visual artist. In many instances the aim is to have as much breadth and risk-taking as possible in order to expand the exploratory and imaginative space for artistic investigations. In this sense, while inquiry and research can become exploratory and risky a background in visual arts provides a great degree of comfort with

experimentation, and also provides the abilities to leverage ambiguity and chance into imaginative possibilities.

- *Epistemological concerns:* Art-making is often seen to be insular and self-referential. Questions in art practice can reflect back on what constitutes art rather than how life is constituted through art. This focus on epistemological concerns, (what is art and how do we know it is art) was a dominant concern during my training as an artist<sup>1</sup>. The practice was focused inward in an epistemological quest of what constitutes art. This has the many drawbacks of being an insular practice yet the ongoing self-questioning and boundary testing becomes a strong self-reflexive mechanism of inquiry: a mode of investigation that challenges assumptions.

Regardless of the strengths and weaknesses of these tendencies of mine; in my role as the designer inquirer they strongly influence the design inquiry.

Each project required a collaborative and interdisciplinary approach. In ec(h)o, the team included Dr. Marek Hatala, a faculty colleague who led the user model and information retrieval aspects of the project. Dr. Hatala's background is in computer science with a research focus in artificial intelligence and user models. Dr. Hatala has a record of applied research projects from learning systems for online systems to design support systems in manufacturing. Additionally, Kenneth Newby, who led the dynamic audio display efforts in ec(h)o, is an electro-acoustic composer whose art practice focus includes live electronic performances and interactive installations. Graduate and undergraduate students from Simon Fraser University worked on the project as paid research assistants in a range of roles. For example, Dale Evernden studied as an interaction designer and was completing his Bachelors degree and later enrolled in a Masters degree during the course of

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<sup>1</sup> For example during my education and early career in visual arts my work was influenced by conceptual art that philosophically challenged assumptions of forms of art-making while simultaneously challenging the known boundaries of its own art strategies. My own short career was involved in post-conceptual art of the 1990s that challenged the systemic structures of art such as financial exchange and institutional rules and supports.



the project. He then went on to a career position as an interaction designer with Business Objects and later SAP.

The collaborations in socio-ec(h)o built on the team involved in ec(h)o, including Dr. Marek Hatala once again, who again led the user model and information retrieval aspects of the project. Two additional post-graduate and faculty researchers were involved in the first half of the project. These included Dr. Alissa Antle, whose background is in design production and design research. Her interest in the project was to transition into design research from the new media industry where she worked with the Canadian Broadcasting Corporation and other new media companies. Another faculty researcher involved was Jim Bizzocchi, a faculty member whose background is in game studies and interactive narrative. Kenneth Newby contributed during the early stages of the project with the audio display. As with ec(h)o, graduate students from Simon Fraser University worked on the project as paid research assistants and for their theses work. These include Dale Evernden, again in the role of interaction designer, and Milena Droumeva, who did substantial work on the audio display. This work contributed to Droumeva's Masters thesis on design process in the development of audio displays (Droumeva, 2007). Ying Jiang's contributions were part of her thesis in strategies for group user modelling (Jiang, 2008).

A main criterion at the design inquiry is to establish the designer inquirer and others who contribute to the inquiry. It is important to articulate the background and overall profile of the designer inquirer since the design inquiry rests on this person. The designer inquirer is the crucible that forms and filters design intentions, rationales, judgments and interpretations. While accounts and findings of the design process are strongest when verifiable, it is clear that the uniqueness, experiences and background of the design inquirer

by no small measure affect the interaction design inquiry. In short, who is designing does matter.

#### **4.1.2 Design intentions and rationales**

The design inquiry asserts the embodied presence of the designer inquirer. The presence of the inquirer is established through making explicit the design intentions and establishing strong rationales for a design inquiry. The triadic formulation of designer, designer intentions, and design rationales serves the basis of any interaction design inquiry.

##### **4.1.2.1 Designer intentions in ec(h)o**

The main components of the inquiry are prospective and speculative. This is most clear with designer intentions. In the case of ec(h)o, the design intentions generally fit within two concerns, the museum context and user experience. The articulation of these intentions emerged through discussions, team reports, publications, and a design specification document. Later in this account we will see how the intentions directed actions within the inquiry. Table 1 catalogues the design intentions that helped form the interaction design inquiry. This table and related tables provide the source or sources for each accounted item. The sources range from publications, documents, videos, and artifacts to events.

ID	Intention	Sources
e-11	Describe the museum in design terms that related as best as possible the full complexity of the context.	M&W 2005
e-12	Aim to integrate as best as possible our design within the ecology of the particular museum	M&W 2005
e-13	Limit our design intervention as best as possible with respect to the ecology and leverage existing routines and actions	M&W 2005
e-14	Maintain a standard level of museum guide functionality without a GUI	UMUAI 2005, DIS 2006, PUCJ 2007
e-15	Create a design in which play is equal to functionality	DIS 2006, PUCJ 2007
e-16	Create a liminal space through the design of the system	DIS 2006, PUCJ 2007

**Table 1 Designer intentions in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

The first set of three intentions aims at understanding the museum context in which the design intervention takes place. Firstly, there is the aim e-11, to describe in design terms the full complexity of the particular museum space. The museum environment was seen as a complex space in which multiple layers of curatorial, institutional, exhibit design, and visitor decisions among others interacted with each other to create the museum visit. This is an important view to articulate in order to situate the resulting design. We came to understand these interactions as ecological relationships. Secondly, an aim was to understand or assess to what degree our design could best integrate within the ecology of the museum exhibit, e-12. Thirdly, in e-13 we felt that limiting our intervention in the context of the existing ecology to be the best approach to integration. Together with limiting our intervention we looked to leverage existing and known actions of visitors along and to integrate with existing and known resources within the museum.

The second set of three intentions is focused on situating user experience within the museum setting. The two sets of intentions interrelate so it follows that user experience intentions are conditioned by the museum context intentions. The first of these intentions aims, e-14, is to maintain a minimum degree of standard museum guide functionality without a graphical user interface (GUI). The premise for this intention is that a GUI as

typically found in a personal digital assistant (PDA) adds an additional layer of design complexity that does not integrate well with the ecology of museums. A second user experience intention is e-I5, in which play can be considered equally with functionality in the design of a museum guide. This aim arose from our preliminary research into theories of ecologies (see 4.1.2.3 Design rationales in ec(h)o) and observations from our ethnographic studies of the museum exhibit and organization (see 4.2 The actions of ec(h)o). In both instances we found play to be a desired outcome that is equal if not greater to the idea of efficient information retrieval. The third intention is a variant on the second. We looked to create a liminal space, i.e. a space for play through our design in e-I6.

#### **4.1.2.2 Designer intentions in socio-ec(h)o**

The intentions in socio-ec(h)o were influenced directly by the ec(h)o project. We aimed to build upon aspects of the previous project that were seen as successful such as the design approach or the findings in dimensions of play. Additional aims were to further investigate in socio-ec(h)o physicality and the role of play in learning, and to address under-explored or areas of challenge in ec(h)o such as sociality and group interaction. The resulting designer intentions are catalogued in Table 2.

ID	Designer Intentions	Sources
sc-I1	Embodied cognition	DIGRA2005
sc-I2	Learning and play	MM2005, TEI2008
sc-I3	Role of physical play and game structures in support of groups in responsive environments	MM2005, TEI2008
sc-I4	Simplicity and off-loading	TEI2008, ICAD2006
sc-I5	Participatory workshop approach	ICAD2006, ICAD2008
sc-I6	Group user models	TEI2008

**Table 2 Designer intentions in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

The design intentions in socio-ec(h)o address the aims of an interactive system and the question of how to design such a system. With respect to the interactive system, embodied cognition (sc-I1) was a critical concern. We felt that in our design, a satisfying experience would rely on a tightly coupled system emerging from real-time, goal-directed interactions between participants themselves, and between participants and the responsive environment. While not knowing exactly how this might manifest, we believed that the physical interaction through movement in space and play with the tangible object in ec(h)o, coupled with the social interaction, would and should be part of our design. We also drew upon the connection between physical play and exploring the museum in ec(h)o that we saw emerge. The aim was to support learning together with play, se-I2, in the interaction such that they became mutually motivating factors in engaging our design. The combined aims of embodied cognition, play and learning led to a related but more detailed aim of exploring the role of physical play and game structures in group in responsive environments, se-I3. Physical play and game structures could be pursued independently but from the beginning we viewed these as integral to each other. In large part, game structures provide a formalized approach to interaction that is appealing to an interaction designer.

The remaining intentions in socio-ec(h)o concentrate on how to design a responsive and physical play system. Whatever the system might be it is clear that it could entail a

great degree of complexity in areas like sensing, reasoning and interaction models. In response, we set out to keep our approach simple and to “off-load” computation, se-I4, wherever possible. The aims were to find the balance between specifying interaction and system functionality and what should not be specified, and to off-load formalized interaction among participants to the situated dynamics of people mundanely interacting, i.e. people will communicate together in whatever form possible given the computational and non-computational resources in the environment. Additionally, an intent was to rely strongly on workshops, se-I5, that explore, guide and develop the system, thus allowing us to continually iterate the system as a whole. se-I5 also allowed us to explore embodied and social aspects more clearly. Lastly, we had utilized user models in ec(h)o in ways that both supported an adaptive response from the system and enabled multiple modes of reasoning on the computational level. An intention was to explore the possibility of constructing group user models, se-I6, an under-researched area.

#### **4.1.2.3 Design rationales in ec(h)o**

Design rationales scaffold design intentions. They guide, constrain, and mobilize intentions. In the case of ec(h)o, design rationales came in the form of theoretical supports and review of existing designs and research. For example, theoretical rationales came in the form of Genevieve Bell’s cultural ecology (Bell, 2002) and Bonnie Nardi and Vicky O’Days’ information ecologies (Nardi and O’Day, 1999). Rationales of related work and research included reviews of non-visual user interfaces and playful aspects of tangible-user interfaces (TUI) and ludic design. In support of play, the ec(h)o project also looked to Tom Djajadiningrat’s framework of aesthetic interaction (Djajadiningrat et al., 2004). Table 3 catalogues the design rationales in ec(h)o.

ID	Rationale	Sources
e-R1	Cultural Ecology: Anthropologist Genevieve Bell's (Bell 2002) study of museums as ecologies. The study concluded with three main components to a cultural ecology: liminality, engagement, and sociality.	M&W 2005, DIS 2006, PUCJ 2007
e-R2	Information Ecology: Anthropologists Bonnie Nardi and Vicki O'Day draw on activity theory (Vygotsky 1925/1982; Nardi 1996) and field studies of technology libraries, virtual worlds, an architectural firm, high schools and a teaching hospital in order to develop their concept information ecologies. The concept they describe strives for a more systematic view of organizations, based on the relationships among people, practices, technology, values and locale.	M&W 2005, DIS 2006, PUCJ 2007
e-R3	Related works and research in non-visual interfaces. Particular attention was given to tangible-user interfaces (TUI) and audio display interfaces.	UMUAI 2005, DIS 2006, PUCJ 2007
e-R4	Related works highlighting play in tangible-user interfaces and ludic design.	DIS 2006, PUCJ 2007
e-R5	Aesthetic interaction as described by Tom Djajadiningrat.	DIS 2006, PUCJ 2007

**Table 3 Rationales in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

In the first of the theoretical rationales, Bell describes museums in terms of cultural ecologies (Bell, 2002), e-R1. As an ecology, the museum space and experience are bound by interrelated components and attributes of the given museum ecology. For example, Bell identifies three significant components of all museum ecologies: liminality, engagement, and sociality. Liminality defines museums as places that embody an experience apart from everyday life – as such the experience can be transforming. Engagement defines museums as places where people go to learn yet often in an entertaining and exploratory way. Sociality defines museums as social spaces like the public spaces of playgrounds and cafes.

The second theoretical rationale, e-R2, is Nardi and O'Day's information ecology (Nardi and O'Day, 1999). The two authors draw on activity theory (Vygotsky 1925/1982; Nardi 1996) and field studies in order to develop their concept of information ecologies. The concept they describe strives for a more systematic view of organizations, based on the relationships among people, practices, technology, values and locale. Nardi and O'Day use the concept of ecology to critique current technocentric views in which technology is seen

as autonomous. The authors argue for a more complex understanding of interdependent elements and influences of which technology is only one part. Constituent elements of information ecologies include a system, diversity, co-evolution, keystone species, and locality.

Additional rationales include e-R3: reviews of related work of non-visual interfaces. Non-visual interfaces, particularly audio display interfaces have been shown to be effective in improving interaction and integration within existing physical contexts. In addition we focused on e-R4, tangible-user interfaces (TUI) as an embodied and physical alternative to graphical user interfaces (GUI). With respect to the latter, we additionally examined the playful aspects of TUIs as in Durrel Bishop's Marble Answering Machine (Crampton-Smith, 1995) and Ishii's Ping Pong Plus (Ishii et al., 1999).

In the last rationale the project returned to a framework to better understand the quality of interaction with TUIs, e-R5, Djajadiningrat's idea of aesthetic interaction (Djajadiningrat et al., 2004). Djajadiningrat argues for a "perceptual-motor-centred" approach to tangible interfaces (Djajadiningrat et al., 2004). He describes three factors as having a role in aesthetic interaction: the interaction pattern of timing, rhythm, and flow between the user and the object; the richness of motor actions found in the potential space of actions and skill development; and freedom of interaction in which a myriad of interaction paths coexist.

#### **4.1.2.4 Design rationales in socio-ec(h)o**

In most instances design rationales manifest as supporting theories or related design and research examples. In socio-ec(h)o a collection of theories supported aspects of the inquiry. These include embodied interaction, play and learning theories, aesthetic



interaction, and infinite play. Related research and design examples from interactive art and interaction design also serve as design rationales (see Table 4).

ID	Rationale	Sources
se-R1	Embodied and Social Interaction	DIGRA2005, TEI2008
se-R2	Play and learning theories	DIGRA2005, MM2005, TEI2008
se-R3	Aesthetic interaction	DIGRA2005, MM2005
se-R4	Game and play theories	DIGRA2005
se-R5	Related interactive art installations	MM2005
se-R6	Related interaction design play environments	DIGRA2005, MM2005, TEI2008
se-R7	Bartle player types	DIGRA2005, MM2005
se-R8	Soundscape studies and acoustic ecologies	MM2005, ICAD2006, CHI2006

**Table 4 Designer rationales in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

Paul Dourish's embodied interaction, se-R1, frames the embodied investigations in socio-ec(h)o. Dourish (Dourish, 2001 , Dourish, 2004) argues that activity and context are dynamically linked – or “mutually constituent” (Dourish, 2004, p.14). Based on the philosophical viewpoints of Heidegger and Wittgenstein, Dourish critiques 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. Additionally, in the context of phenomenology, in particular as described by Schutz (Schutz, 1967), social computing is as much a result of embodiment as it is a shaper of embodied interaction.

In learning theories, actions (play) and learning are seen as mutual enforcers, se-R2. Dewey argues for the construction of knowledge based on learning dependant on action (Dewey, 1959). Piaget, through his child development theory, believes in the development of cognitive structures through action and spontaneous play (Piaget, 1973). According to Piaget, constructivist learning is rooted in experimentation, discovery and play among other factors. Papert extends Piaget's notions by investigating the knowledge-construction

process that emerges from learners actually creating and designing physical objects (Papert, 1980). Malone and Lepper consider games as intrinsic motivators for learning (Malone and Lepper, 1987). Subjective motivations like challenge, curiosity, control and fantasy may occur in any learning situation; other motivations like competition, cooperation and recognition are considered to be inter-subjective, relying on the presence of other players/learners.

Similar to ec(h)o, Djajadiningrat's aesthetic interaction (Djajadiningrat et al., 2004) supports the aims of physical interaction, se-R3. The idea argues for a multiplicity in the physical interaction of design artifacts. In socio-ec(h)o, we aimed to emphasize the qualities of interaction that result in play that facilitates discovery and we therefore explored the embodied and situated aspects of interaction or aesthetic interaction as expressed by Djajadiningrat (Djajadiningrat et al., 2004).

Lastly, we examined a range of game theory ideas, se-R4, that included James Carse's notion of finite and infinite games. James Carse critiques contemporary culture's fixation on finite games (Carse, 1987), and as a result this fixation overlooks the more fundamental aspects of games that are ongoing and not readily codified through mastery or winners and losers. Carse's view relates to Clifford Geertz's idea of "deep play" as evident in Bali cockfights (Geertz, 1973), and Dianne Ackermann's exploration of adult games (Ackerman, 2000). We also reviewed efforts to theorize current game production in Salen and Zimmerman (Salen and Zimmerman, 2004).

Additional rationales include se-R5 and se-R6, reviews of related works in interactive arts and interaction design. For example, in se-R5, interactive art projects such as works by F0am and Sponge (Sha et al., 2003) explore social and mixed reality environments incorporating gesture and wearable computing. In se-R6, recent projects have

investigated the play space of responsive environments and tangible computing utilizing sensors, audio, and visual displays. For example, Andersen (Andersen, 2004), and Ferris and Bannon (Ferris and Bannon, 2002) engage children in exploratory play and emergent learning through sensor-augmented objects and audio display. In the Nautilus project (Strömberg et al., 2002), Strömberg and her colleagues employ bodily and spatial user interfaces as a way of allowing players to use their natural body movements and to interact with each other in a group game within a virtual game space.

The remaining rationales support the user model and audio display goals. In user modelling and games, we came across Richard Bartle's concepts of collaborative play in Multi-User Dungeons (MUDs) and MUD Object Orienteds (MOOs), se-R5 (Bartle, 1996). Bartle identified four types of MUD player styles: achievers, explorers, socializers, and killers. Achievers seek in-game success, explorers satisfy their environmental curiosity, socializers value human interaction, and killers exercise their will at the expense of other players. With respect to the audio display, we drew upon the soundscape studies and acoustic ecologies of Schafer and Barry Truax, se-R8 (Schafer, 1969 , Schafer, 1977 , Truax, 1999 , Truax, 2001).

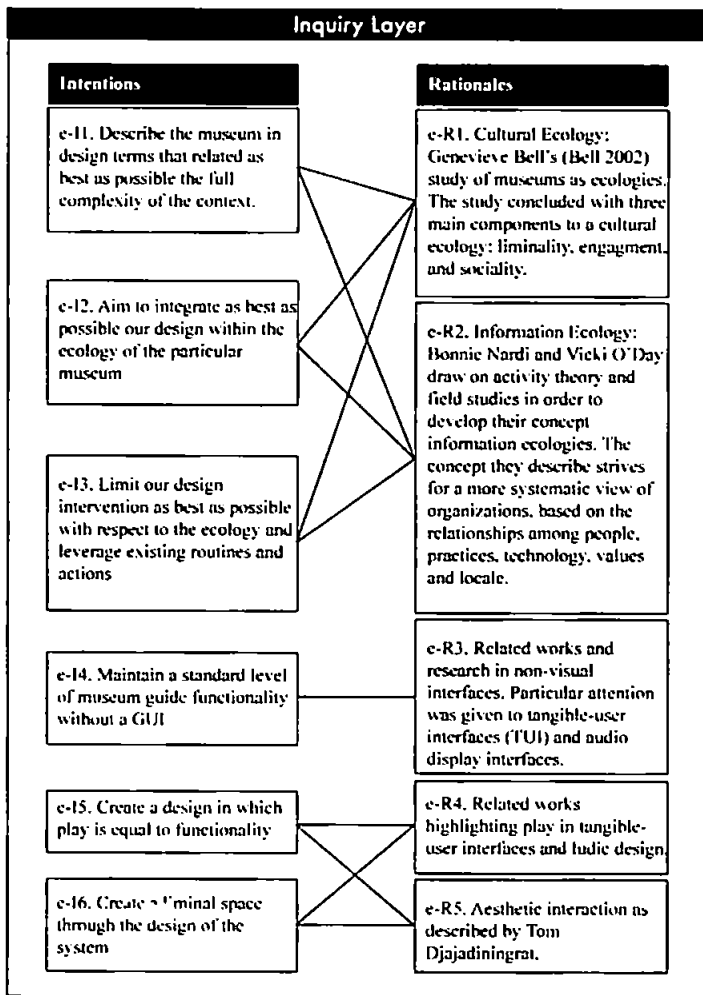
#### **4.1.2.5 Summary of design rationales and intentions**

The design inquiry sets out the foundation for any interaction design inquiry. As discussed previously, it asserts the role of the designer inquirer. The articulation of the design intentions and rationales adds to the triadic formulation of the design inquiry. The theory disambiguates the motivations, reasons, and preliminary research. It does so by providing a descriptive framework that articulates the design inquiry into intentions and rationales governed by the designer inquirer. The preceding descriptions of the designer

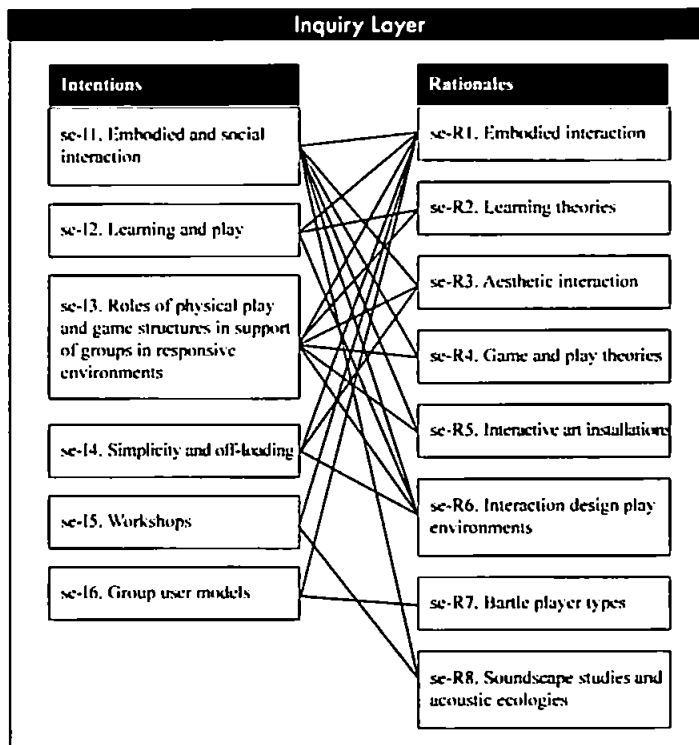
inquirer, design intentions, and design rationales of the two projects show how a level of clarity can be brought to the description of interaction design.

#### **4.1.3 Integrity of the design inquiry**

At the outset, designers need to assure a minimum level of satisfaction regarding the efficacy of their role as designer inquirer, the clarity of designer intentions, and the support of existing or new rationales for the intentions, in order for a design inquiry to even begin. Once the inquiry is engaged and underway, the different components of the interaction design inquiry relate in explicit ways. The quality and kind of these relationships ultimately can be used to assess the relative strength and weakness of an inquiry with respect to potential outcomes and their achievability. It is important to see how the designer inquirer, designer intentions and design rationales work together; i.e. the level of integrity amongst the parts. Explicit relationships can be seen between the designer intentions and rationales and these have been mapped in ec(h)o (see Figure 5) and socio-ec(h)o (see Figure 6).



**Figure 5 Relationships in ec(h)o between designer intentions and design rationales.**



**Figure 6 Relationships in socio-ec(h)o between designer intentions and design rationales.**

For example, in ec(h)o (see Figure 5), the idea of information ecologies by Nardi and O'Day (Nardi and O'Day, 1999), e-R2, supported the intentions related to integrating within the museum context, e-In1, e-In2, and e-In3. Further, the rationale was adopted later in the inquiry and supplemented our initial rationale of Bell's cultural ecology (Bell, 2002), e-R1. Bell's work informed our data gathering, however we devoted equal attention to both the museum organization and museum visitors, requiring the further support of information ecologies for this more defined intention. In general, the intentions in ec(h)o are quite clear which is revealed in targeted supporting rationales. In addition, the segmentation of intentions between museum context and user experience is evident in the minimal crossover support of rationales for intentions. Yet each intention has a supporting rationale. A problematic inquiry would have unsupported intentions or lurking rationales. Yet it should be clear that rationales are not only theoretical but may include past designs, research, and

personal design experiences. What is important is that both rationales and intentions are made explicit.

In socio-ec(h)o, there are few if any external specific factors driving the design, such as stakeholders (the museum organization, staff, and visitors), which differs from ec(h)o. As a result, the intentions of the project are more exploratory and less specific. In Figure 6, it becomes clear that this results in a tightly interwoven set of relationships between intentions and rationales. In contrast to ec(h)o, there is considerable crossover in rationales supporting multiple intentions. For example, a rationale like se-R1, embodied interaction, supports all the intentions. And the intentions se-I1, se-I2, and se-I3 are all supported by the theories and examples, se-R1 through se-R6. Further, the segmentation of intentions is less evident in socio-ec(h)o with the exception of the group user modelling intentions, se-I6, which is mapped to a specific rationale, se-R7. It can be said that similar to ec(h)o, the integrity or cohesion between intentions and rationales in socio-ec(h)o is strong while the nature of relationships is different. In addition to assessing the integral strengths at the inquiry level, the nature and kind of the relationships help us understand the kind of the interaction design inquiry.

The relationships between intentions and rationales are made explicit in the design inquiry. Implicitly, the presence of the designer inquirer is manifest in those relationships. The designer inquirer forms the crucible of the inquiry and therefore determines those relationships. Design intentions originate from the designer inquirer and responsibility rests with the designer inquirer through intellect and experience to support these intentions with design rationales. In other words, the quality of the intentions and rationales is a measure of the experience and ability of the designer. We can then see that the triadic formulation of

the design inquiry is the creation and stewardship of the intentions and rationales by the designer inquirer.

## **4.2 The actions of ec(h)o**

Having discussed the design inquiry of the two projects, I now examine the projects more deeply by moving on to actions of each. My aim is to illustrate the descriptive capacity of the theory that is to further disambiguate the design activities into sensible and articulate descriptions. I will discuss the actions of ec(h)o in the remainder of this chapter followed by a discussion of the actions of socio-ec(h)o in Chapter 5.

I introduced actions in Chapter 3 (see 3.4.3 Actions). These describe the practice of interaction design, the detailed acts and actual outcomes. The results of design decisions and the production of design become visible and help to articulate the experience of interaction design. I will describe actions in two forms, judgment and interpretation. As we will see, each can be subdivided into many sub-components.

### **4.2.1 ec(h)o: judgment**

Earlier in Chapter 3, I discussed how an interaction designer simultaneously reflects, acts and implements through design experimentation. This simultaneity of thinking and action in interaction design requires the integration of judgment into the process of inquiry in ways that are formative, in the moment of design, as well as summative, such as an assessment of an outcome. This ongoing decision-making or exercising of judgment is a mechanism of inquiry that keeps the design inquiry progressing. We can sub-divide these acts of judgment into four sub-categories: 1) representations; 2) activities; 3) models, artifacts, and systems; and 4) evaluations.



#### 4.2.1.1 ec(h)o: representations

Representations are concrete outcomes of the designer's experimentalism. They mark points in the inquiry where sufficient shape has been given to a design possibility or the state of the inquiry. At other times they are in themselves experiments; design tests of what might be possible. Determining these points, experiments and shapes of possible outcomes is an exercise in judgment on the part of the designer. In the case of ec(h)o, representations came in the form of design documents, storyboards, and scenarios. In Table 5 the different representations are shown.

ID	Judgment (representations)	Sources
c-J1	ec(h)o storyboard	SB
c-J2	Video scenario 1	VS1, DC 2005
c-J3	Video scenario 2	VS2, DC 2005
c-J4	Video scenario 3	VS3, DC 2005
c-J5	Video scenario 4	VS4
c-J6	Design Specifications	DS

**Table 5 A sub-category of judgment, representations, in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

Representation in ec(h)o often came in the form of design scenarios. Scenarios are narrative accounts of design ideas (Carroll, 1995). Representations in ec(h)o serve multiple purposes. In one sense they are experiments that test out an idea or design decision by making it concrete and experiential. In another sense they mirror the state of the design inquiry at that time, like a milestone the representation marks the progress of the design inquiry. In either case, representations serve as a concretization of a design understanding that allows for shared views across stakeholders, provides resolution of ideas and problems that also reveals gaps, and acts as design decision outcome en route to a more final goal. In terms of the process of the inquiry, it “gets everyone on the same page” and creates efficiencies across the group so each member can see how each other contributes and can

also see their role within executing the multiple interdisciplinary tasks in an interaction design project.

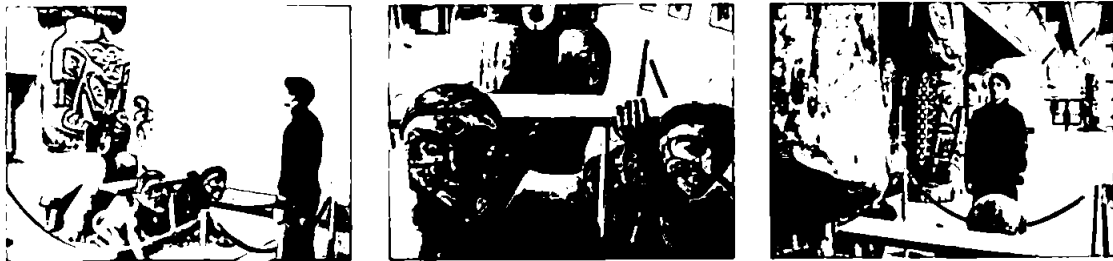


Figure 7 Storyboard panels from the initial storyboard [e-J1] for ec(h)o



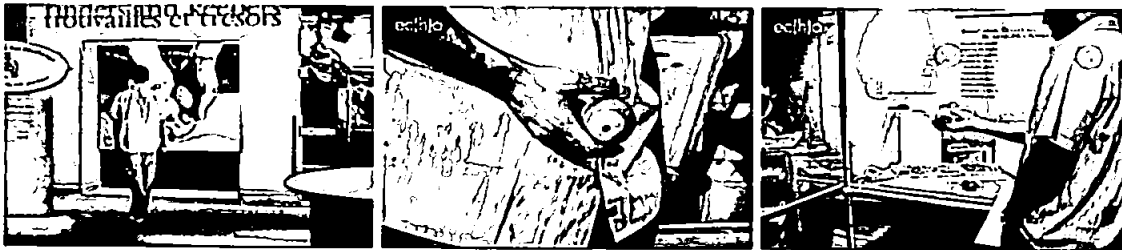
Figure 8 Frames from video scenario 1 [e-J2] of ec(h)o.



Figure 9 Frames from video scenario 2 [e-J3] of ec(h)o.

The storyboard and scenarios clearly show the evolution of the design idea from the earliest storyboard at the beginning of the project to last scenario. The initial storyboard, e-J1 (see 4.2.1.1 ec(h)o: representations), and e-J2, the first video scenario (see 4.2.1.1 ec(h)o: representations) show the concept of the ambient and interactive audio display fairly well-developed from the outset. These scenarios are very much experiments with the audio concepts and explorations of how embodied interaction could be the basis for the interface. The initial scenarios convinced us that movement like walking through the exhibit was a desirable and feasible way to animate the soundscape. In the initial scenarios,

we had not yet come upon the idea of utilizing a tangible-user interface to drive the information delivery. This idea, which was generated in a workshop, was first experimented with in e-J3, the second video scenario, where pure gestures gave way to movements of manipulating a tangible object (see 4.2.1.1 ec(h)o: representations). In the later scenarios, e-J4, scenario 3 (see 4.2.1.1 ec(h)o: representations) and e-J5, scenario 4, we were able to shoot the videos at the site of our eventual installation, the Canadian Nature Museum, and try out a new prototype of a wooden ball as the tangible component. In essence the video used was exactly the same. We updated the audio to include the refinements of the audio strategies.



**Figure 10** Frames from video scenario 3 [e-J4] of ec(h)o.

A third of the way through the project marked a critical point in our process when we had sufficiently conceptualized the proposed system. This point is marked by e-J6, our design specifications document that detailed the design and technical concept in its first complete conceptualization. This is a good example of a milestone in a design inquiry.

#### **4.2.1.2 ec(h)o: activities**

Activities proactively shape the interaction design inquiry by experimentalism. The designer inquirer creates activities to explore, resolve, and test design ideas or intentions. Typically, in keeping with the idea of an embodied inquirer, the designer inquirer is directly involved in each of the activities. Another feature of the activities is the involvement of end-user and stakeholders through either fieldwork or directly in participatory workshops.

In ec(h)o, the majority of activities take the form of participatory workshops with the addition of ethnographic-based engagements. Table 6 catalogues the various activities as forms of judgment in ec(h)o.

ID	Judgment (activities)	Sources
e-J7	Fieldwork at the Canadian Nature Museum	M&W 2004, DIS 2006, PUCJ 2007
e-J8	Expert Data Collection	M&W 2004
e-J9	Workshop 1: How do you catch butterflies	WS1, DC 2005
e-J10	Workshop 2: Sticks and stones	WS2, DC 2005
e-J11	Workshop 3: House of cards	WS3, DC 2005
e-J12	Workshop 4: Serious play	WS4, DC 2005
e-J13	Workshop 5: No buttons	WS 5, DC 2005
e-J14	Workshop 6: prefaces	WS 6, DC 2005

**Table 6 A sub-category of judgment, activities in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

Beginning with the ethnographic work, the project engaged in extensive fieldwork at the Canadian Nature Museum, e-J7. The team spent over seventy hours conducting interviews, video walkthroughs, and site visits with over thirty natural history researchers, staff, and administrative staff at the museum. We also observed museum visitors and conducted an analysis of interaction devices in the museum. In addition to the fieldwork, we developed a process of expert data collection, e-J8, to help us develop the content required for the project. We organized interviews and video walkthroughs with members of the museum research staff. These individuals were chosen based on their expertise in a number of different knowledge domains related to the exhibition. The interviews were conducted in two parts: part one introduced the interviewee to the ec(h)o project and asked them to comment or provide contextual information from their perspective and area of expertise related to the exhibit; part two involved a video walkthrough of the exhibit space in which the interviewer and expert engaged in a discussion of the artifacts and collections on display.

As stated earlier, participatory workshops formed the majority of activities in ec(h)o. The idea of participatory workshops originates with Ehn's idea of design games from participatory design (Ehn, 1992 , Ehn and Kyng, 1991b). Here potential end-users engage in creative workshops facilitated by designers. Workshops are another good example of how an interaction designer inquirer proactively shapes the inquiry by conducting hands-on experiments that look to explore the design space and investigate possibilities.

In the case of ec(h)o, each workshop was given a name and an open call was made for participants, typically ranging from 6-10 people. The design team structured, planned, and facilitated each workshop. What follows are brief descriptions of each workshop:

e-J9 - 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 scenario e-J2. The team initiated the co-designing by beginning with the metaphor "catching butterflies". Through discussion, brainstorming and "bodystorming" sessions, participants helped the design team come up with an alternate metaphor for considering gesture (see Figure 11).



Figure 11 Images from Workshop 2 [J10] in ec(h)o.

e-J10 - Workshop 2, “Sticks and Stones”: In response to workshop e-J9, workshop 2 was an exploration of movement with objects as a form of interaction with 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”<sup>2</sup> audio display system. Participants were given toys, objects, and various materials to modify and construct (see Figure 12).

e-J11 - 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 model the content and enable content navigation. Utilizing an extreme variation of a card-sorting exercise (Shneiderman, 1997), three models were generated including one that we ultimately incorporated in the final prototype.

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<sup>2</sup> A prototype set-up that creates the effect of working technology through the use of hidden technology and human operators.



Figure 12 Images from workshop 2 [e-J10] in ec(h)o.



Figure 13 Images from workshop 4 [e-J12] in ec(h)o.

e-J12 - Workshop 4, “Serious Play”: In response to the navigational model and 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.

e-J13 - Workshop 5, “No Buttons”: The workshop was a response to outcomes of workshop e-J11 and e-J12. The aim was to individually explore different object types with different navigational models (see Figure 14).



Figure 14 Images from workshop 5 [J13] in ec(h)o.

e-J14 - 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 the interaction model. Participants experimented with the approaches with a desktop prototype of the audio display engine (see Figure 15).

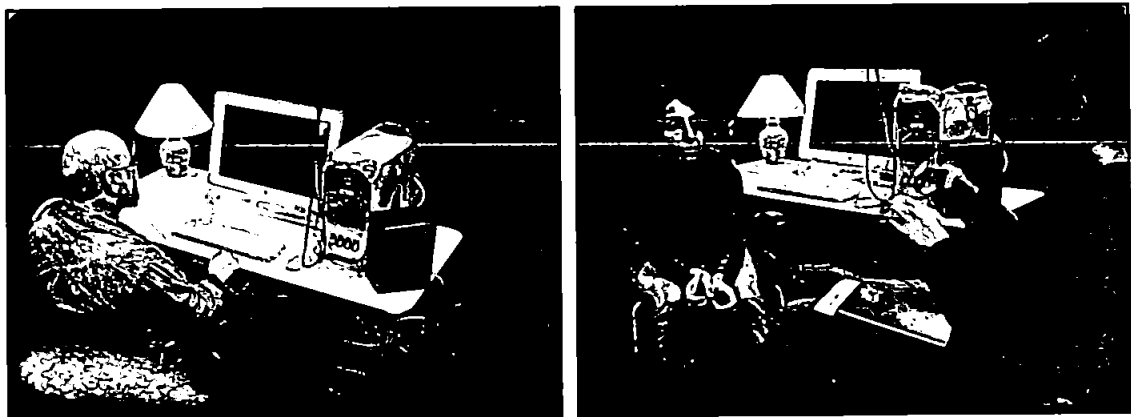


Figure 15 Images from workshop 6 [J14] in ec(h)o.



#### 4.2.1.3 ec(h)o: models, artifacts, systems

The remaining sub-category of design judgment is models, artifacts, and systems. In many respects, these are what we think of as outcomes in interaction design, the things we make. In ec(h)o, these took on the form of prototypes and design models. The instances of models, artifacts, and systems are catalogued in Table 7.

ID	Judgment (models, artifacts, systems)	Sources
e-J15	Prefaces and audio objects	M&W 2004, DIS 2006, PUCJ 2007
e-J16	1-2-4 navigation model	DIS 2006, PUCJ 2007
e-J17	Riddles	DIS 2006, PUCJ 2007
e-J18	Narrative model	M&W 2004
e-J19	Soundscape model	M&W 2004, EC 2006
e-J21	Prototype object - cube	FCC
e-J22	Tangible object – wooden ball	WB
e-J23	Tangible object – wooden cube	WC, EC 2006, DIS 2006, PUCJ 2007
e-J24	MOA interactive prototype	MOAI
e-J25	Trivial Pursuit paper prototype	TPPP
e-J26	Technical prototype 1	TP1
e-J27	Technical prototype 2	TP2
e-J28	Final prototype	FP, UMUI 2005, DIS 2006, PUCJ 2007

**Table 7 A sub-category of judgment, models, artifacts, and systems in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

In ec(h)o, a number of conceptual models for interaction emerged. For example, as a result of initial conceptualizing in scenarios and workshops like e-J14, we settled on an interaction structure that allowed us to play audio teasers as an introduction to longer audio clips of museum information. We described the model, e-J15, as [e-J15] preface and audio objects. The model achieved two things. Firstly it broke audio information down into two parts: an audio preface (a very short audio clip that represents a longer audio file); and an audio object (the longer audio file that relays information about the exhibit). Secondly, the model provided an audio spatial structure for three choices of audio objects. The structure is created by playing in sequence three related prefaces in particular spatial locations in

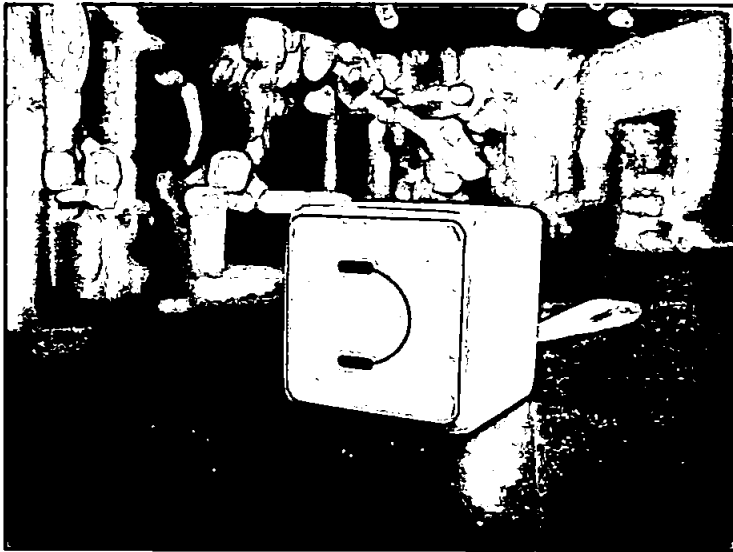
reference to the listener: to their left, centre, and to their right. This creates an audio display that can be navigated by manipulating the tangible object.

Turn	Prefaces played			Preface/audio object selected
	left	center	right	
1	①	②	③	③
2	①	②	④	②
3	①	⑤	④	

**Figure 16 Diagram of the 1-2-4 navigation model.**

A directly related interaction model arose from the workshop e-J11, House of Cards. We referred to this in e-J16, the 1-2-4 navigation model. The structure is very simple given the limited choice of three options. The navigation is as follows (see Figure 16): A visitor is played three prefates, one to his left, another to his centre, and the third to his right. He selects the preface on his right side and listens to the linked audio object. On the subsequent turn the visitor hears the same two prefates he did not select, and again he hears them to his left and to his centre. Since he previously chose the preface to his right, he now hears a new preface in that location. If the visitor then selects the centre preface, on the subsequent turn only that preface is replaced by a new preface in the centre position.

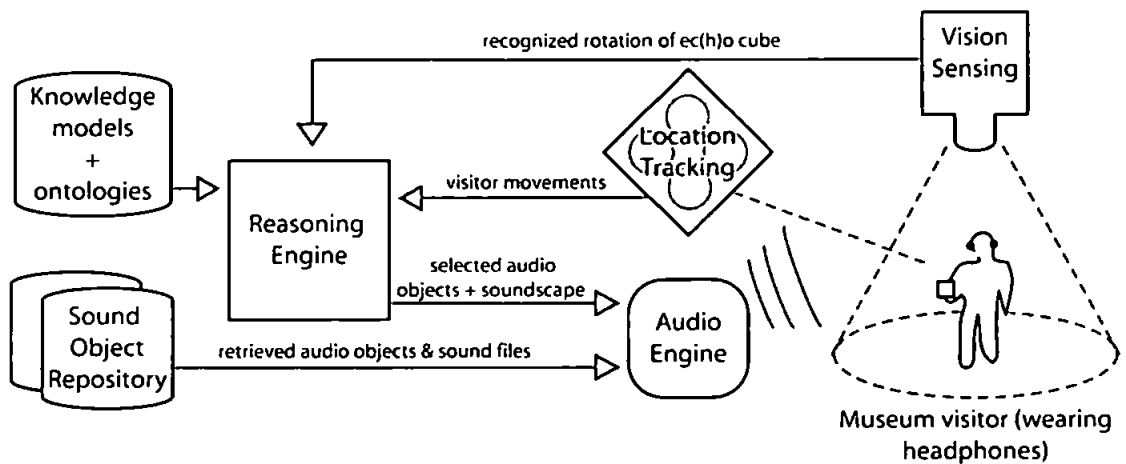
Other models explored the use of riddles in prefates (e-J17), and a narrative model, e-J18, investigated different connecting associations among the hundreds of audio objects that we created. Lastly, e-J19, a soundscape model, was developed through the series of scenarios and interactive prototypes that relied on ambient zones and embedded keynote sounds denoting particular artifacts on display.



**Figure 17** The tangible object for ec(h)o, a wooden cube.

In addition to models, judgments become concrete in that they are embodied in the making of artifacts and physical prototypes. Both artifacts and prototypes represent a clear set of decisions that need to be consolidated in an experiential form for further investigation and experimentation. After initial investigations with gestures in scenarios e-J2 and e-J3 we arrived at the idea of a tangible user-interface that was explored in scenario e-J4 and workshops e-J10 and e-J12. Early low-fidelity prototyping took place in these workshops that led to our first tangible object, e-J21, a foam core cube with chamfered corners, and then e-J22, a small wooden ball that fit the hand comfortably. Eventually, through iterations and matching the needs of the video sensing, the ball returned to a cube with a rounded bottom for fitting the palm, e-J23 thus establishing a clear starting position, coloured sides

for video sensing, and a short leash for attaching to the visitor's wrist (see Figure 17).



**Figure 18** System design for the final prototype of ec(h)o.



**Figure 19** Visitors trying the ec(h)o final prototype.

The last set of judgments led to the prototype system. The final prototype, e-J28 incorporates all of the design decisions and results of the inquiry into its production. See Figure 18 for a diagram of the final technical system, and Figure 19 for user interaction with the final prototype. The technical prototyping in ec(h)o began with sketches and a rudimentary Adobe Flash™ prototype for the Museum of Anthropology at UBC, e-J24 (see Figure 21) that allowed experimentation of movement and sound, and spatializing audio selections. Subsequently, a paper prototype made from modified Trivial Pursuit™ cards, e-J25, was developed to test navigational approaches, and two technical prototypes, e-J26 and

c-J27, evolved the utilization of video sensing, location sensing, audio technologies, and server systems.

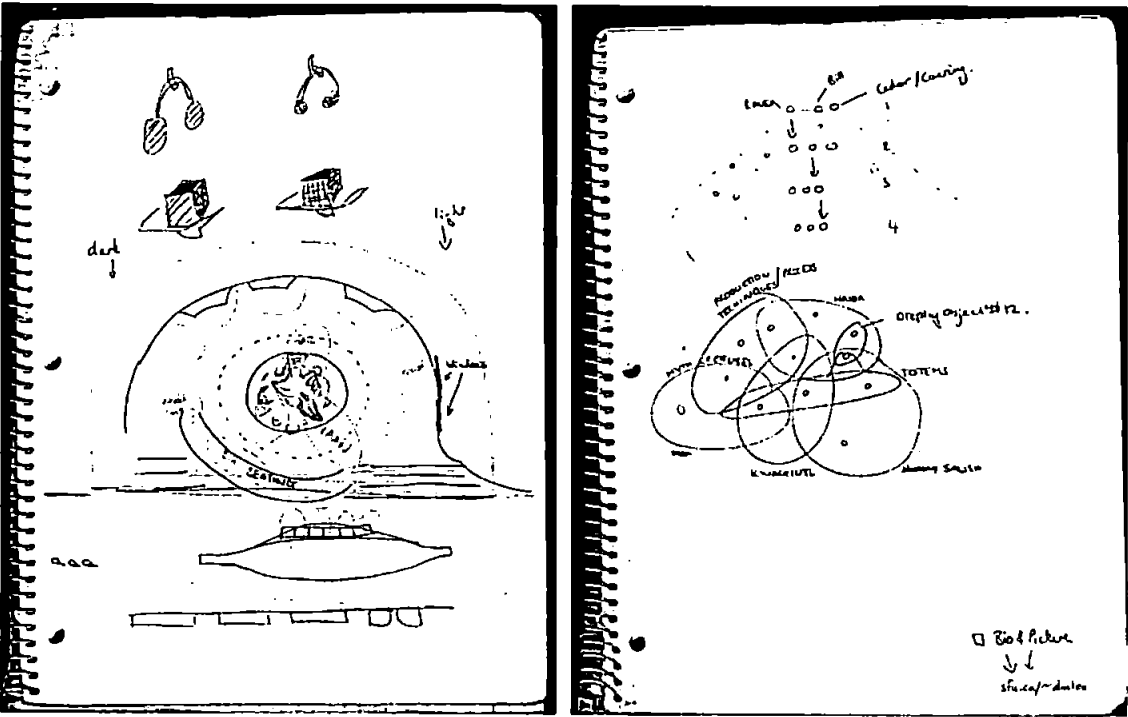


Figure 20 Sketches for Museum of Anthropology interactive prototype [e-J22].

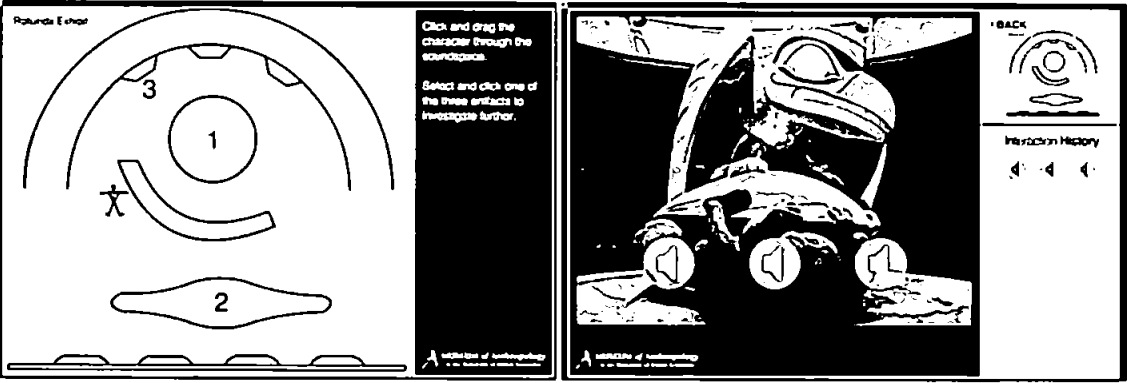


Figure 21 Screenshots from Museum of Anthropology interactive prototype [e-J22].

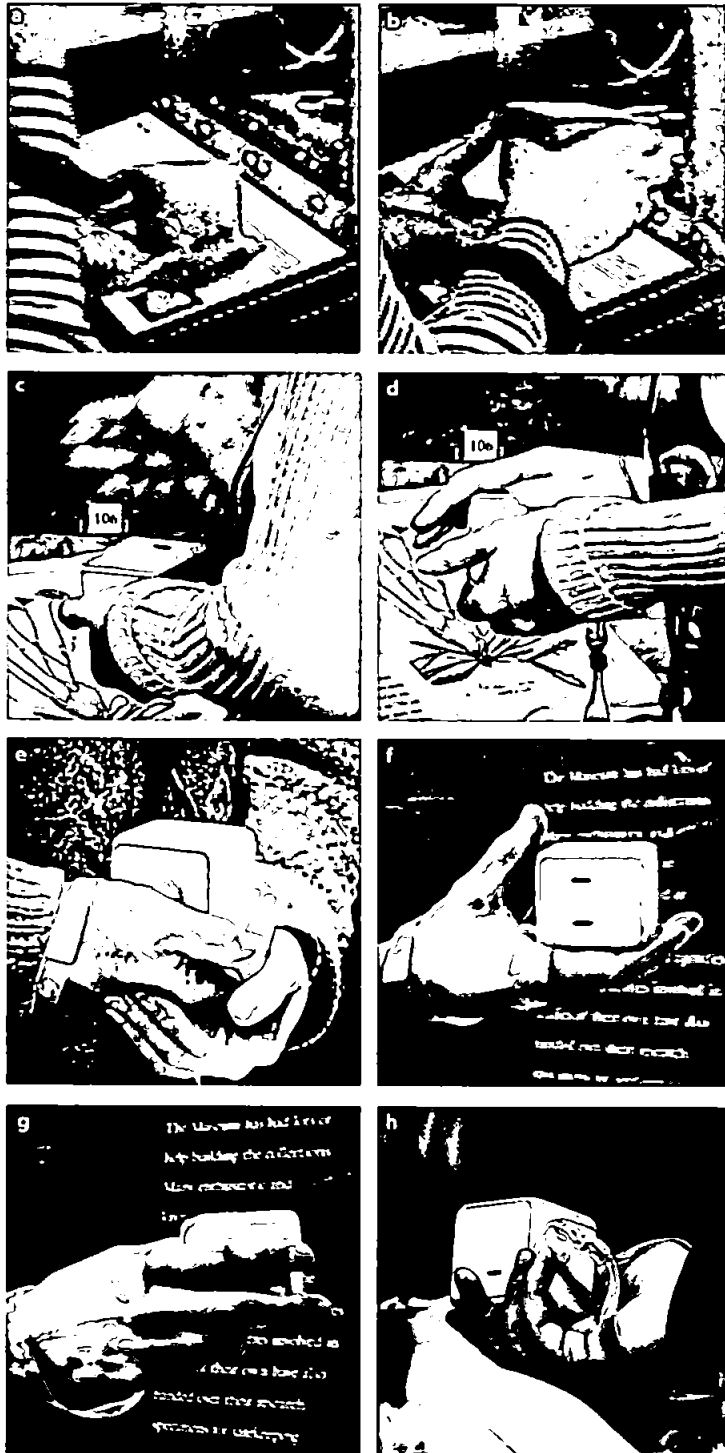
4.2.1.4 ec(h)o: evaluation

Evaluations are actions that test other actions. In the case of interaction design in ec(h)o, the evaluations focused on user experiences of the final prototype. Table 8 lists the instances of evaluation.

ID	Judgment (evaluations)	Sources
e-J29	User testing	UMUAI 2005, DIS 2006, PUCJ 2007
e-J30	Aesthetic interaction	DIS 2006, PUCJ 2007
e-J31	Expert Review	DIS 2006, PUCJ 2007

**Table 8 A sub-category of judgments, evaluation in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

We evaluated, e-J29, the user experience of our final prototype installed at the Canadian Nature Museum with six participants. The participants completed a short questionnaire prior to exploring the exhibit using the ec(h)o prototype. Participants completing a questionnaire and a semi-structure interview followed the use of the prototype. The questionnaire included sixty-three questions that assessed user experience related to the overall reaction to the system, the user interface, learning how to use the system, perceptions of the system's performance, the experience of the content, and degree of navigation and control. Complete results of the user testing have been published in (Wakkary and Hatala, 2006 , Wakkary and Hatala, 2007 , Hatala and Wakkary, 2005). I will discuss the evaluation and results in more detail in Chapter 6.



**Figure 22** Different types of physical interaction described as a result of e-J30, aesthetic interaction evaluation: a-b hold and rotate; c-d hold, rotate, and cover; e cradle and hide; f-g rotate wrist; h rotate cube with fingers.

In another form of evaluation, e-J30, we used Djajadiningrat's description of aesthetic interaction to analyze the tactile and physical qualities of ec(h)o. Djajadiningrat

refers to interaction as the action-potential of physical objects (Djajadiningrat et al., 2004). He describes three factors as having a role in aesthetic interaction: the interaction pattern of timing, rhythm, and flow between the user and the object; the richness of motor actions found in the potential space of actions and skill development; and freedom of interaction in which a myriad of interaction paths coexist.

In simple actions of holding and rotating the cube, we observed a diverse set of play and experimentation when selecting prefaces. We identified at least five basic types, all of which successfully operated the system (see Figure 22). As one might expect, we also observed a range of methods for holding the cube when not selecting prefaces or walking through the exhibition such as cradling it in hands, holding it at one's side or behind one's back, dangling it from the wrist, or holding its leash to gently sway it from side to side.

In addition to the other forms of review we asked Jonathan Ferrabee, the senior exhibit designer for the museum to conduct an expert review, e-J31. We additionally asked Dr. John Graham, the Director of Research for the museum to conduct a similar review. He was however unable to provide a written report. Jonathan Ferrabee had been with the museum for close to a decade. In addition to exhibit design he had a background as an industrial designer. The report submitted was overwhelmingly positive. Among the design intentions that his report supported were the design of the wooden cube, the effect of the multiple voices for audio delivery, and the navigational approach to the content. He cautioned about the challenges of children using ec(h)o and the drawbacks of the headphones. Interestingly, he referred to the experience as cinematic, "a film, but one that is real and in which they [visitors] can move and interact."



#### **4.2.2 ec(h)o: interpretation**

Earlier in our discussion of pragmatism and design (see Chapter 3) I argued how multiplicity in design is irreducible, which leaves no room for absolute knowing. In other words, the interaction designer engages the inquiry in order to uncover the multiple and simultaneous possibilities. As we've seen in the inquiry and actions these possibilities are rendered concrete through judgment and action, the possibilities are given design direction through the setting of intentions and rationales at the design inquiry. The rendering of the possibilities creates a myriad of choices that need to be negotiated. That is the completeness of the action rests on interpretation. In design, this calls for the constant reflection and analysis of conditions on the part of the designer. We can single out these types of actions as acts of interpretation. Further, we can subdivide these acts of interpretation into four sub-categories: 1) accounts; 2) stakeholder views; 3) findings and 4) criticism.

##### **4.2.2.1 ec(h)o: accounts**

Accounts are typically internal to the designer or design team, in that they are self-reflections of actions that guide the interaction designer and team. Accounts help designers make sense of what is happening in the inquiry and results of design actions. This notion of a feedback loop through interpretation is what ties judgments and interpretations together into design actions. Accounts interpret design actions. In ec(h)o, the accounts are catalogued in Table 9.

ID	Interpretation (accounts)	Sources
e-In1	Cultural ecology – visitors	M&W 2005
e-In2	Cultural ecology – space	M&W 2005
e-In3	Cultural ecology – interactions and rituals	M&W 2005
e-In4	Co-evolution	M&W 2005
e-In5	Locality	M&W 2005

**Table 9 A sub-category of interpretation, accounts in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

The accounts in ec(h)o primarily result from the ethnographic fieldwork and observations based on the design rationales of R1, cultural ecology, and R2, information ecologies. In the first instance, e-In1, we interpreted many examples of diversity in visitors in our ethnographic observations as described by Bell in her notion of cultural ecology (Bell, 2002). The examples of diversity in visitors and visit rituals reported by Bell were observed in our own study. For example, visitors included adults and parents, yet many were typically younger (between 8 -14 years of age), and often as groups on a school field trip. Though visiting as a large group, these visitors often fragmented into smaller groups and clearly enjoyed a level of autonomy: running, jumping, speaking loudly, laughing, and exploring the space as if it were a playground. This speaks to the safe social spaces that museums have become.

Strong similarities between Bell's ecologies and our observations occur in other categories as well. For example, e-In2, Bell's discussions of space and displays matched our observations. Bell argues that displays and installations tend to be demanding of the visitors' attention, and we found these characteristics in the four exhibitions we analyzed. For example in the mammals exhibit there was a series of dioramas depicting animals in their natural habitat. In addition to the visual scene, the dioramas were accompanied by ambient sound effects, a detailed didactic, and at least two tactile artifacts relevant to the mammal on display such as fur samples, hoof imprints, and horns busts.

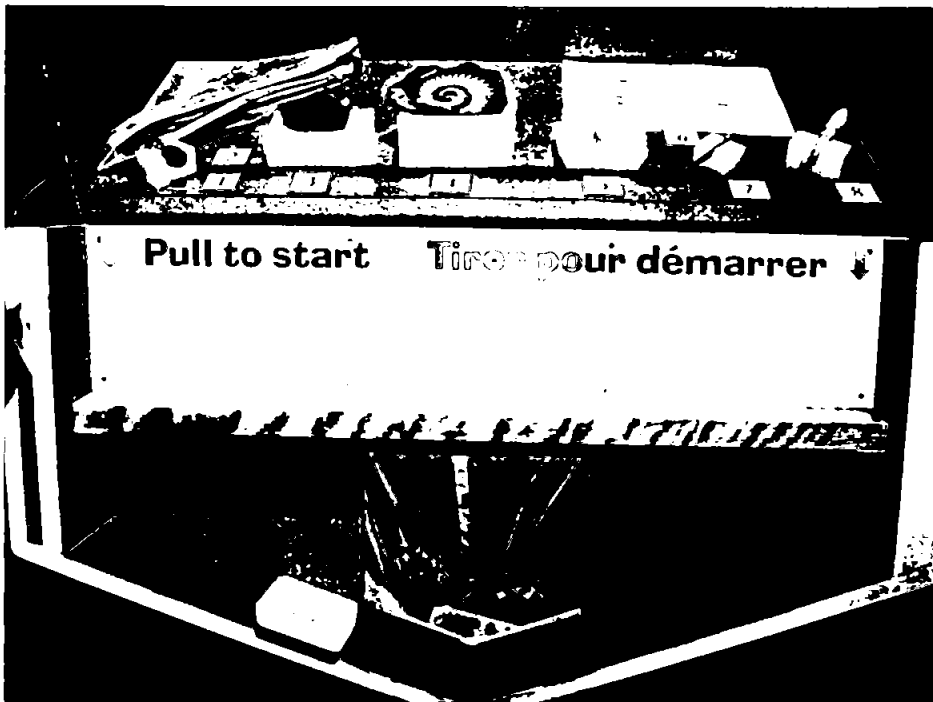


Figure 23 "Rat Pack Challenge" puzzle in the Finders Keepers exhibit in the Canadian Nature Museum.

The displays and installations revealed diverse forms of interaction and learning, c-  
In3. For example, the museum included wooden puzzles, like a game called "The Rat Pack  
Challenge" which tasked visitors to search the room and discern collectable artifacts from  
non-collectable ones. Once completed the collected pieces would fall into a chute at the  
pull of a handle, creating a loud crashing sound that captured the attention of others (see  
Figure 23). The installation also included discovery drawers filled with objects such as  
fossils, fur pelts, and minerals which visitors could touch and inspect at close range. Bell  
describes an attribute of the science museum ecologies, which is to support the fact that  
people learn in a variety of different ways. Alternative approaches to learning turned up  
throughout our observations. Examples included interactive puzzles, quizzes, and games  
that require visitors to explore and think about the artifacts being displayed; multimedia  
stations provided for deeper investigation into a topic or subject area; and dioramas and

immersive displays allowed visitors to imagine through visual simulations of historical periods.

These accounts create a level of confidence in the rationale of cultural ecologies as a basis for design actions. Additionally, accounts of the observations mapped well to aspects of e-R2, information ecologies. For example, e-In4, the concept of co-evolution, was present in our organizational observations of the Canadian Nature Museum. Nardi and O'day describe co-evolution as an adaptive response to change: "information ecologies evolve as new ideas, tools, activities, and forms of expertise arrive in them...parts of the system adapt to each other or co-evolve as newer, faster, and different tools, are integrated repeatedly" (Nardi and O'Day 1999 p. 52). For example we observed significant disparities in the adoption of new technologies across the ecology. Use and adoption of new technologies and supporting practices appeared to flourish behind the public face of the museum in areas such as the administration offices, research facilities, and collections/storage facilities. Conversely, there was a noticeable lack of new technology adoption in the public exhibition spaces.

In another account related to e-R2, information ecologies, we explored e-R5, the idea of localities. Nardi and O'Day argue that we all have special knowledge about our own local ecologies and that this knowledge tends to be inaccessible to anyone who exists outside of that ecology. A good example is the numerous instances where a staff member's localized knowledge transformed a collection of artifacts from opaque and dull to interesting. For example, one of the scientists we interviewed was a paleo-anthropologist. Her knowledge was highly specialized; the information and insights she passed on during the interview were valuable in that they gave life to what was a static display of bones. An

example of how she did this was that she provided details and an explanation of the forensic process of sorting and analyzing the artifacts that she herself had performed.

While accounts may have little significance beyond the inquiry, they close the loop by connecting actions of judgment, intentions, and rationales. For example, we drew from the accounts of different rituals and learning styles, e-In3, which supports a tactile approach that includes holding, manipulating and being highly interactive with your hands. In another example of the feedback loop of accounts, we saw in e-In5, information ecologies' notion of locality, a degree of liveliness toward the artifacts. We experienced this in the locality of scientists' interactions with their own collected artifacts. We modelled our content delivery and audio experience on the informal and humorous storytelling we had experienced, extending it through riddles and word play.

#### **4.2.2.2 ec(h)o: stakeholder views**

Stakeholder views are similar to accounts in that they are formative responses to design actions. Unlike accounts, which are self-reflexive, the stakeholder views are interpretations of design stakeholders such as potential end-users. Interviews and fieldwork analysis are a passive form of gathering stakeholder views. In my analysis, I've covered those approaches under accounts (see 4.2.2.1 ec(h)o: accounts). In the case of ec(h)o, stakeholder views are embodied expressions of the stakeholders directly presented for interpretation or as embodied interpretations of the design inquiry at the time. The stakeholder views discussed here came as a result of activities of judgment, from the various workshops. In this particular instance the feedback came in the form of co-designing from the participatory workshops. Table 10 lists the different stakeholder views in ec(h)o.

ID	Interpretation (stakeholder views)	Sources
e-In6	Clapping – workshop 1	CLV
e-In7	Artifact 1 – workshop 2	WS2A1
e-In8	Artifact 2 – workshop 2	WS2A2
e-In9	“interactive” objects – workshop 4	WS4O

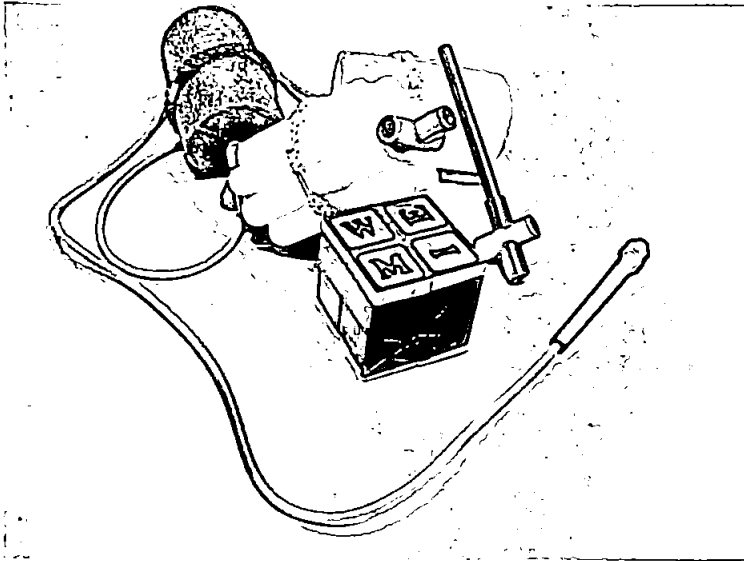
**Table 10 ec(h)o stakeholder views (see ec(h)o abbreviations in Appendix 1 for sources).**



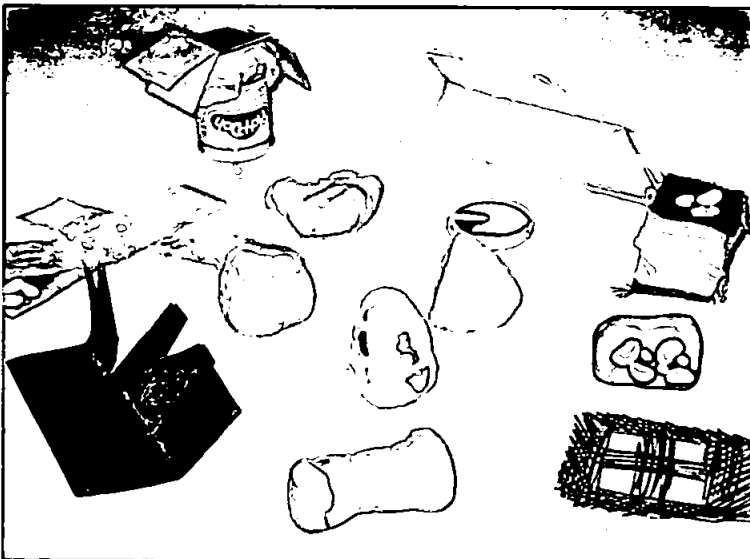
**Figure 24 Image from workshop 1 of a participant clapping to select spatialized audio.**

The first of the stakeholder views resulted from workshop e-J9 in which the activity was designed to generate gestures for navigating spatial audio. The workshop began with the idea of pretending to catch butterflies as an imaginative act to spur on gestures and embodied actions. After rounds of bodystorming together with a ‘Wizard of Oz’ set-up, and after rounds of discussions, the participants began clapping in response to the spatial audio as a form of audio call and response to the sound (see Figure 24). In discussion, the workshop participants felt the act of clapping made the most amount of sense and it was evident from the workshop that everyone was consistent in their use of the gesture. We took this act of clapping as a clear stakeholder interpretation of our design issue, e-In6. It was interesting in that we implicitly directed the workshop to explore deictic gestures, a functional movement in response to a context or purpose, like catching butterflies, but it

took the notion of clapping to make this idea explicit and a focus for our future investigations.



**Figure 25 e-In7 and e-In8, two artifacts made by participants in e-J10, workshop 2.**



**Figure 26 e-In 9, "interactive" objects made by participants in e-J12, workshop 4**

In other examples of stakeholder views, workshop e-J10 (see above) produced two artifacts, e-In7 and e-In8 that resulted from exploring tangible objects that could be manipulated by simple gestures. The workshop as previously described provided participants with children toy kits including wooden blocks, lego, foam, and various other

types. Participants could cut, glue and tape parts together. The workshop was inspired equally by Ehn and Kyng's idea of mock-ups (Ehn and Kyng, 1991b) and Liz Sanders' ideas of creativity workshops (Sanders, 2001). In the first artifact e-In7, different objects are in a tool belt and pulled out when a particular interactive action is being requested (see Figure 25). The second artifact e-In8 is a simple block made up of smaller children's wooden blocks taped together. Rotating the cube reveals different sides and drives interaction. This last artifact had a lasting impression on us and it is an idea we immediately explored in subsequent workshops e-J12 and scenarios e-J3 and e-J4. Workshop e-J12 explored and tested the simplicity of an interactive object like a cube that would result in a range of simply made "interactive" objects, e-In9, made by workshop participants using Play-Doh™, paper, cloth and other materials (see Figure 26).

#### **4.2.2.3 ec(h)o: findings**

Findings can be said to be the most substantive interpretations. This is certainly true for those outside of the inquiry who are interested in what can be learned from a particular design inquiry. These individuals, like other designers, researchers or stakeholders, are not looking for an interpretation to aid the practice of the inquiry but are looking for new understandings about interaction design. For the designer inquirer there are moments in practice, when a finding is a new interpretation that changes the direction of the inquiry. More often than not, findings emerge in practice as seeds that culminate into a more defined expression through ongoing actions and greater reflection near or at the end of inquiries. For that reason, we have already encountered many findings in ec(h)o in less explicit forms like accounts, stakeholder views or predicted in rationales, like the notions of tactility, e-In13, where it became evident that a tactile approach to interactive technology strongly suited a natural history museum like the Canadian Nature Museum; and e-In14,



liveliness, in which we discovered how the power of locality of artifacts could bring information alive; and e-In15, deictic gestures, where workshops e-J9 and interpretation e-In6 made us aware of the natural constraints and consistency in deictic gestures, such as clapping.

ID	Interpretation (findings)	Sources
e-In13	Tactility	DIS 2006, PUCJ 2007
e-In14	Liveliness	DIS 2006, PUCJ 2007
e-In15	Deictic gestures	DC 2005
e-In16	Validation of cultural ecology as a descriptive tool	M&W 2005, DIS 2006, PUCJ 2007
e-In17	Information ecologies as a generative tool	M&W 2005, DIS 2006, PUCJ 2007
e-In18	TUI and embodiment	PUCJ 2007
e-In19	Balance of playfulness	DIS 2006, PUCJ 2007
e-In20	Situating TUIs	PUCJ 2007

**Table 11 A sub-category of Interpretation, findings in ec(h)o (see ec(h)o project abbreviations in Appendix 1 for sources).**

Table 11 shows the different findings in ec(h)o. For example, one finding is that the rationale cultural ecology, e-R1, is validated as a descriptive tool for museum in interaction design, e-In16. The cultural ecology framework proved a valued descriptor of the museum visitors and context, thus providing critical insights and scaffolding that aided design actions. Additionally, in e-In17, information ecologies, e-R2 was shown to be a generative tool in ec(h)o by guiding design actions and intentions such as the aim to make localized knowledge accessible, as well as seeking a complementary influence to current technology interests and use in the museum.

Another finding, e-In18, includes the need to consider embodiment in tangible user interfaces (TUIs). In situating the work of ec(h)o in relation to other TUI research we analyzed ec(h)o utilizing Orit Shaer's TAC paradigm (Shaer et al., 2004) and Kenneth P. Fishkin's taxonomy (Fishkin, 2004). For detailed findings see (Wakkary and Hatala, 2007).

In the analysis of ec(h)o within the TAC paradigm we stretched the paradigm beyond the confines of a purely tangible user interface. We applied Fishkin's taxonomy, which better addresses context, yet we found that the taxonomy encourages fully encompassing all actions within a tangible object. Given the role of embodiment and human movement, we found this to be a misplaced goal in TUI frameworks. This theoretical position overlooks the situational value of the taxonomy and risks overlooking developments in situated tangible user interfaces.

In following up on the design intention e-15 (see Table 1), creating a design in which play is equal to functionality, we discovered the need for a balance of playful intervention, e-In19. In ec(h)o there were two distinct issues with a design of a museum guide being "too playful." In the results of the evaluation e-J 29, playfulness was identified positively in all aspects of the interface yet overall satisfaction was split between those participants who enjoyed playing and those who did not. For example, one participant explicitly asked for a non-playful version. In another example, play with the system was a slight distraction and even an end in itself. Some participants became engrossed in playing with the system at the expense of interacting with their surroundings, which one participant commented happened to her periodically. While we felt we achieved a reasonable balance and are generally on the right track with the approach in ec(h)o, we feel more is required for a better understanding of how to design tangible user interfaces in regard to play.

#### **4.2.2.4 ec(h)o: criticism**

Extending the temporal dimension of a design inquiry, I included criticism of the inquiry and resulting outcomes as part of the inquiry. That is critique from those external to the process who argue from the point of view of design criticism. This is an approach I will

discuss further in Chapter 6. It is a desperately underserved aspect of interaction design, and almost as if to prove a point, there are no instances of criticism in the ec(h)o project.

#### **4.2.3 Reflexive account of actions in ec(h)o**

The framework offers a formal account of the actions of the ec(h)o project. The description disambiguates aspects of the experience within the formalized structure of the framework. In this section I provide a reflexive account to further inform the analysis and to add to the framework account.

In a project like ec(h)o, I often get the feeling of an internal movement or a flow to the design process that as a designer you can subtly guide or shift through redirections. In looking at design actions like scenarios and workshops, the dynamic or movement crystallizes to the point where different types are discernible. One type of movement was evident during the early to middle stages of ec(h)o between the scenarios and workshops. It was a symmetrical movement like a metronome, an action from a scenario or workshop in one direction was met with equal movement in another direction. At these stages of the process it seemed as if the dynamic of reactive forces propelled the project forward. Movement of opposing forces is often described as actions and reactions yet in interaction design terms I came to view the forces as the response of enactments (activities according to the framework) explored in the workshops to the detailed representations of scenarios. In design language, the dynamic is between representation and enactment. Each probed the other spurring corrective, generative, or more detailed explorations.

In my experience, there is such a feeling of push and pull between design actions that each takes on a material quality. In my mind's eye, I see each action as being elastic and thick, able to respond and dictate the movement I described above. This material quality is not unlike an ethnographer's idea of "thick description", whereby detailed and

contextualized descriptions give rise to intrinsic, relational, and even chance qualities that may not at first be evident. For example, the scenarios in ec(h)o, in particular, the video scenarios videotaped in museums were “thick” in their representations. The design team in ec(h)o mulled over the spacing between exhibits when walking through the museum paying attention to gait of walking, the subtle physical interactions of other museum visitors, understanding the pace of engagement and focus when walking through an exhibit, the look of being part of the museum environment or not and the handling of our physical or tangible interaction object. The material quality of the video scenarios was immediately apparent when we moved from text to storyboard to video scenarios. The actions of figuring how to “act” in the scenarios were informative and were the beginning of materializing the design idea. Further embodiment of the idea occurred when we situated each scenario in a particular museum, at first shooting video at a local museum and then later at the Canadian Nature Museum. The particularities in terms of space, setting, and visitor interaction of each location subtly changed the issues we focused on as designers.

The thickness of the scenarios prefigured the importance of how a visitor held and subtly played with the cube when interacting and when simply walking around the museum. The aesthetics of interaction showed a rich and varied set of possible interactions that we paid close attention to when evaluating ec(h)o in our user study. I saw that the value of an interaction object is really a varied and rich set that ranges from mindless play with objects to a seamlessly supporting an explicit interaction goal. Further, multiple paths with origins in play could lead the way to completing explicit goals. Uncovering the subtleties of aesthetics or feeling in interaction is not the stuff of quantified user studies, however neither is it the stuff of requirements gathering and problem solving highlighted in most design process. Like thick description in ethnography, the effects or factors are teased out

and interpreted. Often more descriptively resolved than analytically resolved yet highly important nevertheless. The thickness of the scenarios showing their embodied nature shed light on these design possibilities.

While interaction design might be seen to be dealing with ephemeral concerns like virtuality, behaviour, interactions there is in my view a substrate of embodied experience that interaction design rests upon. Earlier I described the dynamics between representation and enactment (activities) yet both are embodied. I discussed above the thick qualities of scenarios and workshops that are based on interactions of participants, situated presence, and engagement. This embodied nature of practice is evident throughout ec(h)o and critical to creating the degree of awareness and knowledge that informs the design. In the workshops in ec(h)o, participants engaged in activities and discussions that became intertwined such that stakeholder views were embodied in actions and words. For example, in a discussion in our first workshop where we explored gestures for interaction a participant was discussing how the actions of catching a butterfly were difficult to imagine. She clasped her hands together around her head and body as she spoke to the point where she rhythmically clapped by her head. This she then exclaimed was by far a better gesture – clapping! We then initiated a workshop activity with spatial sound and clapping in the direction the sound was coming from.

Embodiment and movement propelled ideas forward or in some ways carried design explorations and concepts – these concepts were sometimes explicit but more often embedded or tacit in the actions occurring. However as the process evolves and the design outcomes take on clearer shape the focus and actions shift from exploration to refinement. It seems obvious enough that this evolution toward refinement would happen in a design process. What is interesting is that it is not typically a linear progression. In my experience

it is a question of balance and finding the tipping point much like a seesaw. In ec(h)o, the project cycle was intensely exploratory at the beginning through to the third workshop and the paper prototype and then as if it hit a tipping point the momentum shifted and the focus became on refinement and incremental changes through to the finish and evaluation. As a designer, it's most interesting to sense the change in movement. There is a momentum to each, inertia. In my experience, intervention relies on the critical judgement of the designer and his or her interpretation of actions and events.

## **CHAPTER 5: PART TWO: TWO INTERACTION DESIGN INQUIRIES**

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### **5.1 The actions of socio-ec(h)o**

In this chapter I continue the analysis and description of the two interaction design projects. The chapter begins with the description of the actions of socio-ec(h)o, a responsive environment for physical play. Again, the aim is to illustrate the descriptive capacity of the theory by articulating the design experience into sensible and actionable descriptions. I will analyze the actions of ec(h)o and socio-ec(h)o and discuss the experience view of each in the remainder of this chapter.

As previously discussed (see 3.4.3 Actions), actions describe two types of actions: judgment and interpretation. These are the decisions and outcomes that determine much of the design. Again, this framework component describes the practice of interaction design, by making the detailed acts and reflections visible. I begin this section with a description of judgment actions in socio-ec(h)o, followed by actions of interpretation.

#### **5.1.1 socio-ec(h)o: judgment**

Judgments are integral to the ongoing decision-making in interaction design. These actions are the mechanisms of inquiry that keep the design inquiry progressing. Similar to

the analysis of ec(h)o, judgment actions are divided into four sub-categories: 1) representations; 2) activities; 3) models, artifacts, and systems; and 4) evaluations.

#### 5.1.1.1 socio-ec(h)o: representations

Representations are concrete outcomes of the designer's experimentalism. They mark points in the inquiry where sufficient shape has been given to a design possibility or the state of the inquiry. In the case of socio-ec(h)o, representations came in the form of design documents and written scenarios. Table 12 shows the different representations.

ID	Judgment (representations)	Sources
se-J1	Preliminary narrative models	MDDoc04
se-J2	Preliminary play models	MPGDoc04
se-J3	Trading game scenario	SC1Doc04
se-J4	Big toys scenario	SC2Doc

**Table 12 A sub-category of judgment, representations in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

Representations mark the progress of the design inquiry by reflecting the state of knowing at the time. Representations in socio-ec(h)o show how we experimented with defining aspects of the design situation. Preliminary narrative models, se-J1, and play models, se-J2, show that developing the game structure became a matter of shaping narrative and play. Unlike ec(h)o, scenarios played less of a role in socio-ec(h)o. The first scenario, se-J3, describes a trading game in which players gather and exchange resources as a means to alter their environment. The second scenario, se-J4, is a competing idea to se-J3 and not an incremental variation. se-J4 describes a playground environment made up of large toys that respond to players' interactions. Both scenarios take a tangible computing approach showing that our starting point was influenced by the previous ec(h)o project.



### 5.1.1.2 socio-ec(h)o: activities

Activities are an integral part to the proactive shaping of the interaction design inquiry or experimentalism. The designer inquirer creates activities to explore, resolve, and test design ideas or intentions. The designer inquirer, as an embodied inquirer is directly involved in each of the activities. In socio-ec(h)o, the majority of activities take the form of design charettes, design team workshops and participatory workshops that involved potential end-users. Table 13 catalogues the various activities as forms of judgment in ec(h)o.

ID	Judgment (activities)	Sources
se-J5	Walk home observations	WHDoc04
se-J6	Team interviews	IntDoc04
se-J7	Games and play charette	GPCDoc04
se-J8	Infinite play charette	IPDoc04
se-J9	Information ecology charette	IEDoc04
se-J10	Sensor charette	SDoc04
se-J11	Metaphor charettes	MWDoc04
se-J12	Sticks and Stones Workshop	W1Doc
se-J13	Environment workshop	W2Doc, ICAD2006
se-J14	Movement workshop	W3Doc, ICAD2006
se-J15	Trading game charette	W4Acc
se-J16	Here there workshop	W5
se-J17	Narratives workshop	W6,
se-J18	Lights out workshop	W8, DIGRA2005

**Table 13 A sub-category of judgment, activities in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

The project employed limited ethnography due to the lack of an end-user context for the design. Members of the design team conducted walk home observations, se-J5, in which they looked for instances of physical play in and around their neighbourhoods. Additionally, team members conducted interviews with each other on their ideas and experiences with play, se-J6.

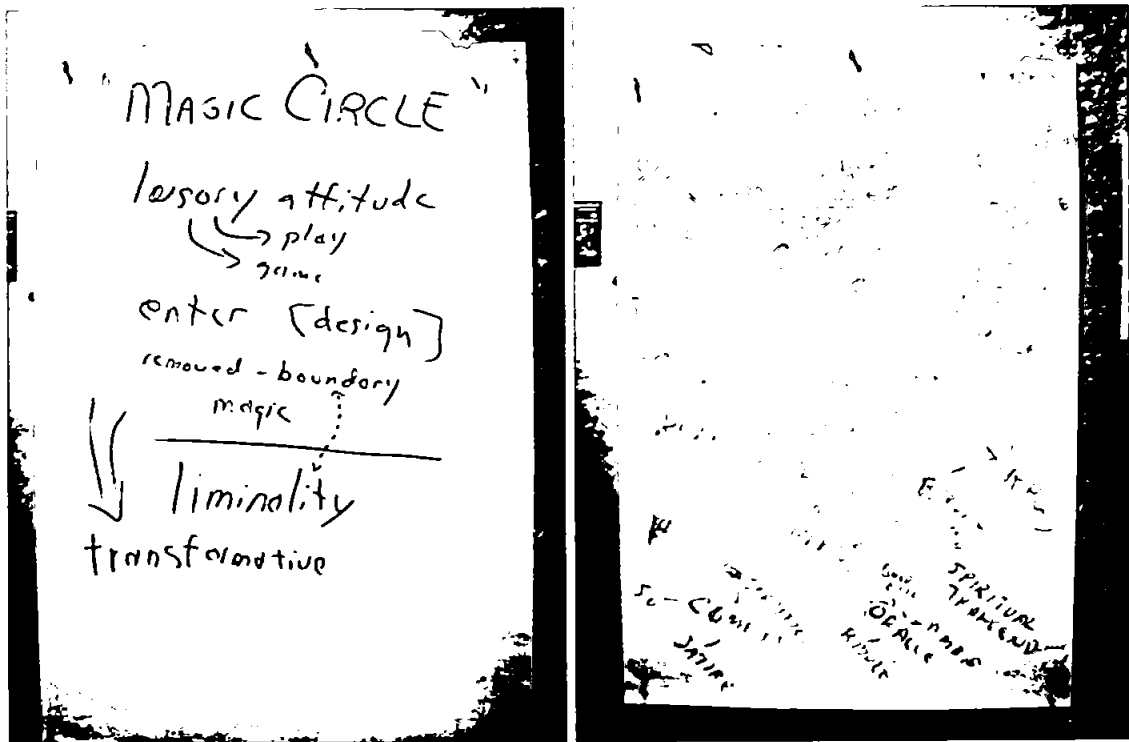


Figure 27 Notes from the games and play charette, se-J7

The mainstay of the activities in socio-ec(h)o were charettes and workshops. Charettes are typically collaborative sessions among design team members in which different design situations are explored and draft ideas are quickly sketched, improvised or even prototyped. In the case of socio-ec(h)o a series of charettes initiated the design process. The team met frequently over several weeks to investigate different ideas and experiences related to the project. Two charettes, games and play, se-J7 (see Figure 27), and infinite play, se-J8, explored game concepts like rules, mechanics, competition, deep play, risk, and rituals. Design team members constructed simple game improvisations, and investigated ideas of cooperation and competition. The charettes proved an effective way to quickly understand ideas as a group and begin the process of synthesising and generating design responses. The information ecology charette, se-J9, and sensors charette, se-J10, are good examples of this. The charettes allowed the team to improvise design ideas and test them quickly as in the metaphors charette, se-J11 (see Figure 28), in which the team



narrative and focused exclusively on embodiment over tangibility. This back and forth between the different foci continued close to the end of the project.

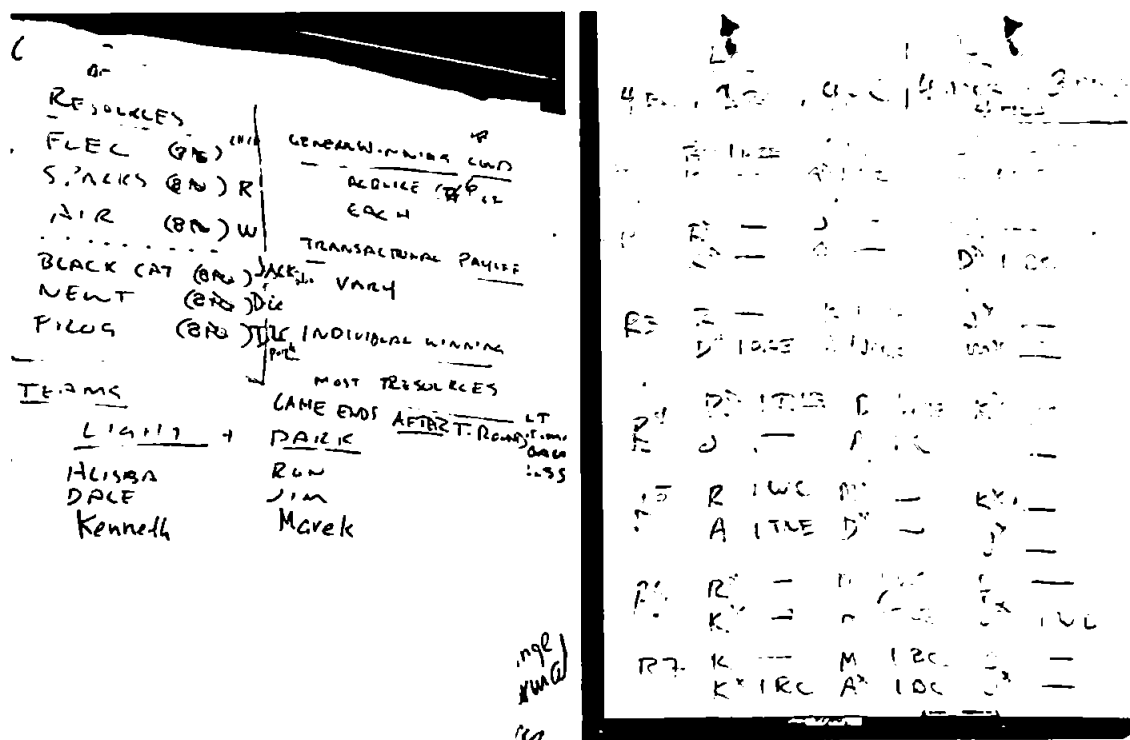


Figure 29 Notes for rules and scorekeeping during the trading game charette, se-J15

As stated earlier, participatory workshops formed the majority of activities in socio-ec(h)o. The idea of participatory workshops originates with Ehn's idea of design games from participatory design (Ehn, 1992). Here potential end-users engage in creative workshops facilitated by designers. Workshops are another good example of how an interaction designer inquirer proactively shapes the inquiry by conducting hands-on experiments that look to explore the design space and investigate possibilities. The following is the series of workshops we conducted:

se-J12 – “Sticks and stones workshop”: This workshop investigated group play with resources. In the workshop we divided groups into teams. We looked to see how gathering objects in a space could engender collaboration and competition. We also

played with the effect of environmental change based on participant actions. The workshop was held in a black box space and used “Wizard of Oz” techniques to mimic system responses (see Figure 30).



**Figure 30 Sticks and stones workshop, se-J12**

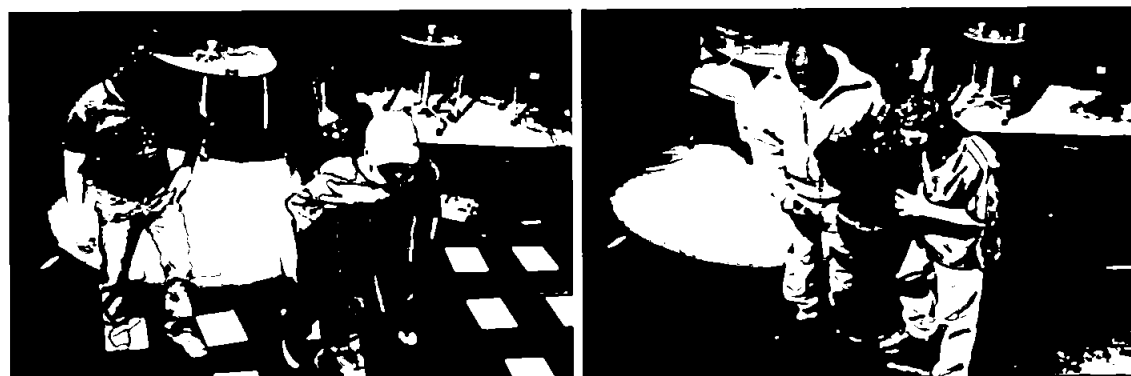
se-J13 – “Environment workshop”: This workshop was our initial exploration of sound avatars, game mechanics and narrative progression. The underlying focus was on the interaction patterns between players and system, and the role of the ambient response in audio and light. We subsequently invited participants to suggest changes in the environment and interaction rules based on their experience of the environment and their avatars.

se-J14 – “Movement workshop”: In response to se-J13 workshop, we focused on utilizing only four environmental sounds signifying wind, earth, water and fire and how participant movement and interaction affected understanding of the narratives of the sounds (see Figure 31). We aimed to see how identity might establish itself in play. We also looked to see if participants would perceive identity and narrative in the audio and visual displays.



**Figure 31 Movement workshop, Se-J14**

se-J16 – “Here there workshop”: This workshop investigated an alternate path to narratives by exploring the role of puzzles and games in physical play. Participants generated physical puzzle games for each other using paper and other materials. Puzzles were then experimented within a black box responsive environment.

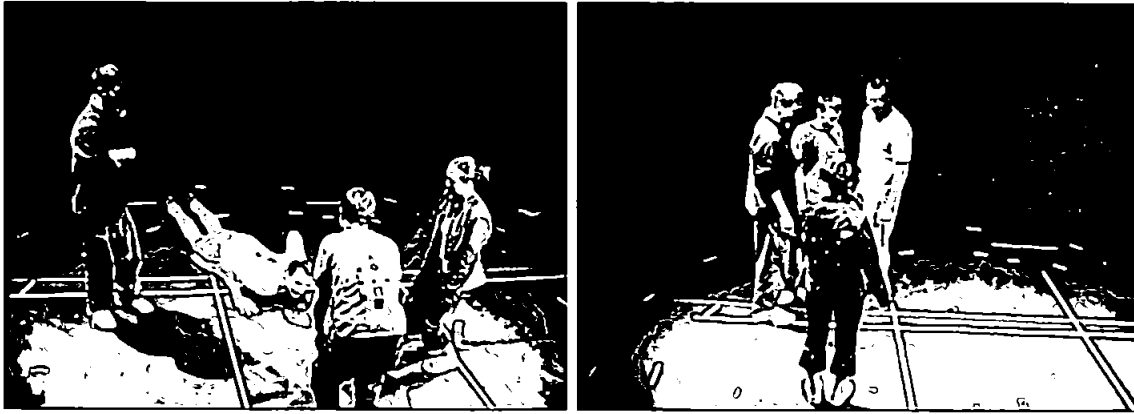


**Figure 32 Here there workshop, se-J16**

se-J17 – “Narratives workshop”: This workshop aimed to formalize a narrative approach to socio-ec(h)o. Interestingly, the team had more or less decided that a more embodied and puzzle approach would work best and so this workshop aimed to put the narrative question to rest.

se-J18 – “Lights out workshop”: This workshop built on workshop se-J16 by experimenting with more structures, formalizing responses from the system, and

overall gameplay (see Figure 33). The results were similar to the final prototype in socio-ec(h)o.



**Figure 33** Lights our workshop, se-J18

### 5.1.1.3 socio-ec(h)o: models, artifacts, systems

Models, artifacts, and systems are the most visible of judgment actions as they are typically seen as outcomes in interaction design. In socio-ec(h)o, these took on the form of models, parameters and prototypes. The instances of models, artifacts, and systems are catalogued in Table 14.

ID	Judgment (models, artifacts, systems)	Reference
se-J19	Game model	MM2005
se-J20	Interaction schema	MM2005
se-J21	Narrative model	MM2005
se-J22	Final prototype	MM2005
se-J23	Sensing parameters	MM2005
se-J24	Rigid back tags	MM2005
se-J25	Battle types implementation	MM2005
se-J26	Intensity model	MM2005
se-J27	Audio display model	MM2005, CHI2006
se-J28	Visual display model	MM2005
se-J29	Prototype I	DIGRA 2005

**Table 14** A sub-category of judgment, models, artifacts, systems in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).

Theme	Levels	Body State	Goal	New Game Skill
Discovery of light	1	"high-low"	create day	body position
Day for night	2	"moving low"	create night	movement/ duration
	3	"loosely moving"	create day	proximity
Rhizome	4	"dense center - scattered edge"	create spring	sequencing
	5	"this way slow - low to high"	create winter	sequencing/ duration
Biota	6	"two low moving - two high"	create summer	composition
	7	"ringing around the rosie"	create fall	composition & location

Table 15 Game model, se-J19

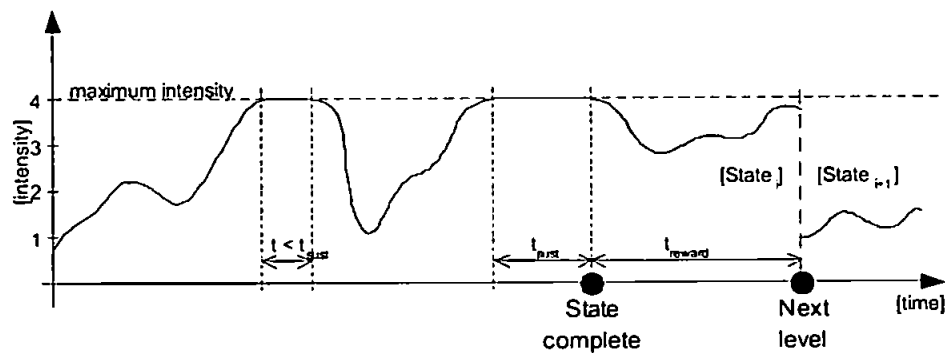
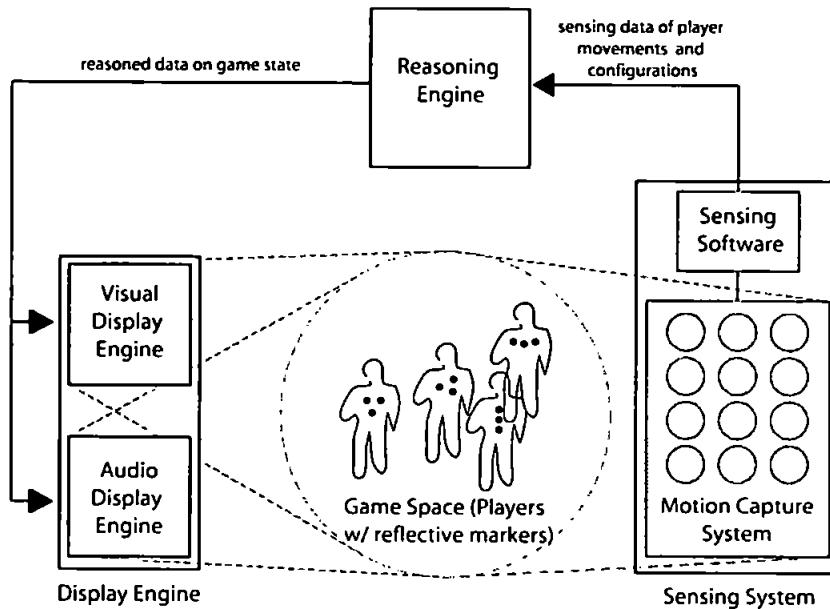


Figure 34 Representation of the intensity model, se-J26 during game play

The first three actions of models, artifacts, and systems laid the foundations for the design in socio-ec(h)o. The following models: game model, se-J19 (see Table 15), interaction schema, se-J20, and narrative model, se-J21, together form the basis for the system design. The game model, se-J19, sets out the formalization of the system as a game with rules, rewards, goals and skills. The interaction schema, se-J20, models the response of the system to participant actions and the intent or support intended by the designed responses. For example, the intensity model, se-J26 (see Figure 34), emerged from the interaction schema. In the end, we considerably played down the narrative aspects of the



game in comparison to some earlier explorations. Nevertheless, a narrative model, se-J21, underpins the display models of audio and visual. The aim is to provide a perception of coherency and natural progression between the game levels.



**Figure 35 System architecture for the final prototype, se-J22**

Technical prototyping was the consolidation of numerous technical experiments and the emerging design of the system. A preliminary prototype, se-J29, was used in workshop se-J18. The final technical prototype, se-J22, for socio-ec(h)o includes three key components: a sensing system, reasoning engine and display engine. The sensing system is comprised of a twelve-camera Vicon MX motion capture system ([www.vicon.com](http://www.vicon.com)) and a custom program written in Max/MSP. Each participant is differentiated by a unique configuration of reflective markers worn on his or her back. Data is transmitted to the reasoning engine for high-level interpretation. The reasoning engine provides the intelligence for the system. It interprets the sensing data samples in real time, identifies the level of body state completion, and manages the narrative flow of the experience. The engine receives sensing data from the sensing system and interprets it in terms of high-level

group behaviour. The display engine has two components: an audio and a lighting component. The audio display engine for socio-ec(h)o provides a sound ecology for each individual level of the system. It is custom software programmed in Max/MSP. Lighting is manipulated with a DMX 512 controller via a Max/MSP patch. A small light grid and theatrical style lighting instruments as well as colour scrollers are used.

Other actions were judgments used to build out the various models and final prototype as the project progressed. For example, rigid back tags, se-J24, was an incremental innovation by Robb Lovell, a PhD student on the design team, that allowed us to utilize the high resolution motion capture and maintain unique identification of multiple individuals. This worked especially well given the relative low resolution of our sensing parameters. In fact the sensing parameters, se-J23 (see Table 16), underpin the interaction schema. The parameters emerged from the series of charettes and workshops. In the model, sense data of individual movements are reasoned in the following parameters: “low/high”, “middle/outside”, “fast/slow/still”, “near someone/not near someone”, “travelling/stationary”, “direct/indirect motion, velocity”, “location”, “direction”, “facing north-south/east-west/horizontal” and “visible/hidden”. Composite values for the groups are determined by compiling the individual states into a group value determined with an intensity rating. This rating is based on the intensity model, se-J26 that was previously mentioned. The model maps the trajectory of the body states to a participant’s actions in order to determine the intensity level, or proximity to the desired body state. The intensity level is measured from 0 to 4 with 4 representing the maximal intensity or state completion. The intensity function is not computed by a single formula but is defined by heuristics that are applied in full response to the current state of the game. The overall shifts in intensities

toward and away from the goal must be represented in a gradient effect yet be sufficiently real-time in order to best support actions in the environment.

Parameter	Threshold	Timing	Values
<i>Activity</i>	n/a	n/a	Visible/Lost
<i>Level</i>	700-900 mm	n/a	High/Low
<i>Speed</i>	0 & 1.5 mm/sec	2 sec	Still/Slow/Fast
<i>Space</i>	140-170 mm	2 sec	Stationary/Travelling
<i>Position</i>	600-800 mm @ 0,0,0	n/a	Middle/Outside
<i>Path</i>	2-3 changes	2 sec	Direct/Indirect
<i>Orientation</i>	.5 radians	1 sec	N-S/E-W/Horizontal
<i>Density</i>	600 or 1250mm	1 sec	Loose/Dense
<i>Duration</i>	n/a	4 sec	Short/Long

**Table 16 Sensing parameters, se-J23**

Two other models make up the final system. The first is the audio display model, se-J27, which uses several techniques for gradient responses that map to the intensity model. The techniques include variance and coherence (Truax, 1999), which refers to the changing of the sameness and diversity of sounds, the colour of sound that alters the core characteristics like amplitude, pitch, and tempo, and the final technique is the use of filters that among other things altered the sharpness of sounds creating space in the perception of sounds. The identity of the sounds were then mapped to the different difficulties and characteristics of the word puzzles, and used to support the underlying subtle narrative of evolution through the game levels.

The second model that makes up the final system is the visual display model, se-J29. This model uses two techniques to provide a gradient response to the participants. Initially, the only feedback provided was based upon intensity of the overall lighting in the room. As participants came closer to achieving the goal, the lighting moved toward a condition of light or dark that corresponded to the system's estimation of closeness to the goal. Direct mapping between intensity and goal closeness is used. While this is a useful

technique for providing feedback, it did not provide much room for creating an ambient environment. A second technique allowed for environmental ambience and feedback to the participant by using a relative gradient between two states (two lighting states such as different colours and lighting levels for fall and winter). Transitions in the lighting were based on the value of the intensity function. This is used to signal the lighting to transition toward the goal state over a fixed period of time (10 seconds). If the participant moves away from the goal, the lighting moves toward the other environmental state (the start state). At any point if there is no progress, or there is negative progress, the system moves toward the non-goal environmental state. When the goal state is achieved, then the lighting moves to the goal environmental state.

Lastly, we came up with an implementation model for Bartle types, se-J25. As explained earlier, Bartle described four types of MUD players that interacted together differently, forging particular types of collaborations. The model is essentially two distribution patterns of Bartle types in teams of four. The model itself is theoretical in that we did not implement it in the system but used the model to determine team compositions for evaluation. The aim was to have two different data sets that we could analyse for potential group user modelling.

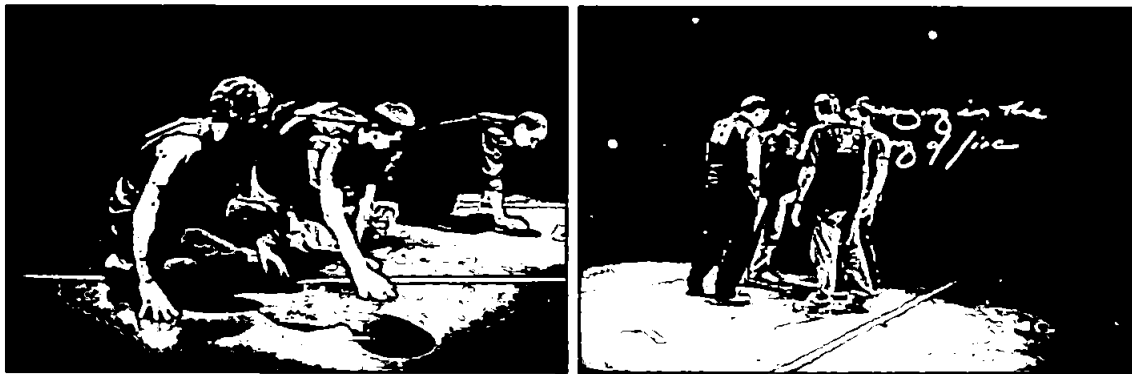
#### **5.1.1.4 socio-ec(h)o: evaluation**

socio-ec(h)o included a preliminary evaluation, se-J30 (see Figure 36), followed by a significantly more structured and larger study and evaluation, se-J31 (see Table 17) (Wakkary et al., 2005). The preliminary study, se-J30, included two three-hour sessions with eight participants, and an additional two-hour session with four other participants. The groups included three females and nine males ranging in ages from twenty-one to fifty-nine. Two of the three teams had a gender mix. Each team of four played two levels

followed by questions and discussions. After all levels were achieved or a total of two hours of interaction (60 minutes in the shorter version) had taken place, the game was stopped and a general open-ended interview and discussion took place.

ID	Judgment (evaluations)	Sources
se-J30	Preliminary evaluation	MM2005, CHI2006
se-J31	Study and evaluation	TEI2008

**Table 17** A sub-category of judgment, evaluations in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).



**Figure 36** Preliminary evaluation, se-J30

The final study and evaluation, se-J31 (see Figure 37), included 56 participants (Wakkary, 2008). This produced 14 teams of 4 players. The study participants were divided into two groups, each with slightly different protocols, yet they generally shared the same process. Each session began with a warm-up that introduced the concept of puzzles solved through physical action that was helped by implicit responses. The warm-up was a modification of the child's game of "hot-cold." Participants were also played a range of sonic cues and rewards in order to adjust their perceptual hearing to our sound ecologies. Each team of four played the first four levels without any intervention from the research team. After a short break the last two levels were played. A time limit of 15 minutes was given for completing these last levels. The evaluation was performed with the socio-ec(h)o prototype in our 'black-box' lab environment. The sessions were videotaped and audio

recorded. In addition, each participant wore a wireless microphone to record conversations. Following the sessions each participant completed a questionnaire (see 6.1.2.2 Evaluation in socio-ec(h)o).

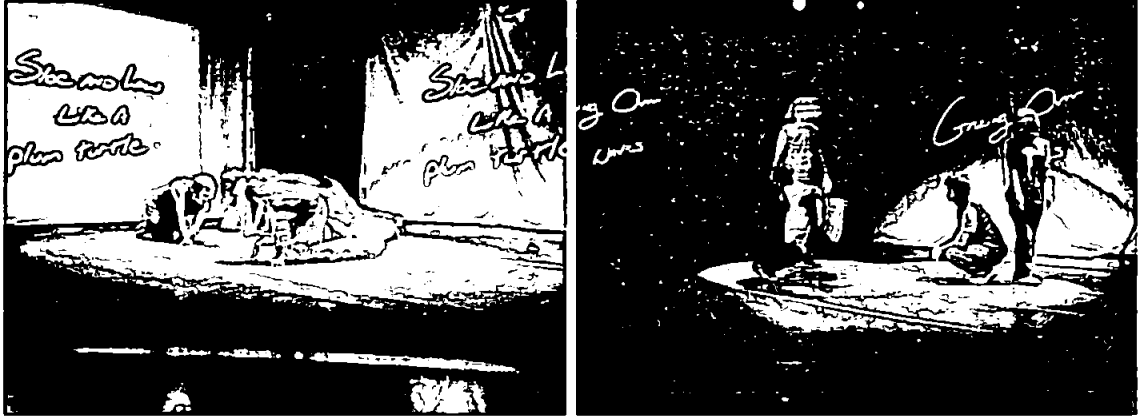


Figure 37 Final evaluation, se-J31

### 5.1.2 socio-ec(h)o: interpretation

Multiplicity in interaction design roots the field in interpretation. The successful design inquirer uncovers multiple design possibilities. These myriad possibilities need to be negotiated. In design, this calls for the constant reflection and analysis of conditions on the part of the designer. These types of actions are acts of interpretation that can be sub-divided into four sub-categories: 1) accounts; 2) stakeholder views; 3) findings; and 4) criticism. This section will detail three of the four sub-categories in socio-ec(h)o. As with ec(h)o there are no instances of criticism.

#### 5.1.2.1 socio-ec(h)o: accounts

As I discussed in the previous chapter (see 4.2.2.1 ec(h)o: accounts), accounts are self-reflections of actions that guide the interaction designer and team. Accounts are signs of designers making sense of what is happening in the inquiry and the effect of their actions. In socio-ec(h)o, the actions are catalogued in Table 18.

ID	Interpretations (accounts)	Sources
se-In1	Midway reflection	ICAD2006
se-In2	A stick is not a stick	WHODoc
se-In3	Social engagement and rest in physical play in the playground	PODoc
se-In4	Cohesion schema	TEI2008
se-In5	Goal focus schema	TEI2008
se-In6	Density	TEI2008

**Table 18 A sub-category of interpretations, accounts in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

Midway and ongoing reflections on the part of designers are part of the process, however they rarely are explicit. Even internally, while summaries of design activity or project management may occur in design meetings and internal documents, things like design diaries are rarely kept. No such diary was kept in the case of socio-ec(h)o but a midway reflection, se-In1 was published (Droumeva and Wakkary, 2006):

The two workshops that we describe came midway through the design process. We had previously hosted several other participatory workshops and conducted concept development meetings where we developed the conceptual foundations of socio-ec(h)o, which included core game mechanics, game progression and structure, and narrative development. We had yet to build a working prototype. Our main concern at this stage was the design of a compelling environment based on user engagement, movements in physical space, immersion, and narrative or game progression. We knew at this point that we needed to investigate specifics in the role that the audio display would have. We had determined that the technical preconditions included location tracking, and an ambient interface that might involve body and object movement, location, and gestures. Given the Aml [ambient intelligence] nature of the project we ruled out a graphical user interface of any kind (Droumeva and Wakkary, 2006, p.37).

Two accounts emerged from the field observations that helped orientate us early in the design process: se-In2, a stick is not a stick, and se-In3, social engagement and rest in physical play in the playground. In se-In2, observations illustrated how children in play could use objects as a metaphoric stand-in for play objects. For example, a stick found on the way home from school could become a fishing rod, a bow and arrow, a pencil, a tree hitter and musical instrument. In se-In3, observing children playing in a playground

showed that while play was highly physical it involved a great deal of social interaction, namely eye contact and verbal communication. Additionally, intensive play would be punctuated by moments of rest or stillness, which children seemed to use to figure out what to do next or to sort out what just happened.

The remaining accounts are analytical schemas for the data that resulted from the evaluation. Interestingly, our focus on collaboration among Bartle types in group play proved to have little significance. Based on our own preliminary and internal findings, plus observations like the accounts above and those from the workshops, we devised two schemas and a metric for data analysis. We collected video and audio data from our evaluation sessions for qualitative analysis. To aid the analysis we devised two schemas for video coding based on group cohesion, se-In4, and goal focus, se-In5. We felt these two dimensions formed a useful matrix for plotting players' attentions in respect to both the social and play aspects of the interaction (Wakkary, 2008).

In se-In4, the cohesion schema, cohesion can be described as the extent to which players appear to be acting as a team (all members coordinating together); whether that is working on a game solution, playing, thinking, or talking to each other. Cohesiveness is a measure of team dynamics and does not necessarily reflect players' focus on the game but only whether players are acting in unison as a team. It is in se-In5, goal focus, that we studied teams' focus on the game. Goal focus can be described as the extent to which players appear to be or are attempting to "play the game" the way they understand it. Game activity is not dependent on whether players are working as a team or not. In addition, game activity does not necessarily only mean that players are actively playing, i.e. in our case moving. If players are still because they believe the game requires them to be still, then



they are “playing the game.” I also discuss the evaluations and findings in more detail in Chapter 6 (see 6.1.2.2 Evaluation in socio-ec(h)o).

In order to support statistical analysis of the results we determined a density value, se-In6 in which our analysis looked at the different levels of cohesiveness and goal focus over the duration of each level in order to determine a density value in percentages. We looked for combinations of density values of the different degrees (high, medium, low) of the two factors (cohesion, goal focus) and compared these to team performance or duration of the game level. This provided a level of quantification of our interpreted results.

#### **5.1.2.2 socio-ec(h)o: stakeholder views**

The stakeholder views in socio-ec(h)o were not as explicit as they were in ec(h)o (see 4.2.2.2 ec(h)o: stakeholder views). The views were discerned from interviews conducted after workshops and from observations of actions during the workshops. These include the perceived engagement of puzzles over narratives, se-In7. Participants expressed in interviews and through actions that in relation to physical play, the puzzle activities in se-J17, the narrative workshop, were more engaging. We found a recurring pattern in workshops se-J12, se-J14 and se-J17 the need to try to “break rules” and “trick” the system, se-In8. This led us to design simple rules and clear system responses as best we could. In workshop se-J16, the physical and body puzzles we experimented with were highly successful and it was stressed to us that this type of activity was both engaging and rewarding. Lastly, it was evident throughout the workshops beginning with the movement workshop se-J14 that participants quickly got over the novelty of system responses to interactions and that they looked for additional depth and challenges in the interactions, se-In10. Table 19 lists the different stakeholder views.

ID	Interpretation (stakeholder views)	Sources
se-In7	Puzzles over narratives	NWDoc
se-In8	Rule breaking and tricking the system	NWDoc
se-In9	Physical and body puzzles	HTTWDoc
se-In10	Seeking more challenges	MWD0c

**Table 19 A sub-category of interpretations, stakeholder views in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

### 5.1.2.3 socio-ec(h)o: findings

Table 20 lists the findings in socio-ec(h)o. The findings were a result of the evaluations discussed in the previous section. The initial three findings can be considered to be formative in that they supported refinements to the ongoing design of the system. For example, the method for construction of group parameters, se-In13 supported our composition of individual sensing parameters into a group value. We used this method in our preliminary evaluation se-In11, and it showed through observations and participant interviews to be convincing and effective. Similarly, we found that relative direction in the visual display was an effective technique, se-In14. We tried two techniques for responding to participant action in the visual display, absolute positioning of lights, e.g. more areas of the space would be lit as participants progressed toward the puzzle answer, and a relative focus of light relative to participants' position. The latter proved to be more informative to the players. In another finding, we found that in participatory design workshops and preliminary user testing, the perception of intensity in the displays, se-In15 was quite rewarding to the participants and encouraged their attentiveness towards the environment; both for light and sound display, interchangeably or complementary to each other. As well, our representation of intensity was largely successful as participants were able to identify their progress throughout the game based on the environmental cues.

ID	Interpretation (findings)	Sources
se-In13	Method for construction of group parameters	MM2005
se-In14	Relative direction in visual display	MM2005
se-In15	Perception of intensity display	MM2005, CHI2006
se-In16	High level of cohesion and goal focus does not necessarily lead to good performance	TEI2008
se-In17	Transitions are an influencing factor	TEI2008
se-In18	Players' perceptions	TEI2008
se-In19	Aural fluency	ICAD2008

**Table 20 A sub-category of interpretations, findings in socio-ec(h)o (see socio-ec(h)o project abbreviations in Appendix 2 for sources).**

The data from the final study and evaluation, se-In12, was analyzed with attention to how groups interacted in socio-ec(h)o. Utilizing the schemas se-In4 and se-In5 discussed above, we found that a high level of cohesion and a high level of goal focus does not necessarily lead to better game performance in socio-ec(h)o, se-In16. This led to our other finding of transitions as an influencing factor, se-In17. We found that transitions from different levels of coherence and goal focus held statistical significance when compared against performance virtually throughout levels 3 and 4 of the game, except for transitions to high cohesion. Transitions were a better indicator of performance, at least in terms of speed in completing the puzzles. In other words, teams that made fewer transitions, i.e. shifting between different degrees of either cohesion or goal focus, completed levels faster. We found that transitions allow players to strategize, analyze the system's response (similar to our observations in the playground in se-In3), and to communicate, in that order. It is clear that fewer transitions may help a team to perform faster but that does not mean that no transitions are an optimal pattern.

In another finding, se-In18, players' perceptions did not match players' performance. We examined the relationship between players' perception of the helpfulness of the system and their performance. No correlation was found, thus fast players did not

necessarily believe the system to be more helpful than slow players. However, there was a significant relationship between players on teams who completed the most levels and their perception of the support of the system. This suggests that the more “skilled” players (those who could complete the higher levels) perceived the system to be more helpful. I discuss the findings in further details in Chapter 6 (see 6.1.2.2 Evaluation in socio-ec(h)o).

Our last finding, aural fluency, se-In19, arose from a careful look into the relationship between progression and skill acquisition between the two settings, which led us to consider the concept of aural fluency as a skill in its own right (Droumeva and Wakkary, 2008). In other words, participants developed a certain competency about interpreting the sonic feedback as they played. In our final evaluation, se-In12, we described two protocols. In one protocol, participants had a manual that guided them through the levels 1-4. These groups did not rely on the audio display feedback for most of the game, which could explain why they had trouble and less patience for it in levels 5 and 6 when they had to rely on it. In contrast, non-manual groups, especially ones who took awhile to solve certain levels, built up an aural fluency over time which allowed them to better interpret the system’s feedback, and with more subtlety, which resulted in a deeper connection to the system and a more positive view of the auditory display as being helpful. The concept of aural fluency may not directly explain how better performance can be supported by ambient audio display, however it does suggest a “necessary but not sufficient condition” for that support. Players must first establish a level of fluency in understanding and responding to the dynamics of subtle, complex and changing audio, not unlike acquiring a new language before achieving gains in performance or higher levels of communication.

### **5.1.3 Reflexive account of actions of socio-ec(h)o**

In this section I provide a reflexive account of the actions of socio-ec(h)o. Similar to the reflexive account I gave of the ec(h)o project (see 4.2.3 Reflexive account of actions in ec(h)o), the intuited themes I discuss here weave in and out of the analysis provided by the framework in the preceding section. In respect to ec(h)o, socio-ec(h)o is unique and its own project yet its not surprising that as part of the same design practice I'd reflect on similar themes.

In this reflexive account I return to the discussion of movement in interaction design projects. I discussed how with ec(h)o (see 4.2.3 Reflexive account of actions in ec(h)o). I get the feeling of an internal movement or flow with every project, in which the role of the designer might be to directly intervene to change the pace of the process or to move the direction differently but more than not the role is to guide and shift incremental redirections. I discussed how in ec(h)o, the early to middle stages of the process felt like a metronome, in socio-ec(h)o the sense of movement was present but different. What is clear from the analytical account (see 5.1.2 socio-ec(h)o: interpretation) is that socio-ec(h)o was exploratory up until very late in the process. The result was a high degree of experimentation throughout and a constantly changing set of factors. The flow of socio-ec(h)o mirrored this situation. The overall movement is one of constant exploration, trial and error, and adapting to changing circumstances with only an emerging overview. The felt risk is high, which is both thrilling and taxing for a designer. In socio-ec(h)o, the experimental nature was a result of the novelty of the design and the lack of any clients or constraining factors. Similar to ec(h)o, the movement is internal to the project and has its own inertia. The interventions of the designers need to be measured, informed, and rely on judgment as much as calculation.

The movement in socio-ec(h)o is similar to navigating while sailing with only a general direction in mind and the need to adapt and change course whenever it is deemed required. Like a ship, the trajectories are dependant on environmental factors of land, water, wind, and heat. This combination changes constantly and a straight course is not possible, rather a ship tacks or zigs and zags from one point to another leveraging or mitigating the environmental conditions in order to successively average one's way in the correct general direction. In the exploration of the design experience, as in socio-ec(h)o, path-setting and path-finding become the same thing, that is one sets navigation while simultaneously exploring new space. In sailing, there is a navigational approach known as "dead reckoning" in which a current position is estimated based on a previously determined position known as a "fix". In reflecting on socio-ec(h)o, interpretations of actions are a design way of determining a position or setting a "fix". For example, in socio-ec(h)o there is the ongoing need to determine the design value of an action. This occurred early on in the project when interpreting observations of social engagement and rest when playing in the playground. Judgment that spurred on actions was a calculation of future direction based in previous interpretations or "fixes". This dynamic of "dead reckoning" in socio-ec(h)o continued late into the project creating the impression or reflecting the fact that even as the project was coming to a resolution many possibilities remained open up until the last possible moment.

One would be forgiven if in reading the description above the reader feels that the project was at times adrift or reactive. That may well be but for the most part the nature of socio-ec(h)o is best explored with a high degree of concurrent divergence. I found this exciting since it allowed for experimentation until the end, however despite the divergence there was in the process a cumulative commonality among the different paths. That is

similar ideas and themes would re-emerge time after time albeit in different form and not always very explicitly. For example, our early interpretation of “a stick is not a stick” (see 5.1 The actions of socio-ec(h)o) was a reminder that objects or rules are highly interpretable and used in imaginative and playful ways that are richer than considering only the utility value of the object or rule itself. We constantly came across this interpretation in our charettes and workshops where less and simpler rules and resources created more imaginative and engaging situations than complex and rigid rules. That in itself is not a surprise but we needed the constant reprise of this interpretation and judgement to help us find the right degree of simplicity and minimalism. In socio-ec(h)o, it was fascinating for me to see this reminder to be simple show up in different forms from notes in a charette, to discussions in a workshop, to issues to resolve in a prototype.

The inherently divergent strategies of exploration were responsible for the sheer number of possible paths in the design. Even more challenging (or exciting) was the fact that these possibilities existed through to the later stages of the design. In ec(h)o, I discussed the feeling of a tipping point in the process where the project shifts from exploration to refinement. In socio-ec(h)o this tipping point occurred very late in the project. Lastly, similar to ec(h)o, the design actions took on a sense of materiality. The concurrent and divergent paths explored and being explored accrued actions and prototypes that felt like thick and entangled pathways that were laid bare but given a persistent presence. In some sense, this to me is similar to the “archaeological map” of the painter’s studio discussed in Chapter 3 (see 3.5 Reflexive account of the framework).

## **5.2 The experiences of ec(h)o and socio-ec(h)o**

### **5.2.1 Integrity of actions**

In my description of ec(h)o and socio-ec(h)o I hope I made it evident, if not explicit, that design actions interact together in clear and specific ways. These actions work in concert across the different parts of the framework. In essence, it is the very interaction among the actions and elements of the inquiry that is responsible for the exploration of the design space and from which design outcomes ultimately emerge. Understanding the relationships among these aspects, as entities-in-interaction, allows the quality and the nature of the pragmatic inquiry of design to become clearer.

Similar to the design inquiry, actions consist of interactions between acts of judgment and interpretation in ways that mobilize the inquiry. The mechanics of judgment and interpretation actions are critical to design exploration. Generally, interpretations arise from reflecting on actions. However, not all actions are followed by reflection or interpretation like a predictable action-reaction causality chain. The patterns of interaction between the actions do not predictably or linearly take shape (I will later show how many judgments and interpretations simply lead to the next judgments or interactions). While at other times actions create a series of interpretations. This is evident when the relationships among judgment and interpretation actions are mapped. In Figure 38 and Figure 39 the actions relationships have been mapped in ec(h)o and socio-ec(h)o, respectively.

The strength or depth of the inquiries can be seen in the level of integrity between actions. Similar to the discussion of integrity within the design inquiry, the kind and quantity of connections plays out in actions. In fact, this idea of integrity is what holds the whole inquiry together. The theory makes sense of the dynamics and activities surrounding the design process. It aims to clarify the entities-in-interaction and bring to them



descriptions of quality and kind. Integrity can be seen at its simplest level of understanding as the dynamics of interaction design. It answers the question: to what degree do these events or entities support each other? In some sense the aim is to find a structural integrity among the events that simultaneously expands the inquiry and mobilizes it by moving it forward. For example, in Figure 39 we can see that se-J1, preliminary narrative models, is not supported by any connections to interpretations. As it turns out, narrative played a minor role in the design of the interaction and the system. Determining the reasons for this requires a better understanding of the qualities of the integrity or relationships. In the discussion that follows I describe the qualities of the relationships by describing mirrors and feedback loops, formative findings, and summative findings.

Mirrors and feedback loops extend the reflection in interpretations by reflecting back into a judgment action or a new design event. As an example, stakeholder views illustrate the idea of mirrors and feedback loops well. In ec(h)o (see Figure 38), several workshops, e-J9 and e-J10, were interpreted by stakeholder views e-In6, where clapping was a favoured interpretation of a gestural response to spatial audio, and e-In8, where taped together children blocks were seen as an effective tangible resource for navigating audio. In each case, the stakeholder views reflected back into the judgment process of design by influencing the actions of scenarios that created new representations of the design. By contrast, e-In7, the toolbelt that resulted from workshop e-J10, cannot be said to be a mirror or feedback loop relationship since it has no further impact on design actions. In socio-ec(h)o (see Figure 39), similar to ec(h)o, the stakeholder views like se-In7, se-In8, se-In9, and se-In10 that interpreted the actions of workshops se-J16 and se-J17 reflected back into the inquiry in new design actions. In this case, the stakeholder views directly influenced models in socio-ec(h)o like se-J19, the game model, se-J20, the interaction model, and se-

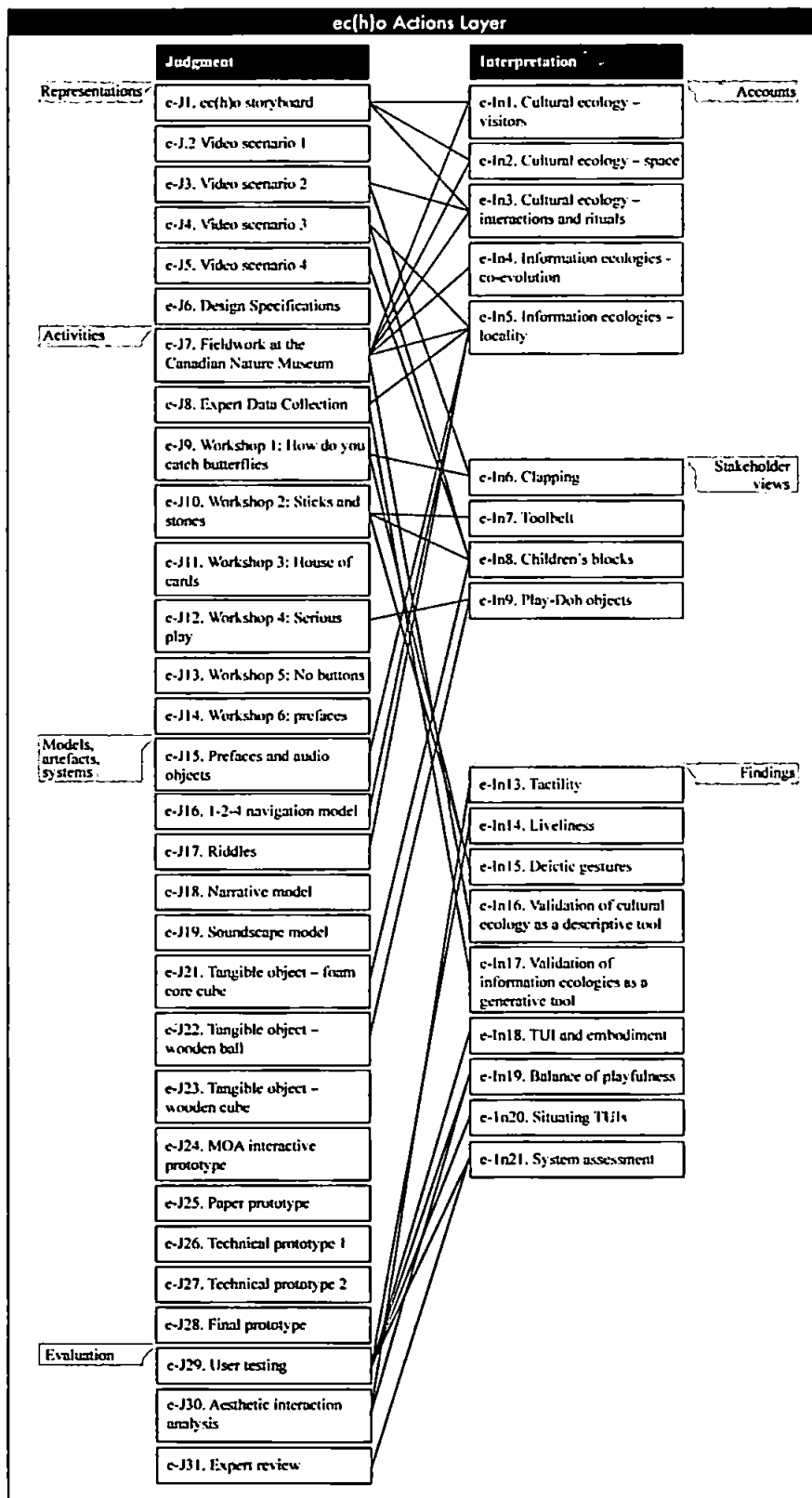
J21, the narrative model. This shows a greater reliance on scenarios in ec(h)o and the need to emphasize workshops in socio-ec(h)o given the phenomenological and embodied aspects of the design intentions.

Mirrors and feedback loops are not only manifest in stakeholder views. They are a quality that extends to any relationship. For example, in socio-ec(h)o (see Figure 39), the actions of se-J5, walk home observations, resulted in an interpretation in the account se-In2, a stick is not a stick. This account influenced se-J3, trading game scenario. Similar examples can be found in ec(h)o. So mirrors and feedback loops can be found across the inquiry.

There is a particular type of reflection that needs to be noted. It is the idea of formative findings. Findings play a key role as an outcome in research and design practice. They are the tangible outcome we point to other than design artifacts. They can potentially improve our design abilities and design knowledge. Typically, findings refer to validated conclusions or results that are at minimum definitive and are a contribution to what is known, i.e. the findings are new. I will refer to this more traditional understanding as summative findings. Formative findings are a substantive formulation or interpretation that can be used immediately in the design inquiry, typically to push the inquiry further. For example, in socio-ec(h)o, a method for construction of group parameters, se-I13, was realized in the preliminary evaluation se-J30. This method was put directly to use in determining the sensing parameters, se-J23 in the final prototype. In ec(h)o this can be seen with e-In15, the role of deictic gestures, which is a substantive interpretation discovered early on in the design inquiry in the e-J9 workshop. The finding shaped the inquiry and the judgments on exploring tangible user interfaces at an early stage of the project by informing workshop e-J10.

There is a qualitative difference between formative and summative findings.

Formative findings need to be definitive enough that they offer prescriptive directions for design actions, like a method for specifying sensor parameters. The issue of validation can also be of a different order. The value of a formative finding is its relevancy to the inquiry at hand. This judgment rests with the designer inquirer. Formative findings may be generalized as in the case of summative findings yet they need not be. Returning to summative findings, the theory suggests that the interpretation cycle is ongoing and therefore findings (summative and formative) are open to criticism and ongoing debate. Unfortunately, neither ec(h)o nor socio-ec(h)o provides a good example of interaction design criticism.



**Figure 38** Diagram showing the relationships between judgment and interpretations in ec(h)o.

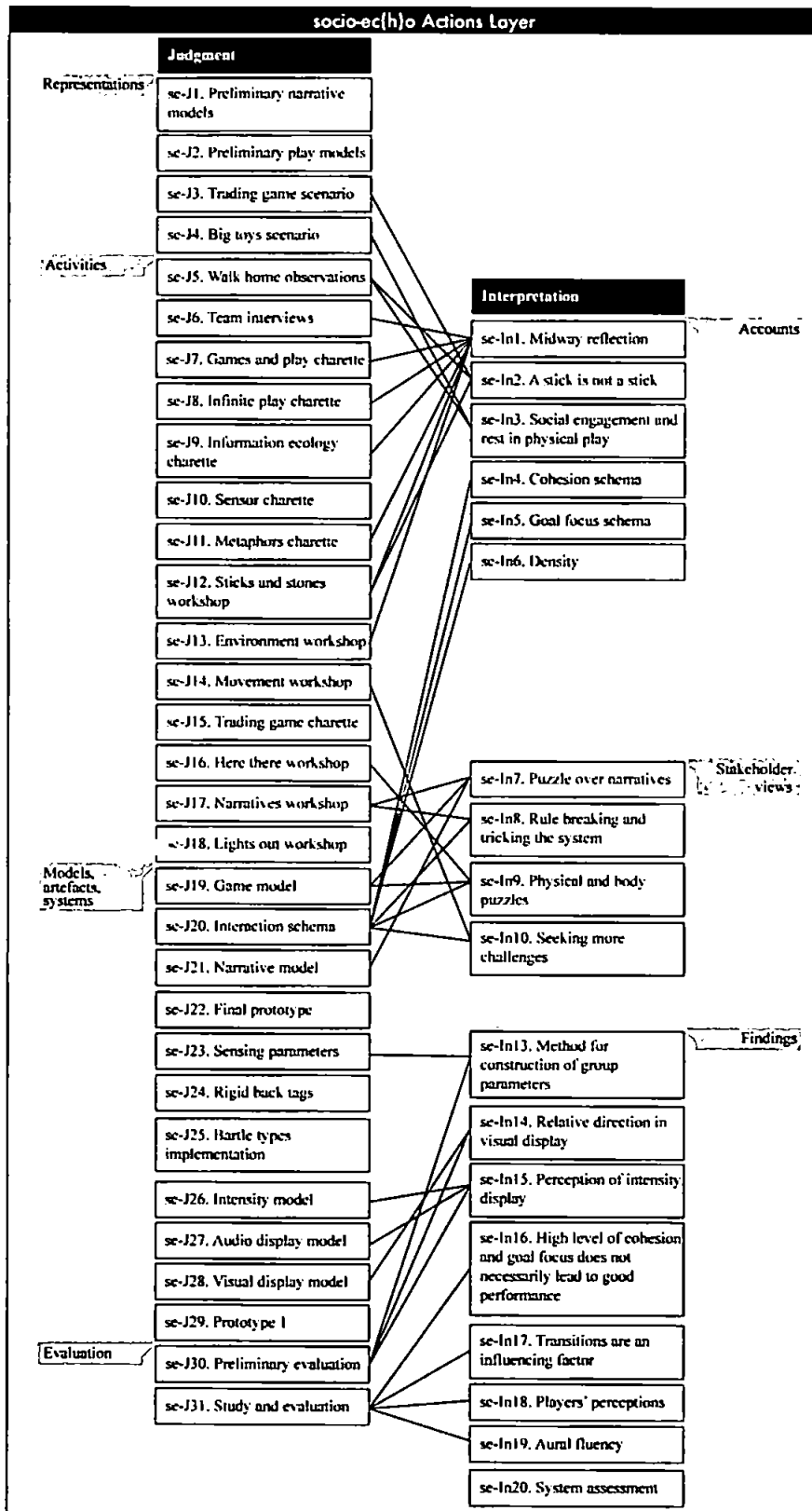


Figure 39 Diagram showing the relationships between judgment and interpretations is socio-ec(h)o.

## **5.2.2 The experience view**

### **5.2.2.1 The relationships in an interaction design inquiry**

I hinted earlier that relationships cut across the framework and occur within actions as well. In order to get this fuller view we need to look at the experience view of the projects. In Figure 40 and Figure 41, I've mapped the complete ec(h)o and socio-ec(h)o projects as described by the theory. The map is a wider view that shows relationships across the inquiry and actions. The map also reiterates the connections within the respective parts of the framework, like the previous discussion about the relationship between judgments and interpretations, or the discussion earlier on links between intentions and rationales (see 4.1.2 Design intentions and rationales). The map also shows the relationships within actions or aspects of the design inquiry, like one action leading to another. Unlike the previous figures of the design inquiries that showed only the relationships between inquiry elements, Figure 40 and Figure 41 show more relationships but are also temporally structured so you can read the inquiry as beginning at the top of the diagram and progressing through in time to the bottom of the diagram. It is important to note that actual concurrency of events, particularly with judgments, is difficult to describe in the figures. The experience view views allow us to return to our previous discussion of the quality and kind of relationships with a broader view of the interactions.

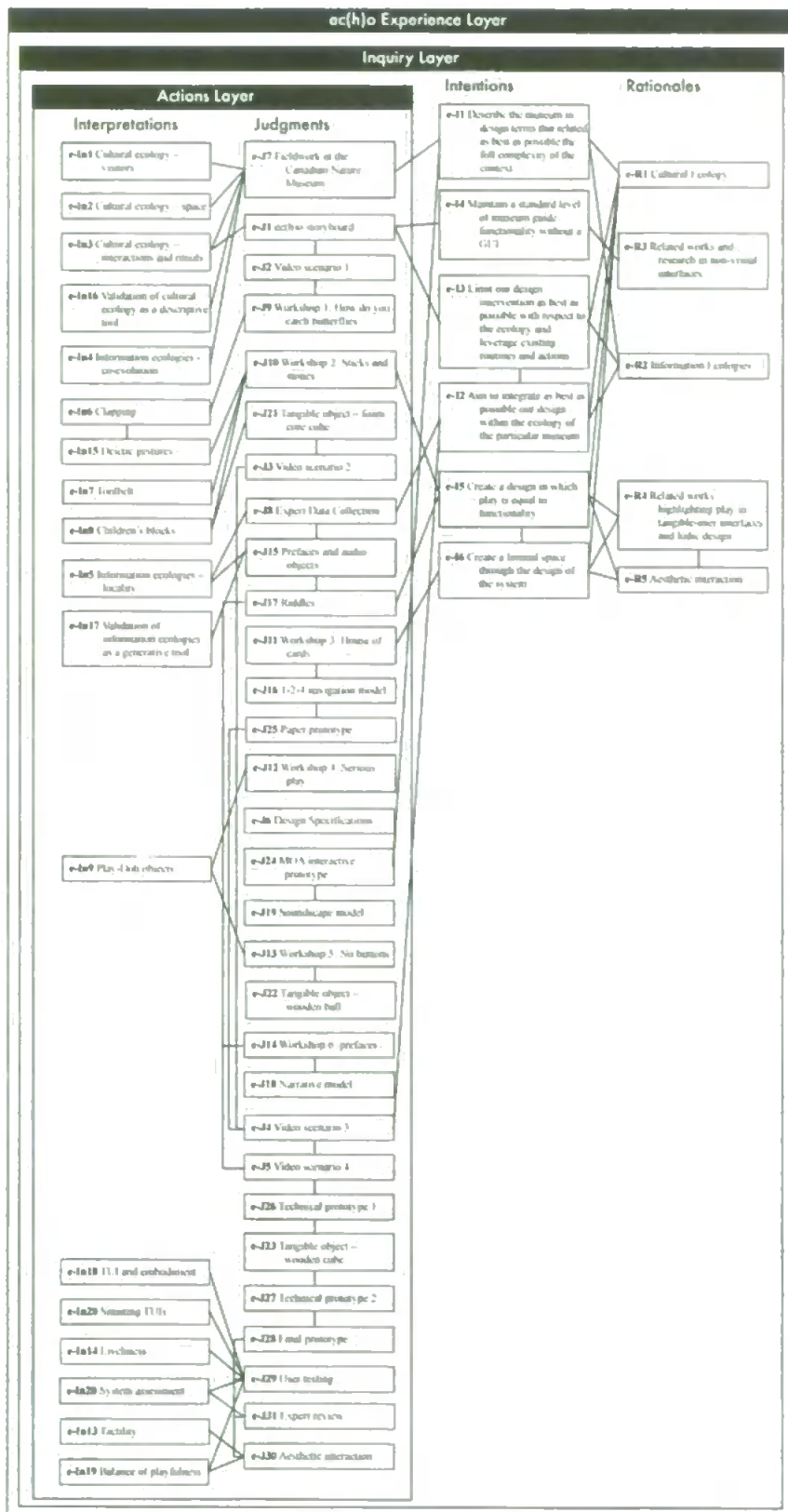
Cascading is another type of integrity or quality of relationship. I discussed how se-J1, preliminary narrative models, is isolated and has little impact on the project since it lacked a mirror and feedback loop relationship. Yet this is not to say that it was completely abandoned. In Figure 41, se-J1 informs se-J2, preliminary play models, which is another judgment action. The line connecting the two actions represents this. In effect, issues raised and put forward in se-J2 became incorporated in subsequent actions. The effect of se-J1 is

to cascade into another action. We can see how the initial charettes and preliminary models cascade together to inform each other and ultimately influence the first workshop, se-J12. This clustering or concurrency of actions results in actions tending to influence each other, and the clustering has a more summative effect in a new type of action like a workshop or prototype. For example in ec(h)o, we can see in Figure 38 a similar clustering in which scenarios and a series of prototypes cascade into the final prototype. Judgment actions e-J4 and e-J5 are the final versions of the scenarios for ec(h)o. From here a series of technical prototypes e-J26 and e-J27 and the final tangible prototype e-J23 together inform the final prototype, e-J28.

In the midst of cascading actions an interaction designer may feel he or she is “on a roll,” yet a stronger set of relationships is presented when reflection and action work together. In these instances, mirror and feedback loops that result in a cascade help to really propel the interaction design inquiry. A good example of this is in ec(h)o. In Figure 40, the action of data collection from experts on the museum staff, e-J8, led to the analysis of the data based on the information ecologies notion of locality, e-In5. This fed back into the process in the actions of e-J15, the development of prefaces and audio objects. This is a clear mirror and feedback loop relationship. The results of the prefaces and audio objects cascade into the idea of devising riddles, e-J17, that ultimately influences the final scenario, e-J5, and joins the cascade we described previously that led to the final prototype, e-J28. The leap from data collection to a formalized concept of prefaces and audio objects is accountable to the reflection in action of the mirroring and feedback loop. A combination of mirror and feedback loop with cascading can show how an idea is experimented with fully before being abandoned with confidence. In socio-ec(h)o, there is a mirror and feedback loop between the walk home observations, se-J5, and the interpretation of a stick

is a stick, se-In2. This account is reflected back into the action of a trading game charette, se-J15, followed by a trading game scenario, se-J3. It is at this point that the cascade ends. We abandoned the idea of trading resources as a game structure. These examples show how cascades between actions progress the inquiry but cascades in combination with mirror and feedback loops forge stronger and better quality relationships given the clear reflection in action.





**Figure 40 A map of ec(h)o as an interaction design inquiry. The map shows the relationships across the inquiry.**

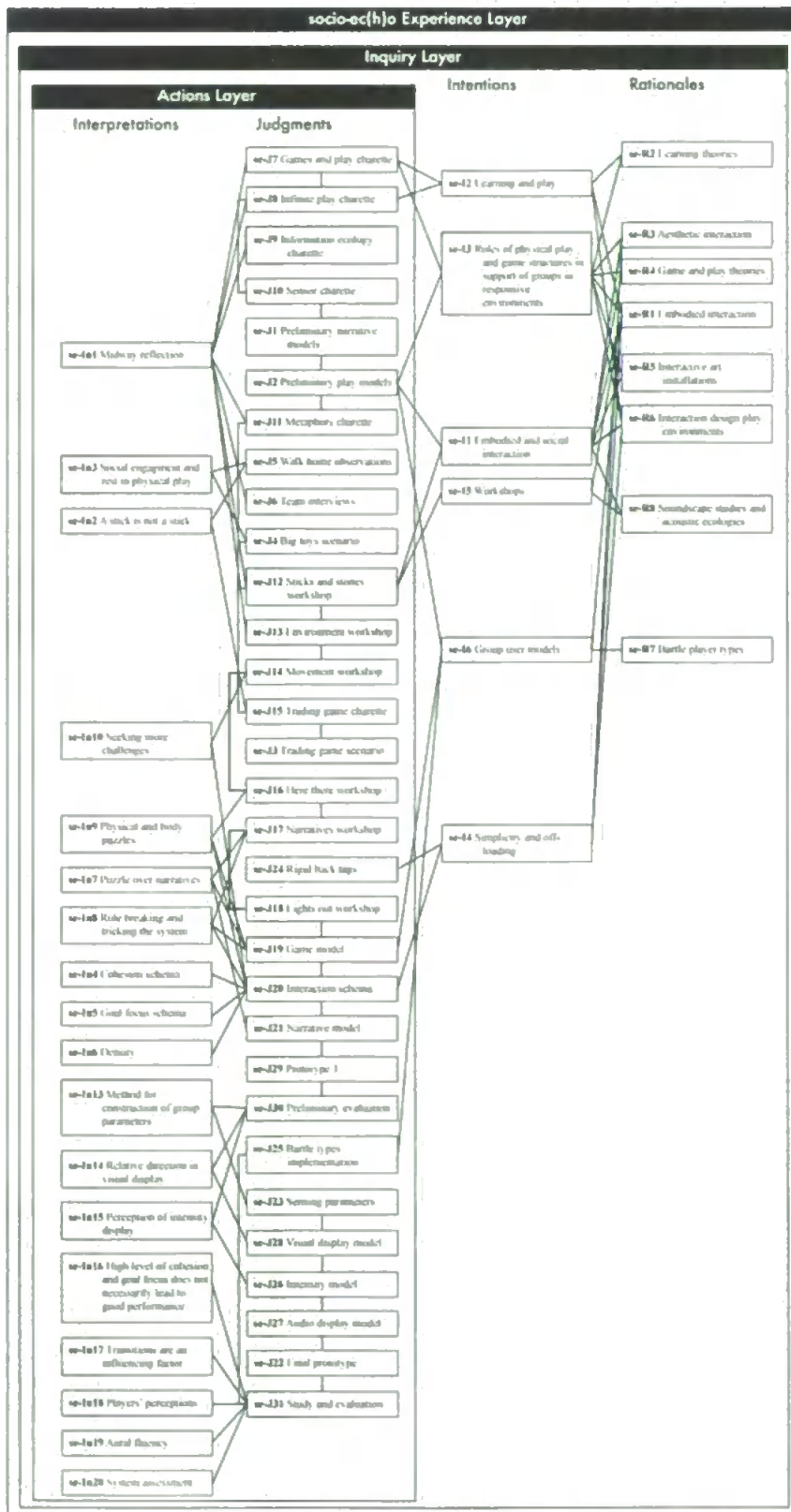


Figure 41 A map of socio-ec(h)o as an interaction design inquiry. The map shows the relationships across the inquiry.

In considering where actions are initiated it is clear if not self-evident that inquiries begin with intentions. In looking at ec(h)o and socio-ec(h)o, we can trace backward through all the cascading relationships and mirror and feedback loops to end up with a connection that crosses from actions to the design inquiry and ends with an intention. In that sense, there is a clear dependence of judgments on intentions with respect to initiating a series of actions. This does not preclude intentions from shaping an existing series of actions without initiating a new action – a form of feedback. For example, in ec(h)o (see Figure 40), the intention e-I5, create a design in which play is equal to functionality, connects to the judgment e-J17, riddles, that is part of a cascade I discussed earlier. Additionally, there is a temporality to the intentions in that we should not expect all the intentions to initiate actions at the beginning of the inquiry. The design inquiry is extant throughout the inquiry meaning that new intentions and rationales may emerge or be refined throughout the inquiry. And as a result intentions can initiate new actions at any time like in socio-ec(h)o (see Figure 41) where se-14, simplicity and off-loading, initiated the action se-J24, rigid back tags. In looking at intentions, they initiate actions at anytime throughout the inquiry and can augment existing series of actions.

#### **5.2.2.2 The common pattern in interaction design**

Interaction design inquiries are predisposed to exploration. The ongoing restless shaping and experimentalism of the design inquirer is the intrinsic energy that moves things along. By movement I mean the step from action to action throughout the inquiry. The movement can be described as ad hoc in appearance. It is not easy to predict a pattern, rather the movement is influenced by the nature of the project, e.g. clear stakeholders and context in ec(h)o versus an embodied exploration in socio-ec(h)o, the experience and

judgment of the designer inquirer, and the available resources be they technical, human or material.

In the descriptions so far what is evident is that there exists a common pattern of mechanics found in any inquiry involving a sequence of actions and quality of relationships. This pattern includes an intention to initiate a judgment followed by an interpretation that creates a second judgment. The mechanics are as follows:

1. An intention is required to initiate the design inquiry. Ideally it is supported by a design rationale.
2. The intention initiates a judgment that is the first interaction design action.
3. The action is interpreted and the reflection is mirrored or fed back into the inquiry in the form of another judgment.

The pattern is indisputably simple. Some may argue it could be simpler, e.g. an intention and a judgment, or cascading judgments rather than a mirror or feedback loop, yet either case denies the need for explicit reflection or interpretation, which is critical to any inquiry. The reflection is the negotiated awareness between actions, materials, and the world. The simplicity is reminiscent of the passage by Dewey that was cited in Chapter 3 and repeated here:

The outline of the common pattern is set by the fact that every experience is the result of interaction between a live creature and some aspect of the world in which he lives. A man does something; he lifts, let us say a stone. In consequence he undergoes, suffers, something: the weight, strain, texture of the surface of the thing lifted. The properties thus undergone determine further doing. The stone is too heavy or too angular, not solid enough; or else the properties undergone show it is fit for the use for which it is intended. The process continues until a mutual adaptation of the self and the object emerges and that particular experience comes to a close (Dewey, 1934, p.45).

As I've discussed previously (see 3.2.1 Concreteness), in this passage from *Art as Experience* (Dewey, 1934 45), the "man" is an experimenter playing with different actions

in a continuum between knowing and doing. The common pattern Dewey refers to is to the fundamental idea that *every* experience, not only a design experience, is an inquiry. The simplicity of the mechanics supports an adaptive process by which the pattern repeats with minor revisions and additions, like cascading actions. This pattern propels the inquiry toward the mutual adaptation as Dewey puts it or the resolution or near resolution of the design inquiry. The pattern can be found in our descriptions of ec(h)o and socio-ec(h)o. It is the mechanic that animates every interaction design inquiry.

### 5.2.2.3 The dynamic structure of an inquiry

The common pattern describes the inner mechanics of the inquiry but what can be said of the overall structure of interaction design inquiries? What we can describe are the different attributes to the movement and relationships that formulate parts of the structure. I have in fact already described the elements that make up the parts:

- *Inter-integrity (Mirrors and feedback loops, formative findings, and initiations)*: relationships across types of actions like interpretations and judgments; relationships like intentions crossing from the design inquiry to actions; and formative findings that prescribe judgment actions;
- *Intra-integrity (Cascades)*: relationships that connect similar actions together like a series of judgment actions leading up to a final prototype, or a series of design charettes to orientate the design team;
- *Extra-integrity (Findings and criticism)*: a series of findings that cascade into forms of criticism external to the designer inquirer. Criticism takes on the form of a “meta feedback loop” that influences subsequent design inquiries. This pattern is more speculative and posited theoretically. Given the state of interaction design it is not evident in the projects described.

The parts form three discernible structural attributes viewable in the pattern of relationships like those mapped out for ec(h)o and socio-e(h)o (see Figure 40 and Figure 41). While these parts are evident the overall structure is not static but is unpredictable and

dynamic. For example, the parts manifest differently in the inquiries of ec(h)o and socio-ec(h)o. In ec(h)o, the beginning of the inquiry is marked by inter-integrity relationships, where many of the connections traverse the inquiry and action types. The inquiry is quickly acting on the intentions and validating responses through mirroring and feedback that became fixed in a series of scenarios. This initial phase is followed by an intra-integrity cycle where actions cascade in an alternating series of workshops, scenarios, and prototypes that result in the final prototype. On the other hand, in socio-ec(h)o the inter-integrity relationships are virtually distributed throughout the inquiry as are the intra-integrity relationships. This is clear in looking at the initiation connections of the intentions that occur well into the inquiry. This pattern can be explained by a project that maintained a high degree of exploration and experimentalism throughout. In both cases the extra-integrity pattern is partly visible.

The final evaluations in each project spurred several findings that cluster at the end of the project. Yet the theory argues for the need for external criticism. The ensuing dynamic of criticism and responses would complete the pattern. It is evident that we can describe attributes of parts of the inquiry and that their combination or distribution within a given inquiry informs us about the nature of the exploration.

### **5.2.3 Reflexive account of experiences of ec(h)o and socio-ec(h)o**

The experience view is a way of looking across individual projects to reflect on the practice of interaction design that is the experience of being a designer that grows from project to project. In Chapter 3, I discussed how ‘practice’ is the understanding that emerges from continual and accrued experiences of creative making. I described practice as knowing about making that is informed by constant acts of doing that are embodied, hands-

on, and interactive. For me, the experience view is a meta-lens that helps me see my own interaction design practice.

I've always had a sense of practice that was mostly tacit and intuited. As a designer, like others I design from a sensibility and I tune this sensibility by reflecting on past design experiences. In reflecting back across various projects, I've acquired a greater awareness of the dynamics of interaction design, how I respond or initiate through design actions, and how my judgement helps to guide the next set of actions. This awareness is really a level of self-awareness that is tested and embodied in practice. The concurrency of reflection and action ensure that both design understanding and design skills constantly evolve. However, the understanding can take a more transparent form, a language as I described in Chapter 3 (see 3.5 Reflexive account of the framework). The theory proposed here is a scaffold for this language of design experience. Interaction design in this way is not a mystery, an indescribable talent, or a black box, it is rather a comprehensive set of abilities, perceptions, and judgments that with ongoing reflection becomes more felt and more understood.

In the preceding sections I discussed the detailed terms of the framework that make up the scaffolding for the experience view. In this section I add to that description by returning to the themes of movement, materiality, and archaeological maps that I've discussed in preceding reflexive accounts (see 3.5 Reflexive account of the framework, 4.2.3 Reflexive account of actions in ec(h)o, and 5.1.3 Reflexive account of actions of socio-ec(h)o).

I wrote earlier how I felt there is a movement to interaction design like the “metronomic” movements discussed in reflecting on ec(h)o (see 4.2.3 Reflexive account of actions in ec(h)o) or the “dead reckoning” of socio-ec(h)o (see 5.1.3 Reflexive account of actions of socio-ec(h)o). I feel that the movement has its own momentum and it can very

much feel like one is “along for the ride” responding at each turn. Yet the response as a designer is not random but is a choreography of moves, responses, coordinated actions, and judgments. Every movement in a project is different yet on reflection one can pick out patterns of actions and decisions that repeat across projects. As I said, the movement has its own inertia and so it is always a balance between design actions and external factors. Like downhill skiing or mountain biking, each run down a mountain trail is different yet the dynamics, and your techniques, responses and judgments have common patterns across the various runs. The experience of the ride is holistic. The “sensibility” of the designer to manage such a ride can be seen as a comprehensive set of understandings and quality interpretations that are enacted knowingly and intuitively.

Articulating the interaction designer sensibility is a matter of giving it a form like a language. However, a language that needs to be negotiated and remain open like the discussion among painters during a studio critique (see 3.5 Reflexive account of the framework). Reflections on practice is not reducible to reductionist thinking, it relies on organic, agreed upon, and embodied communication that references the concreteness of acts in order to achieve coherency and create shared meaning. But there are patterns that emerge some of which I describe in this chapter like cascading, mirror and feedback loops, initiations, etc.

Language in this sense is a representation. It is also not only an intellectual structure but as a part of practice it is felt and has embodied qualities as well. I discussed earlier how I perceived aspects of ec(h)o and socio-ec(h)o to have material qualities (see 4.2.3 Reflexive account of actions in ec(h)o, and 5.1.3 Reflexive account of actions of socio-ec(h)o). Scenarios in ec(h)o are thick descriptions of imagined ideas and workshops are inherently embodied. In socio-ec(h)o, the overall sense of the project takes on material



dimensions of entangled and worn pathways that are made of artifacts, actions, and interactions. That is the material and immaterial mix to create an embodied presence to the course of the design project. As such I perceive the experience of the design to be a felt experience that intertwines intellect and embodiment. The intuited response is the embodied response to the felt nature of the project, e.g. its movement and materiality. In short, any given design project takes on a perceptible materiality in addition to its dynamic flow. A project can display itself to the experienced designer like an emergent landscape that the designer moves through (or the oncoming rush of a mountain trail!). In such a landscape, one that is evident when seen from the experience view, common and similar features and relationships among features become as clear as the learned response to navigating these features.

Returning to the discussion of the importance of the studio critique and the painter's studio began in Chapter 3 (see 3.5 Reflexive account of the framework), a reflexive and theoretical account of the practice or experience of interaction design begins to create the archaeological map of the experience. The painter's studio contains an "archaeological" record of the decisions, experiments, risks and failures. In interaction design, the materialized actions of projects given representation through the scaffolding of the proposed theory form the metaphoric "studio". Here, the studio is full of the actions and results of inquiries: intentions, rationales, judgments, interpretations, accounts, and reflections that expose the archaeological record of interaction design. This uncovering allows for deconstruction and sharing of the decision-making and judgment process. For example, a designer can readily demonstrate a failed experiment, or as a result of a critique or reflection explore possible alternative paths to the decision taken. The "archaeological

map” of practice gives representation to the invaluable knowledge and wisdom of making in interaction design.

### **5.3 Summary**

In this chapter and the previous one, I applied the theoretical framework proposed in Chapter 3 to two interaction design research projects. In Chapter 4, I described the design inquiry and discussed the designer inquirer, design intentions and design rationales. I discussed the integrity among intentions and the supporting role of rationales. The designer inquirer is implied by the choice of intentions and the nature of the relationships between intentions and rationales. Descriptions of the actions of each project were spread across the two chapters, *ec(h)o* in Chapter 4 and *socio-ec(h)o* in Chapter 5. These descriptions were in considerable depth, and they aimed to show the dimensions to actions and how each descriptive category plays out at the level of practice. Each inquiry embarked on its own path including different design strategies and different contexts. The dynamic and qualitative relationships among the actions were described in this chapter in an analysis of the integrity of actions for each project. I concluded the description of the inquiries with a discussion of the experience view of the projects. I discussed the different attributes of the relationships in the inquiry including mirrors and feedback loops, cascades, and formative findings. The overall nature of the inquiry can be encapsulated at the level of inner mechanics as a common and simple pattern to all inquiries that ensures adaptivity and progression of the inquiry. At a structural level I described three anatomical elements: inter-integrity, intra-integrity, and extra-integrity. Each can be found in an inquiry but also combine and distribute differently resulting in a dynamic structure. Lastly, I concluded each account of the design inquiry with a reflexive account of each project and provided a reflexive account of the experience view.

This two-part description aimed through the use of the proposed theory to make sense of the interaction design experiences, and to reveal the dynamics and critical relationships among the aspects or entities of the inquiries. The description and analysis focused on how the design inquiry can be disambiguated into sensible descriptions, and on making the dynamics of how the inquiry progresses clear.

The fourth proposition is that a pragmatist view leads to the understanding of interaction design as experience and an interaction designer as an embodied inquirer that shapes the experience through experimentalism. Instances of interaction design experiences can be seen as inquiries in which judgment and interpretation are central actions.

In revisiting the fourth proposition of the thesis, the essence of an inquiry is that the dynamics of judgment and interpretation mobilize and govern the interaction design inquiry. At the centre of these actions is the designer, who reflectively acts within the interpretive loops and actions that make up interaction design. This focus on the self-reflective embodied designer does not disavow externalizations nor the need to concretely communicate and validate outcomes in the process of design or research. I will explore this issue in the next chapter. The designer accrues through practice knowledge and sharpens his or her judgment in design through past experiences, embodied reflections, and an overall sharper understanding of the experience of interaction design. The process of active reflection adds to the development of the designer by tuning and retuning the designer's understanding of outcomes and adding to his or her catalogue of experiences embodied within him/herself and their practice. To reiterate a point I made at the outset of the thesis, judgment takes the form of a warrant on behalf of the designer, design team, or firm in relation to quality of the designing and design outcomes. The interaction design inquiry

converges on the designer in terms of both practice and research. The challenges in this role lie in need for the designer to make future design decisions and to have the ability to reflect on past judgments making them evident, communicable, and valid.

## CHAPTER 6: TRUSTWORTHINESS, VALIDATION, AND CRITICISM

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At the outset of the thesis I stated that an ideal theory for interaction design would describe critical concepts, principles and definitions, and provide an explanation of the relationships, actions, actors and processes. In chapters 4 and 5, I applied the theory to two interaction design projects that demonstrate the descriptive capacity of the theory. I also stated that an interaction design theory would facilitate the generation of new forms of practice, creativity, and discoveries with a prospective orientation grounded in the practice of making. Knowing how we generate trustworthy knowledge in our practice and research in interaction design is at the heart of facilitating these issues. In this chapter I will address knowledge creation by discussing the role of validity in the theory.

As was discussed at length in chapters 1 and 2, interaction design has a particular relationship to human-computer interaction (HCI). I earlier commented that the strength of HCI theory is that it has depth. Underlying HCI is an epistemological grounding in scientific realism such that there is agreement on core concepts. The epistemological viewpoint holds steady and affords a dynamic research and practice space for experimentation and debate. Practice and research methods in HCI are open to revisions and are subject to vigorous and critical debate, which grows the field intellectually. This strength in focus and epistemology creates coherence around principles in research that in

turn allow for flexibility and experimentation with methods of research, practice, and the means to verify claims.

The theory of interaction design proposed here is modelled after such an approach, however there is a substantive difference in epistemological viewpoints: pragmatism over scientific realism. This leads interaction design down a different path that both intersects with and diverges from HCI. I have argued that the pragmatist philosophical orientation is acutely relevant to interaction design whereas scientific realism is not. This difference reframes basic theoretical views of interaction design. This difference also reframes how the discipline is described, namely the concepts, definitions, actors and processes, and how the discipline verifies its claims to new knowledge.

Prior to delving into the issues of validity in the theory it is helpful to take a step back and to position the theory in a broader research context. Scientific realism in HCI is grounded in a positivist paradigm that relies on a quantitative research perspective, whereas pragmatism leads our interaction design theory towards a qualitative research perspective. Despite the differences, the paradigms interact more than the respective advocates would admit, in approaches that are plainly described as “mixed methods” (Creswell, 2007), to more nuanced theoretical positions like postpositivism (Phillips and Burbules, 2000 , Denzin and Lincoln, 2005), critical realism (Danermark et al., 2002), and subtle realism (Hammersley, 1992 , Seale, 2000). Pragmatism comfortably sidesteps foundational boundaries in openness to experimentation of any kind. As such, our pragmatist theory willingly incorporates a quantitative view within a qualitative orientation. The qualitative orientation is critical to understanding the importance of the descriptive capacity of the pragmatist theory and its approaches to validity.

In order to understand the context of qualitative research in which the theory operates, I quote at length from Denzin and Lincoln:

Qualitative research is a situated activity that locates the observer in the world. It consists of a set of interpretive, material practices that make the world visible. These practices transform the world. They turn the world into a series of representations, including field notes, interviews, conversations, photographs, recordings, and memos to the self. At this level, qualitative research involves an interpretive, naturalistic approach to the world. This means that qualitative researchers study things in their natural settings, attempting to make sense of, or interpret, phenomena in terms of the meanings people bring to them.

Qualitative research involves the studied use and collection of a variety of empirical materials—case study; personal experience; introspection; life story; interview; artifacts; cultural texts and productions; observational, historical, interactional, and visual texts—that describe routine and problematic moments and meanings in individuals' lives. Accordingly, qualitative researchers deploy a wide range of interconnected interpretive practices, hoping that each practice makes the world visible in a different way. Hence there is frequently a commitment to using more than one interpretive practice in any study (Denzin and Lincoln, 2005, pp.3-4).

The importance of qualitative research to the pragmatist theory is the many characteristics they share. In adapting the shared principles to interaction design they are further shaped and refined. Denzin and Lincoln describe how the researcher or observer is placed in the world. In short, the researcher is implicated in the same world he or she is studying. Qualitative research does not afford the researcher a distant or objective relationship to the research. In Creswell's view this characterizes the inquiry as interpretive: "The researchers' interpretations cannot be separated from their own background, history, context, and prior understandings" (Creswell, 2007, p.39). In our pragmatist theory of interaction design, the implication of the researcher goes much further. The designer inquirer actively shapes the phenomenon of the study, the design practice. In the interaction design inquiries in this thesis, the theory relied on self-reflection and auto-ethnography. The theory argues for the embodied designer inquirer and this highlights

issues of data collection methods, as well as the relationship between practice and research. Firstly, in interaction design research, the main data collection is more often than not interpretive, self reflective, and ethnographic. The critical modes of data collection are the self-reflexivity, as in the inquiries in this thesis, or participant observation with a strong emphasis on descriptions and accounts of the designer inquirer. This does not preclude other data collection methods like interviews, document analysis, artifact analysis, experimental studies and so on. Yet the interpretive and self-reflexive nature raises the importance of carefully addressing the verifiability of the claims and findings in interaction design research. The discussions and principles of qualitative research traditions are particularly helpful in this regard.

Given that the designer inquirer influences the phenomenon of study, the question of the practice and research in interaction design has many dimensions. Firstly, as noted by Denzin and Lincoln, in qualitative research there is the aim to “transform the world.” This in itself has many nuances and varies among the different qualitative research strategies. For example, postmodern strategies see the world in the text, and the outcome of the research directly reshapes the textual reality through language. In another example, researchers are seen as enmeshed in a political and ethical existence that inevitably leads to research having both an advocacy role and a goal of advocacy and change, whether through policy or activism. In interaction design and design theories in general, some make the distinction between the descriptive nature of purely empirical research, describing and explaining the world, with what some refer to as normative research, an approach aimed at changing the world in and through research (Robinson, 2001). For example, Schön’s reflective practice can be viewed as a normative theory, which means that the measure of its success or validity is the degree to which it aids professional practice in changing the



world, and not in the validity of its descriptions or findings about professional practice. Hence the practice of design itself is research in the normative sense and the effects of the outcomes are results. The pragmatist theory supports this assumption but argues that an understanding of interaction design requires a systematic and consistent descriptive representation of the phenomenon as well. This level of reflection, in addition to reflection on practice, is how we will best understand interaction design and its role and impact on other disciplines and modes of knowing. A normative view makes the separation of research from practice difficult if not impossible but I suggest that the theory proposed here ably describes both aspects and supports both research and practice without having to completely disentangle the two from each other.

The demand for and ability of the theory to reflectively offer a descriptive representation of interaction design is akin to making the world visible through interpretation in qualitative research. In social sciences, this is a question of the hidden social relations made evident, or in health sciences, the discoveries of social interconnections that determine or affect health or health practices but are typically overshadowed by medical and biological research. Interaction design is a social and human practice that is comprised of many social interactions and relations, but as we have seen it is reliant on designer inquirer judgments and interpretations that have largely been hidden, mystified, or romanticized. This makes it even more imperative to have a theory that aids the explicit and clear representation of interconnections, reflections and decisions in interaction design. In this sense the theory acknowledges its normative framing and also sees equally important the role of descriptive representation and explanation.

A description of the experience of interaction design is a critical step in making the world of interaction design visible, establishing critical cues in normative practice, and

making explicit the phenomenon for future study and to verify new knowledge and findings. Creswell summarizes the aim in establishing a holistic account in qualitative research that largely applies to the theory in interaction design:

Qualitative researchers try to develop a complex picture of the problem or issue under study. This involves reporting multiple perspectives, identifying the many factors involved in a situation, and generally sketching the larger picture that emerges. Researchers are bound not by tight cause-and-effect relationships among factors, but rather by identifying the complex interactions of factors in any situation (Creswell, 2007, p.39).

A research account of an interaction design inquiry shares this holistic aim and stresses the importance of identifying the interaction of factors more so than determining the causality behind actions. In design practice, the holistic view may not be explicit but no doubt the experienced interaction designer is aware of the contours of the emerging process, keenly mindful of cues leading to the key actions like formative findings. The theory describes these interactions by identifying critical aspects in practice and detailing the holistic view for the research inquiry.

Lastly, Denzin and Lincoln (Denzin and Lincoln, 2005) refer to a commitment to multiple and interconnected interpretive strategies in order to make the world visible in a different way. Multiplicity is found in the different research strategies applied, particularly with verification of knowledge. I will now move on to discuss how the theory adopts multiple plausibility strategies including trustworthiness, validation, and criticism.

## **6.1 Plausibility of interaction design knowledge**

Guba and Lincoln ask the central question about the aims of any social research: “How do we know when we have specific social inquiries that are faithful enough to some human construction that we may feel safe in acting on them, or, more important, that members of the community in which the research is conducted may act on them” (Guba

and Lincoln, 2005, pp.206-207)? The claims of validity rest on the establishment of security and 'trustworthiness in the knowledge generated by research. Guba and Lincoln see the debate about validity cresting over two forms of rigor. One form, rooted in positivism, looks to the rigor in the application of method thus asking researchers to negotiate terms of internal validity, external validity, and reliability en route to a secure claim to new knowledge. The second form of rigor advocates community consent along with a rigor of interpretation that invokes terms like credibility, transferability, dependability, and confirmability (Guba and Lincoln, 2005). The differences lie in the rigor of method versus rigor of interpretation. Needless to say the differences are not steadfast, which has both negative and positive implications. Negatively, Guba and Lincoln argue that warring advocates conflate the separate issues of methods and interpretation thus comparing apples to oranges. On the positive side, research strategies shift from the exclusive positivist perspectives on one side (rigor of method) and postmodern perspectives on the other side (rigor of interpretation) to constructively cohabitate the two forms of rigor in validation. Our own pragmatist theory comfortably adopts a range in qualitative strategies that varies the emphasis on interpretation over method for validity, with an incorporation of quantitative strategies that accedes to a rigor of methods in order to gain a wider interpretive space.

In explaining the role of validity in our pragmatist theory of interaction design, our discussion will traverse across the strategies of credibility, validity, and criticism. All play integral if at times separate roles in securing the claims of knowledge in interaction design.

### **6.1.1 Trustworthiness in knowing**

Interaction design research is a qualitative endeavour. As such it incorporates the many qualitative strategies for validation. Creswell enumerates eight procedures (Creswell,

2007): prolonged engagement and persistent observation in the field; triangulation and multiple sourcing of data; peer review and debriefing for external checks; negative case analysis; clarifying of researcher bias; member checking; thick description; and external audits. Lincoln and Guba (Lincoln and Guba, 1985) use the terms credibility, transferability, dependability, and confirmability to group various procedures together under larger aims, and to offer alternative terms to positivist concepts. They establish that trustworthiness of research and its findings are the central issues in positivist ideals of validity and reliability. In that sense, the terms proposed by Lincoln and Guba are very useful in explaining the trustworthiness aims of the theory.

#### **6.1.1.1 Credibility**

The basis of any claim to trustworthy knowledge is credibility. Rather than assume that there is a “truth value” in the research, e.g. the singular truth to be uncovered, credibility establishes that the representation constructed through research is indeed valid and believable. Seale sees credibility as follows:

First, credibility should replace truth value. Through prolonged engagement in the field, persistent observation and triangulation exercises, as well as exposure of the research report to criticism by a disinterested peer reviewer and a search for negative instances that challenge emerging hypotheses and demand their reformulation, credibility is built up (Seale, 2000, p.44).

On the first count of prolongment and persistence, the role of the embodied designer inquirer ensures that this count is met. In the case of a third person study, ethnographic commitments would need to be considered. Critics of first-person studies argue that the accounts are distorted and biased and that a third-person researcher is required to mediate in the case of an informant with an agenda. What of an informant researcher like the designer? As I have discussed, the proactive shaping of the designer is integral to the design experience so the designer’s “agenda” is commensurate or so commingled with the

experience as to not be separable (the pragmatist point of entities-in-interaction forming the experience). However, if we put this issue aside there is a greater weight on the designer inquirer to ensure multiplicity and triangulation of sources and data. In the analysis of the two interaction design inquiries, the sources were diverse: including design documents; process artifacts like videos, sketches, storyboards; peer reviewed publications; personal memories; interviews with stakeholders including design team members, stakeholder views and stakeholder generated artifacts and actions, recollections, evaluation results, notes authored by different team members, and so on. In addition, many of the documents and artifacts were collaboratively produced, manifesting the consolidated but multiple viewpoints of those involved in the making of the design experiences. The descriptions were careful to note the different sources and to depict the connection among the sources that in turn supported actions and findings. The theory strongly supports reflexivity of the researcher, which mitigates the concerns of first-person data collection and analysis (see 6.1.1.3 Dependability and confirmability).

Disinterested peer reviewers are incorporated in the peer review publications in the form of blind reviews. A negative case analysis was not discussed in the earlier accounts but one is clear in the case of socio-ec(h)o. Early in the inquiry we conducted an information ecology charette, se-J9. The charette has no connection to any intentions or prior judgments (see Figure 41). The theory claims the common pattern (see 5.2.2.2 The common pattern in interaction design) that judgment actions are initiated by an intention or on the receiving end of a mirror or feedback loop, or at minimum a cascading connection from a previous judgment. None of these attributes applies to the information ecology charette yet they are part of the inquiry. What has been discussed is that the designer inquirer is implicitly embodied in the relationships (or non-relationships) among the entities

in the inquiry. In addition, the presence of the designer inquirer at the design inquiry is expressed as a set of interests, experiences, and aims. The information ecology charette can be explained as an influencing factor of the previous research project, ec(h)o, by the designer inquirer. Information ecology was such a central concept to that project that it is not a surprise that the designer inquirer would carry it forward into a new project. It is also not a surprise that since it was not supported by an explicit intention or rationale it did not have an impact on the inquiry. Noting this, the theory currently does not fully address the longer cycle of inquiry to inquiry. Additionally, this is in part discussed further in the section on criticism (see 6.1.3 Criticism).

Credibility through prolonged engagement, triangulation and diversity of data, disinterested peer review, and negative case analysis establishes the believability in the representation and findings generated by the research.

#### **6.1.1.2 Transferability**

The next critical step en route to trustworthiness is the degree to which the representation and findings are applicable beyond the particular setting or inquiry. Lincoln and Guba (Lincoln and Guba, 1985) argue that naturalistic inquiries or qualitative research seek transferability by providing the details of the phenomena and setting in formal accounts like research reports. This is achieved by thick description, a rhetorical strategy that richly and “thickly” describes events such that the reader can feel that they experience the events described. This technique arose from rhetorical strategies used in ethnography. Geertz describes how anthropologists persuade readers that they have ‘been there’:

Ethnographers need to convince us...not merely that they themselves have truly ‘been there,’ but...that had we been there we should have seen what they saw, felt what they felt, concluded what they concluded (Geertz, 1988, p.16)

I used this technique in describing the experience of the Canadian Nature Museum from the perspective of a designer inquirer in order to illustrate concreteness in interaction design experiences (see 3.2.1 Concreteness). Other examples of thick description in interaction design are system and interaction experiences that I've used in published accounts of the interaction design inquiries in this thesis. For example, here is an account of socio-ec(h)o that accompanied many of the published articles (Wakkary et al., 2005 , Wakkary, 2008):

Madison, Corey, Elias and Trevor have just completed the first level of socio-ec(h)o. They discovered that each of them had to be low to the ground, still, practically on all fours. Once they had done that, the space became bathed in warm yellow light and filled with a wellspring sound of resonating cymbals. Minutes earlier, the space was very dim – almost pitch black until their eyes adjusted. A quiet soundscape of “electronic crickets” enveloped them. They discussed and tried out many possibilities to solving the word puzzle: “Opposites: Lo and behold.” At Corey’s urging, the four grouped together on the edge of the space and systematically sent a player at a time to the opposite side in order to gauge any change in the environment. Nothing changed. Madison, without communicating to anyone realized the obvious clue of “Lo” or “low”. She lowered herself to a crouching position. The space immediately glowed red and became brighter. The audio changed into a rising chorus of cymbals – not loud but progressively more pronounced. Corey and Trevor stopped talking and looked around at the changing space. Madison, after a pause began to say “Get down! Get down!” Elias stooped down immediately and the space became even brighter. Corey and Trevor dropped down in unison and the space soon became bathed in a warm yellow light like daylight. The audio reverberated in the space. A loud cheer of recognition came from the group, “Aaaaahhh! We got it!” (Wakkary et al., 2005, p.766)

The theory provides clear guidance to description of the entities in the interaction design inquiry. As a consequence, the details and setting of both the design events and reflections can readily be incorporated as an embedded rhetorical strategy in the research accounts. In another account, we published a reflection on the design process as a way of illustrating the use of participatory workshops for designing the audio display:

The two workshops that we describe came midway through the design process. We had previously hosted several other participatory workshops and conducted concept development meetings where we developed the conceptual foundations of socio-ec(h)o, which included core game mechanics, game progression and structure, and narrative development. We had yet to build a working prototype. Our main concern at this stage was the design of a compelling environment based on user engagement, movements in physical space, immersion, and narrative or game progression. We knew at this point that we needed to investigate specifics in the role that the audio display would have. We had determined that the technical preconditions included location tracking, and an ambient interface that might involve body and object movement, location, and gestures. Given the Aml [ambient intelligence] nature of the project we ruled out a graphical user interface of any kind (Droumeva and Wakkary, 2006, p.37).

The aim of thick description with respect to validity is to describe the event and context in sufficient detail that the reader and researcher can apply relevant knowledge from the account to another setting or event. Seale concisely illustrates the role of thick description and transferability:

Thick descriptions of particular settings are appropriate, giving sufficient detail about context of events so that readers can vicariously experience what it was like to be in the setting. Readers can then conduct their own 'thought experiment' in seeking to transfer the lessons learned from this setting encountered through a research text (Seale, 2000, p.41).

The onus is therefore on the interaction design inquirer to detail the accounts of the interaction design experience and research such that it supports a 'thought experiment' of applicability in another or similar circumstance. In short, the designer inquirer or interaction design researcher must support the reader in making their own judgment about the relevance of the findings for their own particular design situation or design research problem.

By Lincoln and Guba's own account, transferability is the natural inquirer's response to external validity in positivism (Lincoln and Guba, 1985). The idea is that causality proven in a sample study can be generalized to a similar sample or the larger set from which the sample was drawn. In this example, the sample is the typical case, and great



efforts are put into the rigor of method in establishing and testing the sample. Qualitative researchers argue that ecological validity prevents this type of large number sampling, yet transferability shows how single studies with ecological validity intact can be seen as types. There is also what Seale refers to as theoretical generalization that supports single in-depth qualitative cases that can be generalized from the particular, and not from a type (Seale, 2000). I believe this applies to interaction design research. Seale states that theoretical generalization rests on the logic rather than the probability that results from the study. He cites Mitchell (Mitchell, 1983) to say that a case or study may not be representative but the analysis emergent in the case is “unassailable.” He points to analytic induction in which cases are not chosen beforehand as representative examples; rather they serve to illuminate aspects of a theory.

The idea that design of embodied systems is best supported by activities like workshops rather than iterated design representations like scenarios can be regarded as an example of how the theory supports theoretical generalization. In socio-ec(h)o, the overall pattern in the inquiry was for interpretations to build upon each other through participatory workshops (see Figure 41). In the isolated cases where a scenario was used, like se-J3, the trading game scenario does not connect to other actions. Further, a key decision between either puzzles or narratives as the way to structure the game play was resolved by workshops. These workshops occurred late in the inquiry, suggesting that each concept was successfully carried and experimented with through the workshops. The pattern or underlying logic of the actions of workshops and supporting interpretations substantiates the finding on the use of participatory workshops in similar types of inquiries. In comparison with ec(h)o, which was more of a tangible user interface design problem, workshops played supporting roles to scenarios as opposed to being relied upon exclusively

to explore concepts. Additional descriptions in other inquiries do help support the claim, but the particular example can substantiate a logic quite clearly and fully.

#### **6.1.1.3 Dependability and confirmability**

I have brought together the two issues of dependability and confirmability under one discussion since the supporting approaches overlap both concerns. Dependability asks what are the shared or common constructs by which we assess research accounts.

Confirmability asks to what degree we can confirm the findings by ensuring a degree of replicability in qualitative terms of any study. Qualitative researchers do not agree upon these terms; some question their import given the underlying constructivist notion of multiple perspectives over absolute truth that underpins qualitative thinking. Nevertheless, they serve a practical end, which is to explicitly show how studies and findings can build on each other through follow-up studies of similar inquiries. Additionally, the concepts when followed up on strengthen the claims to transferability by showing the methodological rigor of the interpretive approaches. This rigor is best characterized as transparency.

The main claim to transparency comes from reflexivity in research investigations. Reflexivity is the presence of a methodologically self-critical account of how the research was conducted. The notion of reflexivity extends to other aspects like credibility where the matter arises through the researcher's explicit accounting for his or her presence in the research. However, the critical principle underlying reflexivity is the understanding that trustworthiness of research is a discursive matter, e.g. it is always negotiable or open to productive criticism, and not absolute or unassailable as a matter of conclusive proof. The exposure through self-critical accounts offers the most constructive platform for negotiation, criticism, and being shown to be false. This assumes a fallibilism that is

grounded equally in the pragmatism of C.S. Peirce and Dewey as it is in Popper's fallibilistic presuppositions in quantitative approaches. The embodied and proactive designer inquirer at the centre of the interaction design theory ensures reflexivity in research accounts and data collection, as does the careful categorizing and descriptions of multiple types of data afforded by the theory.

Lincoln and Guba propose a procedure that they call auditing that manifests reflexivity clearly in the research process (Lincoln and Guba, 1985). In essence they argue for an "audit trail" as part of the research process. They propose a systematic accounting of the instances of methodological reflexivity in which data and data analysis produced through the research are catalogued and reviewed during the course of the study by peer auditors. Auditors would look at the "raw data" and examples of analysis, in addition to the triangulation and relationships drawn between the data and evaluations. In addition, auditors would seek out research diary entries, meeting notes for decision-making, analytical strategies and so on in order to provide a complete and thorough methodological formative assessment. According to Lincoln and Guba, researchers and auditors would agree to meet prior to a series of visits at different stages of the research. The proposal is quite thorough and exhaustive. For most researchers it is a challenge to follow the process yet it is less time-consuming than replicating the study (Seale, 2000). Interestingly, the description of auditing and auditors, while less formal, is not unlike the actual collaborative practice of an interaction design inquiry. The auditors are of course peers and members of the team, however in most teams there is this ongoing check of design representations, arguments, and strategies that are not unlike an integrity check of the practice.

Returning to research aims, there is a range of practical strategies to auditing a research study. This is similar to the range of strategies with inter-rater reliability that

include hiring external coders, to calculating statistical reliance between codings, to working within the research team to arrive at a consensus with the codings. The critical point in interaction design is to formalize evidentiary data collection that is diverse and ensure the data is sufficiently detailed to offer an explicit and public accounting of the research process. Similarly, Amanda Jane Coffey and Paul Atkinson write:

Transactions and the ideas that emerge from them should be documented. The construction of analytic or methodological memoranda and working papers, and the consequent explication of working hypotheses, are of vital importance. It is important that the processes of exploration and abduction be documented and retrievable. Their documentation is part of the transformation of data from personal experience and intuition to public and accountable knowledge (Coffey and Atkinson, 1996, p.191).

The proposed interaction design theory provides the taxonomical descriptors that cover the range and diversity of data, and also cover the transactions and ideas that result from the design inquiry. This in effect provides the tools for an intellectual and research audit trail of the interaction design inquiry. The accounting extends to the “triangulation” or the relationships among transactions and entities. While the theory does not call for external auditors, the explanation of relationships among the inquiry data is expressed as a matter of integrity with respect to practice and research. The higher-level taxonomy conveniently reduces these elements to actions and framework components that ultimately create descriptive flexibility. The theory provides the interaction design researcher and practitioner with procedural support. Chapters 4 and 5 amply demonstrated the descriptive or auditing functions of the theory.

Framework componets		Actions	Outcomes
Experience			Theoretical Reflections Accounts
Inquiry			Designer Inquirer Design Intentions Design Rationales
Actions	Judgment		Representations Activities Models, Artifacts, Systems Evaluations
	Interpretations		Accounts Stakeholder Views Findings Criticism

**Table 21 Interaction design theory framework**

Equally important is that the theory provides the shared construct necessary for confirmability. In Table 21, the framework is represented to show the structure based on a hierarchy of components, actions, and outcomes. I have detailed the interactions and the descriptive purview of each element in earlier chapters.

In addition to the taxonomy, I discussed structural descriptors that analyse the design inquiry and help the researcher measure the structural quality (see 5.2.2 The experience view). These offer added support for reflexivity. Table 22 shows the common pattern, which is a basic structure of any inquiry (see 5.2.2.2 The common pattern in interaction design). Table 22 also shows descriptions of relationships among entities that include formative findings, mirrors and feedback loops, and cascading (see 5.2.2.1 The relationships in an interaction design inquiry). At a higher level, the inquiry can be seen to be composed of the anatomical structures of inter-integrity, intra-integrity, and extra – integrity (for more details see 5.2.2.3 The dynamic structure of an inquiry).

<b>Common pattern</b>
<ol style="list-style-type: none"> <li>1. An intention is required to initiate the design inquiry. Ideally it is supported by a design rationale.</li> <li>2. The intention initiates a judgment that is the first interaction design action.</li> <li>3. The action is interpreted and the reflection is mirrored or fed back into the inquiry in the form of another judgment.</li> </ol>
<b>Relationships of the inquiry</b>
Formative and summative findings Mirrors and feedback loops Cascading
<b>Anatomical structures</b>
Inter-integrity (Mirrors and feedback loops, formative findings, and initiations): relationships across types of actions like interpretations and judgments; relationships across the design inquiry to actions like intentions; and formative findings that prescribe judgment actions. Intra-integrity (Cascades): relationships that connect similar actions together like a series of judgment actions leading up to a final prototype, or a series of design charrettes to orientate the design team. Extra-integrity (Findings and criticism): a series of findings that cascade into forms of criticism external to the designer inquirer. Criticism takes on the form of a “meta feedback loop” that influences subsequent design inquiries. This pattern is more speculative and posited theoretically. Given the state of interaction design it is not evident in the projects described.

**Table 22 Structural descriptors of interaction design inquiries that can support reflexivity and auditing**

The framework itself is open to further negotiation and becomes a discursive object in itself. However, the clear articulation of a construct for description and analysis of interaction design is necessary to ground and manifest the researcher’s reflexivity. The framework functions as the agreed upon (or further negotiated) construct by which the knowledge generated can be said to be confirmed and dependable.

### 6.1.2 Quantitative validation

In pragmatism there is no single methodology that can be utilized to cover the scope and complexity of experience. Inquiries share the general pattern of beginning with a genuinely problematic situation that can come to a resolution via processes of manipulation and experimentation. I have detailed this in the earlier accounts and described at the framework level a common pattern for interaction design (see 5.2.2.2 The common pattern in interaction design). This pattern and the theoretical framework encourage wide latitude

for specific methodologies that are judged only by their matching with particular types of problematic situations. There is no absolute or foundational language to which all other languages must be reduced. A constructivist approach is adopted in which quantitative methods are included if not welcomed.

The judgment actions are expansive and inclusive. While the inquiries analyzed in the thesis show no evidence of this, an experimental study is as much at home at the beginning of an inquiry as a charette or workshop. Such a study could be followed by an interpretation and its findings could be based on statistical analysis. Design fields have been open to and have used scientific realism findings in psychology, sociology or computing science, yet less so is scientific realism used within its own practices nor is it typically seen as part of the various practices. In our own practice we have incorporated quantitative analysis where it was sensible. For example we examined the coefficient alpha, which is often used as a measure of the reliability of a questionnaire instrument, for our own questionnaire as a test of internal validity (Jiang, 2008).

For the most part, our use of quantitative analysis is part of a “mixed methods” approach (Creswell, 2003). In this section, I will discuss two examples. The first is the use of data from an evaluation of the ec(h)o system, the second discusses the statistical analysis of video coding of a socio-ec(h)o user study.

#### **6.1.2.1 User perception testing in ec(h)o**

In this example, our evaluation mixed quantitative statistical analysis with qualitative analysis of a semi-structured interview of each participant in order to confirm and support the findings. This analysis was previously published in (Wakkary and Hatala, 2007). We evaluated the final prototype of ec(h)o in a user study at the Canadian Nature Museum. The formal user evaluation effort involved sessions with six participants that

included two men and four women, from 25 to 53 years old. Table 23 shows the characteristics of each user session: total length of the interaction, number of interaction cycles, number of selected and listened to audio objects, and number of location changes.

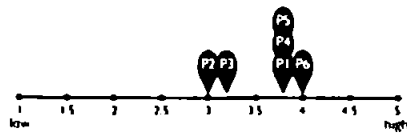
Participant	Length	#Cycles	#Selections	#Locations
Participant 1	10:36	27	19	8
Participant 2	6:19	11	7	4
Participant 3	8:56	22	12	10
Participant 4	9:53	21	16	5
Participant 5	9:18	22	17	5
Participant 6	5:01	16	7	9
Expert 1	15:03	32	23	9
Expert 2	17:58	36	29	7

**Table 23 Test session characteristics per participant and two expert reviewers**

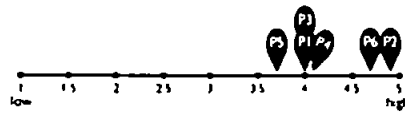
We evaluated user experience through observation, a questionnaire, and a semi-structured interview. The questionnaire included sixty-three questions that assessed the overall reaction to the system, the user interface, learning how to use the system, perceptions of the system’s performance, the experience of the content, and degree of navigation and control. The majority of the questions in the questionnaire were on a Likert scale (5 points), while some were open-ended written responses.

The results showed that participants found the system enjoyable and stimulating. The general sense of satisfaction was split between those participants who liked the playful approach and those who did not. While our sample was small, we noted a clear age difference in that the “younger” participants rated satisfaction higher based on their liking of the playful approach (this was confirmed in the semi-structured interviews).

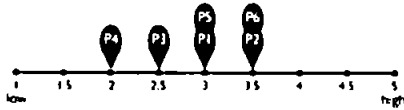




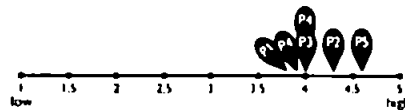
**Overall reaction:** 5 ratings including "terrible-wonderful; difficult-easy" averaged for each participant. Overall average rating is 3.6 with a standard deviation of 0.78.



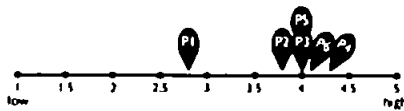
**Tangible user interface:** 7 ratings including "uncomfortable-comfortable; difficult-easy to manipulate; annoying-enjoyable" averaged for each participant. Overall average rating is 4.24 with a standard deviation of 0.50.



**Headset:** 2 ratings including "uncomfortable-comfortable" averaged for each participant. Overall average rating is 2.92 with a standard deviation of 0.12.



**Learning Curve for the system:** 8 ratings including "difficult-easy to get started; risky-safe to explore features; unclear-clear feedback" averaged for each participant. Overall average rating is 4.07 with a standard deviation of 0.36.



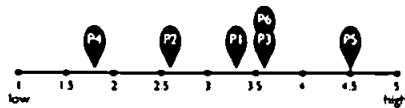
**Perception of system performance:** 8 ratings including "slow-fast system response; never-always reliable" averaged for each participant. Overall average rating is 3.83 with a standard deviation of 0.39.



**Quality of the content:** 15 ratings including "uninformative-informative; generalized-customized for me; rigid-playful; predictable-surprising" averaged for each participant. Overall average rating is 3.78 with a standard deviation of 0.52.



**Quality of the audio experience:** 9 ratings including "confusing-clear; mechanical-human; wasteful-valuable" averaged for each participant. Overall average rating is 3.67 with a standard deviation of 0.30.



**Navigation and control:** 8 ratings including "never-always able to navigate efficiently; always-never found myself lost in the system; always-never found myself uncertain of the system state" averaged for each participant. Overall average rating is 3.23 with a standard deviation of 0.29.

**Figure 42 Summary of the questionnaire results on user experience (n=6; 63 questions on Likert scale of 1-5 (5 being best))**

Among the factors that stood out as most positive for the participants was that the cube and audio delivery were seen as playful. The open-ended written comments and semi-structured interviews made this point clear as well. The tangible user interface was also well received especially in terms of ergonomics and ease of use. These two activities were documented in Chapter 4 (see 4.2.1 ec(h)o: judgment). In addition, learning to use the

interface and navigation were both rated highly and participants felt the system had a low learning curve and that it was easy to get started:

Umm, I found it was really easy. Sometimes I got so engaged in listening to what they were saying that I forgot in which orientation I was holding the cube. And I found that I would have to occasionally look down. But the way it was designed with the round part to go in your palm... it was really easy to quickly reorient myself to how I was holding that cube (Participant 5).

The questionnaire did point out some challenges and areas for further research. We expected some of the challenges, for example the headphones were uncomfortable, yet to such a degree that it led us to rethink the trade-off between personalized spatial audio and use of headphones that resulted in the audio display design choices in socio-ec(h)o. Other results point to a threshold in the balance between levels of abstraction and local information. Some visitors had difficulties at time connecting what they were listening to with what was in front of them (in part this was an inherent challenge in the exhibition since the display cases had dozens to over a hundred artifacts). In addition, we see both a threshold point in play and focused attention on the exhibit, which is evident because the question relating to the content asking if it was “distractive-synergistic” scored 2.83. This raises the issue of balance in play and the possibility that play shifts attention away from the environment rather than acts as a means of further exploring the environment.

In an open-ended question in the questionnaire and through the interviews, we explored the issues of liminal play and engagement further. The results here are quite clear that play was a critical experiential factor in using the system. It was often remarked how the experience was similar to a game:

The whole system to me felt a lot like a game. I mean I got lost in it, I found myself spending a lot of time in a particular area then I normally would. And just the challenge of waiting to hear what was next, what the little choice of three was going to be. Yeah... So I found it over all engaging, it was fun, and it was very game-like (Participant 4).

The playfulness did in most instances suggest a quality of engagement that led to learning, even through diverse types of museum visits; from the visitor who browses through quickly but is still looking to be engaged to the repeat visitor who experiences the audio information differently each time:

I learned a lot and well you know I'm a scientist here, and I think anybody going through, even people who are in a real rush, are going to pick up some interesting facts going through. And... I mean, that was good, the text was great and was short enough that somebody in a rush is still going to catch the whole thing (Participant 1).

As mentioned earlier, there is a threshold between play in support of the exhibit on display and play with the system that can be an end in itself and even a distraction. For example, one user's enthusiasm for the game-like quality led her to at times pay more attention to the interaction with the system than the exhibition. In addition, people respond to play differently and can be argued to belong to different types of players (Bartle, 1996), a point we investigated later in socio-ec(h)o. One participant would have preferred a more serious and "non-playful" approach.

The prefaces were playful, but the text was not at all, you know, that contrast between them.... but I find it was too playful and I think maybe, either you, or maybe you could give people the choice between you know choosing a playful or a non-playful version" (Participant 2).

In addition, participants' observations on the liminality of the experience manifested in comments suggesting that play was more natural for children than themselves, however as expressed below, they soon overcame this issue:

At first it felt a little bit strange, especially holding this cube that looked like a children's toy, and I felt a little bit awkward about doing that, but I got over that pretty quickly (Participant 5).

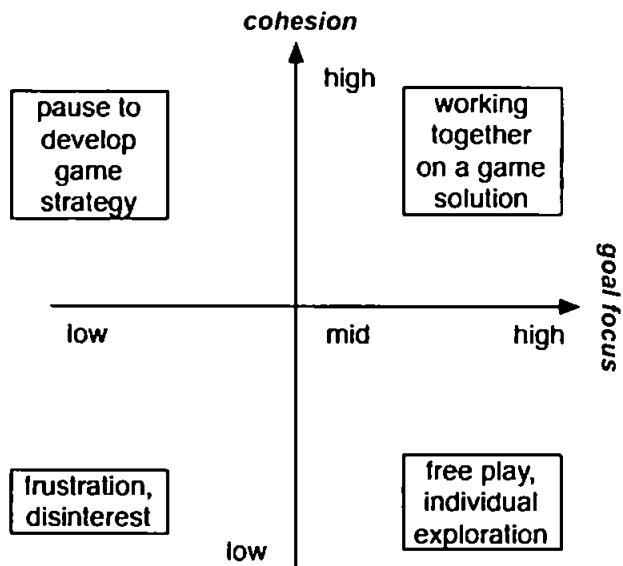
It was quite chatty, which was kind of fun. I kind of felt like 'Oh, I bet like a twelve year old would really like this (Participant 3).

In this example, we used a mixed method approach in which quantitative findings were supported and refined with qualitative analysis. The combined approaches led to the findings described in Chapter 4 (see 4.2.2.3 ec(h)o: findings).

#### **6.1.2.2 Evaluation in socio-ec(h)o**

In evaluating socio-ec(h)o we had vast amounts of data in the form of video and audio transcripts, system logs, and questionnaire data. This evaluation and analysis was previously published in (Wakkary, 2008). Interaction aspects of the research were exploratory and so we used quantitative analysis to identify points of foci that we could later examine in greater detail through richer qualitative analysis. We analyzed questionnaire data but the bulk of the analysis was conducted with video coding data. In the overall final study, we conducted an experiment involving 56 participants divided into teams of four. The experiment included a two-hour session of playing in the socio-ec(h)o environment. The teams were divided into two groups that each followed a different protocol (see 5.1.1.4 socio-ec(h)o: evaluation). The analysis here reports on only one of the protocols that included groups of thirty-six (36) participants and the play.

Each session was recorded with three cameras and audio, providing ample data to code group actions and behaviours. Our coding scheme was based on two main factors: cohesion and goal focus. I earlier described the scheme (see 5.1.2.1 socio-ec(h)o: accounts) but it is worth detailing further in the context of understanding the data analysis. The combination of these factors in a two-dimensional matrix shows the degree of descriptive capacity, see Figure 43. Two researchers independently coded the videos and for inter-rater reliability they negotiated the differences to reach a consensus.



**Figure 43 Matrix showing the descriptive capacity of the two factors**

Cohesion can be described as the extent to which players appear to be acting as a team (all members coordinating together); whether that is working on a game solution, playing, thinking, or talking to each other. Cohesiveness is a measure of team dynamics and does not necessarily reflect their focus on the game but only whether they are acting in unison as a team. We analyzed different degrees of cohesion:

- *Low*: players are not together as a group or they are temporarily fragmented. They are not communicating or are individually exploring;
- *Medium*: players are in the process of becoming a group or are regrouping. Players are negotiating roles and establishing leadership or consensus;
- *High*: players constitute an established team. They make several agreements and are coordinated in their movements or are communicating with each other about strategy and solving the puzzles.

Goal focus can be described as the extent to which players appear to be or are attempting to “play the game” the way they understand it. Game activity is not dependent on whether players are working as a team or not. In addition, game activity does not necessarily only mean that players are actively playing, i.e. in our case moving. If players

are still because they believe the game requires them to be still, then they are “playing the game.” We analyzed different degrees of goal focus:

- *Low*: players are not involved in playing the game. They are resting, or are distracted, or engaged in activities not related to the game;
- *Medium*: players are in the process playing the game. They are experimenting with different actions, and communicating with each other about or reflecting on the effects of their actions;
- *High*: players are actively and consciously playing the game and attempting to solve the puzzle at hand. This is reflected in concerted efforts and good communication related to their performance in the game. Many ideas are shared on actions for solving the puzzle.

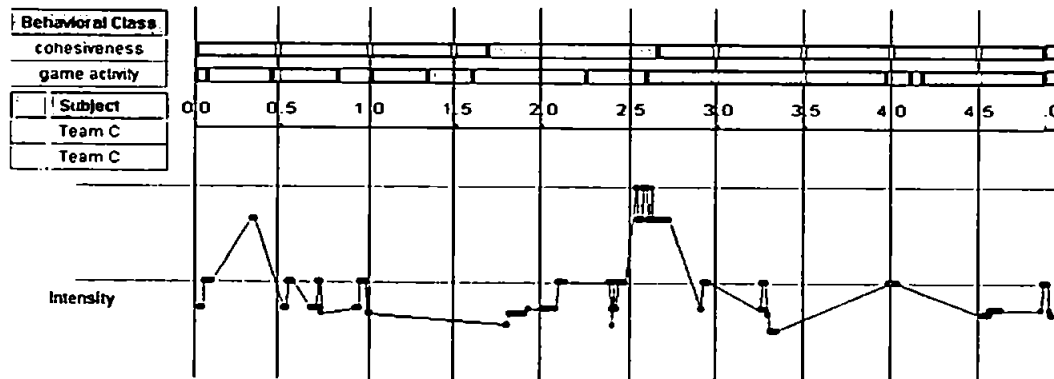
For rationales and discussion of related literature in the development of the schemes see (Wakkary, 2008).

As I discussed in Chapter 5 (see 5.1.1.4 socio-ec(h)o: evaluation), our analysis looked at the different levels of cohesiveness and goal focus over duration to determine a density value in percentages:

$$density = \frac{factor(min)}{duration(min)}$$

We looked for combinations of density values of the different degrees (high, medium, low) of the two factors (cohesion, goal focus) and compared these to team performance or duration of the game level. Additionally, we correlated the different degrees of cohesion and goal focus factors with team performance (duration) using the Pearson correlation coefficients. The Pearson correlation coefficients measure the degree and the direction of the linear relation between two variables. That is, how much are changes in one of the variables related to changes in the other variables. Correlation can be used to estimate the extent to which teams' performance, cohesion and goal focus factors were related. Lastly,

we compared the video coding results with the intensity data from the logs (see Figure 44). Based on these comparisons we isolated key events for further study through transcripts and videos.

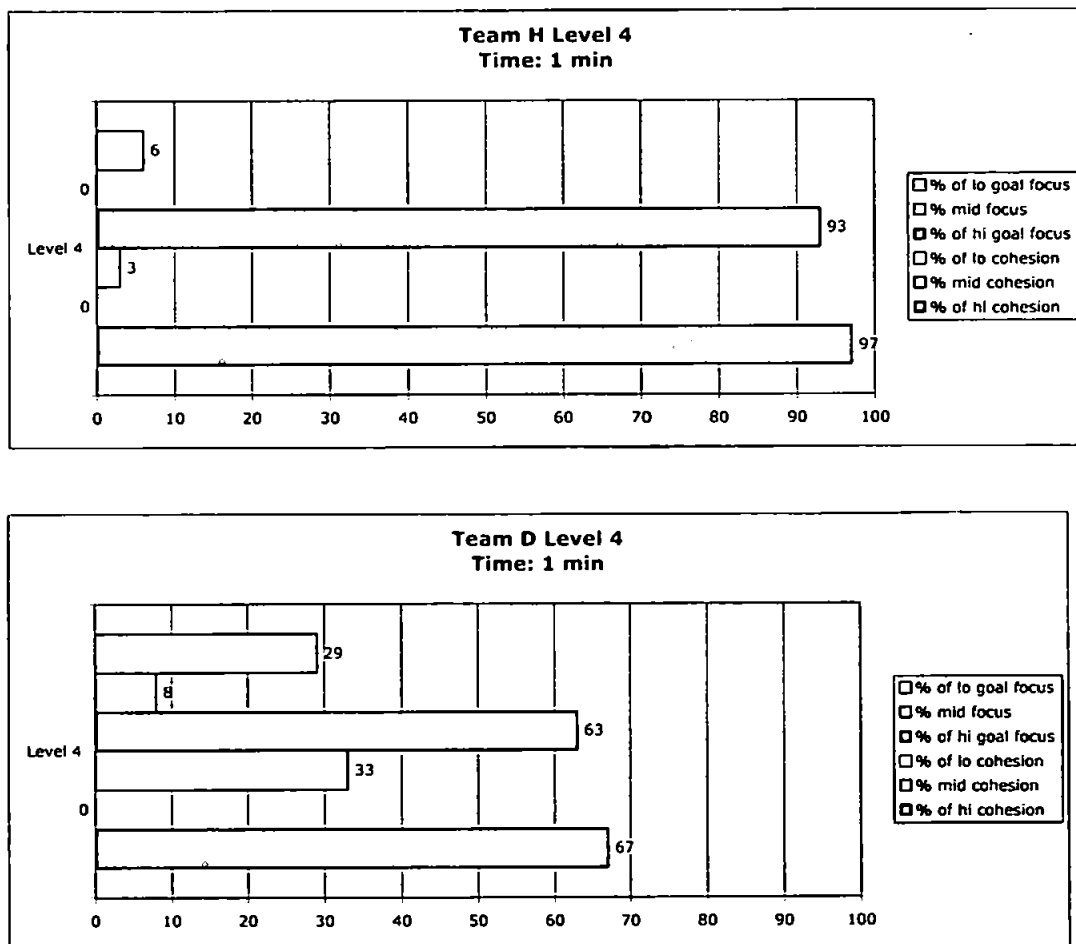


**Figure 44** A comparison of the video coding results (color bars on the top of the figure) with the system logs that measured intensity (graph).

Our results show correlations between high degrees of the two factors: the role of transitions, and players' perceptions. Table 24 and Table 25 show correlations between cohesion and goal focus. Note that in each table, column numbers refer to the same values as rows, for example in Table 24, row 7 and column 2 show a significant correlation of .871 between the medium degree of cohesion and completion time.

One might expect that a team that showed high density values of both cohesion and goal focus factors would lead to a fast performance in the game. Indeed, we found that Team H held density values of 93% for goal focus and 97% for cohesion in level 4, and completed the level in less than a minute. However, Team D had significantly more modest density values for level 4, 63% for goal focus and 67% for cohesion, yet the team was able to complete the level in just under a minute, (see the comparison in Figure 45). To further the point, a team like Team C, which had a density value for goal focus of 66% and cohesion of 89%, required over 39 minutes to complete the levels.

Statistically, we found no significant correlations between high degrees of cohesion or goal focus factors and team performance in game level 3 (see Table 24). We had virtually the same results for game level 4 (see Table 25). However, Table 24 shows a significant correlation between medium degree of cohesion and performance (.871). Table 25 shows a strong correlation between medium degrees of cohesion and goal focus and performance (.892; .927). This led us to examine the role of transitions, where factors change in degrees such as a team shifts from a high degree of cohesion to medium degree of cohesion.



**Figure 45** Bar graphs showing that high density values of high *cohesiveness* and high *goal focus* do not correlate to fast completion as in the example of teams H and D.



Level 3	1	2	3	4	5	6
High degree of cohesion	-	-	-	-	-	-
Medium degree of cohesion	.577	-	-	-	-	-
Low degree of cohesion	-.355	.828**	-	-	-	-
High degree of goal focus	-.346	-.609	.284	-	-	-
Medium degree of goal focus	.303	.799**	-.511	.743*	-	-
Low degree of game focus	.158	-.010	.172	-.651	-.023	-
Whether or not completion time is < 5min	.494	.871*	-.743	-.439	.651	-.012

\* Correlation is significant at 0.05 (2-tailed),

\*\* Correlation is significant at 0.01 (2-tailed).

**Table 24 Correlations in level 3**

Level 4	1	2	3	4	5	6
High degree of cohesion	-	-	-	-	-	-
Medium degree of cohesion	.837**	-	-	-	-	-
Low degree of cohesion	-.785*	.358	-	-	-	-
High degree of goal focus	.854**	.834**	-.566	-	-	-
Medium degree of goal focus	-.785*	.926**	.370	.882**	-	-
Low degree of goal focus	-.590	.450	.586	.816**	.486	-
Whether or not completion time is < 5min	-.037	.892**	-.334	-.647	.927**	.297

\* Correlation is significant at 0.05 (2-tailed)

\*\* Correlation is significant at 0.01 (2-tailed)

**Table 25 Correlations in level 4**

We found that transitions from different levels of coherence and goal focus held statistical significance when compared against performance throughout level 3 of the game, except for transitions to high cohesion, see row 9 in Table 26, and significance in transitions from all degrees of both factors in level 4 of the game except for transitions to low cohesion, see row 9 in Table 27.

Level 3	1	2	3	4	5	6	7	8
Total transitions game focus	-	-	-	-	-	-	-	-
Transitions to low game focus	.985**	-	-	-	-	-	-	-
Transitions to medium game focus	.854**	.771*	-	-	-	-	-	-
Transitions to high game focus	.947**	.963**	.649	-	-	-	-	-
Total transitions cohesion	.860**	.823**	.848**	.744*	-	-	-	-
Transitions to low cohesion	.818**	.839**	.670*	.770*	.923**	-	-	-
Transitions to medium cohesion	.883**	.838**	.889**	.754*	.994**	.893**	-	-
Transitions to high cohesion	.820**	.775*	.825**	.703*	.995**	.906**	.984**	-
Completion time	.939**	.960**	.732*	.916**	.688*	.687*	.725*	.625

\* Correlation is significant at 0.05 (2-tailed)

\*\* Correlation is significant at 0.01 (2-tailed)

**Table 26 Correlations between transitions and duration in level 3**

Level 4	1	2	3	4	5	6	7	8
Total transitions game focus	-	-	-	-	-	-	-	-
Transitions to low game focus	.989**	-	-	-	-	-	-	-
Transitions to medium game focus	.958**	.911**	-	-	-	-	-	-
Transitions to high game focus	.971**	.987**	.863**	-	-	-	-	-
Total transitions cohesion	.897**	.842**	.980**	.769*	-	-	-	-
Transitions to low cohesion	.778*	.690*	.922**	.613	.964**	-	-	-
Transitions to medium cohesion	.897**	.841**	.978**	.770*	.999**	.966**	-	-
Transitions to high cohesion	.942**	.913**	.976**	.845**	.977**	.888**	.972**	-
Completion time	.950**	.971**	.831**	.988**	.722*	.553	.717*	.817**

\* Correlation is significant at 0.05 (2-tailed)

\*\* Correlation is significant at 0.01 (2-tailed)

**Table 27 Correlations between transitions and duration in level 4**

We examined the relationship between players' perception of the helpfulness of the system and their performance. No correlation was found, thus fast players did not necessarily believe the system to be more helpful than slow players. However, there was a significant relationship between players on teams who completed the most levels and the players' perception of the support of the system. This suggests that the more "skilled" players (those who could complete the higher levels) perceived the system to be more helpful. The overall rating of the system was quite good, for example on the question of how helpful the system was, the median score was 4.0 (SD 1.02) on a scale of 1-5 (5 high).

All of the findings discussed here are described in Chapter 5 (5.1.2.3 socio-ec(h)o: findings). This example shows how we validated our findings quantitatively and how quantitative analysis was used to make sense of rich data in order to establish foci for subsequent qualitative analysis.

### **6.1.3 Criticism**

Criticism is an activity central to philosophy for Dewey, who understood it as appraisal or evaluation (Dewey, 1929b). In pragmatism, the value of criticism arises in many respects, from understanding the value of an inquiry in the context of everyday experiences, to the mediation of intended operations over those of chance or whim, and finally to address the role of temporality in experience and its validation over time.

The basis of Dewey's understanding of the relationship between philosophy and democracy is that knowledge and practice are harmonized in the security and freedom that the values embodied in experience are widely shared (Dewey, 1929b). This wider issue aside, criticism enables the sharing of the values articulated by an inquiry to move beyond the limitations and constraints of the initial inquiry. In pragmatist terms, they become intrinsic goods when they are valued in everyday experiences. In other words, criticism

extends beyond the particular inquiry into a wider set of social interactions in a way that qualitative and quantitative validation strategies do not.

Life experience will happen regardless of our intentions and aims. In some sense this is true of design: things will be made or design actions will occur whether or not someone calls himself or herself a designer and consciously assigns intentions and rationales to their actions. This is what Dewey would consider as life experience with a minimum of regulation. Dewey argues that criticism minimizes these acts of “fortune or providence” by affording intelligent actions that are experienced and come with meaning. It is not that chance does not have a role in design or life but criticism enables the accrual of experience that mediates and guides intentions and actions (Dewey, 1929b). The idea of discernment and evolving design intelligence over time is what makes interpretation central to interaction design. I have shown in the description of inquiries how interpretation is manifest in reflection and action simultaneously. Criticism is the explicit extension of the interpretive and dialogic actions of the inquiry beyond the particular inquiry.

Returning to the idea that criticism is inherently democratic, Dewey saw in democracy the increased participation in a diverse set of activities that could be understood and valued in everyday experience: “Criticism is discriminating judgment, careful appraisal, and judgment is appropriately termed criticism whenever the subject-matter of discrimination concerns goods and values” (Dewey, 1958, p.298). The democratic underpinnings to criticism argue for the participation of many and the access to freely discriminate the “goods and values” of an inquiry in an open exchange. It is this open dialogue in an everyday context focused on the value of an inquiry that makes criticism so central. In pragmatist terms, knowledge becomes negotiated within the affairs of ordinary experience. Criticism mediates the intentional and intelligent operations of experience.

Temporality is infused throughout pragmatism. It has many dimensions that affect interaction design processes, from the interaction of actions, intentions, and rationales to the accrual of experience and development of the designer inquirer. Temporality extends actions into experience, for example past actions and interpretations become embodied in the designer inquirer and are then carried from project to project. It is this longer cycle of inquiries in which criticism plays a strong role. As I have discussed, criticism moves the notion of validation beyond the inquiry into lived experiences. It maintains the dialogic aspect of interpretation and in more fluid and explicit ways it sees interpretations to be more negotiable than even the qualitative approaches to validation that I discussed earlier (see 6.1.1 Trustworthiness in knowing).

In addition to discursivity, lived experiences are contextual and temporal, exposed to the vicissitudes of change and the unforeseen. And so the “value and goods” of the inquiry must also be seen as temporal. As such they are extant and therefore assessed or validated over and through time. The real challenge and promise of criticism is to secure and extend the trustworthiness, validation, and ultimately the value of the goods of the inquiry by discerning which are appropriate and which are not at any given time.

And so I posit the vital importance of criticism in interaction design but I have or we have little to show with respect to examples of criticism in interaction design. In the wider context of design, this absence of criticism, criticism practice, or critical theories in interaction design is glaring. Architectural criticism dates back to Vitruvius in the time of Augustus (63 BC- AD 14) and was present in, if not instrumental to, architectural practice during the Renaissance in key figures like Leon Battista Alberti (1404-1472). Industrial design, graphic design and architecture developed a clear practice of criticism through the late 19th and 20th centuries (Margolin, 1989). Richard Buchanan has suggested a liberal

arts foundation for design built on the critical theories and practices of industrial and graphic design (Buchanan, 1995). Adrian Snodgrass and Richard Coyne (Snodgrass and Coyne, 2006) argue to reclaim the term of interpretation from criticism in architecture: “Whereas we agree that architecture is a discursive practice, and is abetted by talk and writing, we will demonstrate that to design is to interpret” (Snodgrass and Coyne, 2006, p.4). My proposed theory centralizes the actions of interpretation into the practice of interaction design, yet there is no talk or writing “abetting” the practice of interaction design.

The lack of a critical practice has not gone entirely unnoticed. One early exception is Steven Johnson’s *Interface Culture* (Johnson, 1997) in which Johnson discusses graphical user interfaces in the context of film and literary criticism. More recently, McCarthy and Wright (McCarthy and Wright, 2004) employ rhetorical approaches similar to criticism to illustrate experiences of technology. We are far from a practice of criticism in interaction design but at least this has been identified as a problem by some interaction design and HCI researchers (Löwgren and Stolterman, 2004 , Löwgren, 2002 , Blythe et al., 2008). Löwgren writes: “An issue of particular interest is the possible role of critics in interaction design. One can imagine a field of interaction design criticism in analogy with more mature design fields such as architecture or graphic design” (Löwgren, 2002). He sees a problem in that the scientific realism orientation of HCI prevents a criticism approach and cites Preece et al’s *Interaction Design: Beyond HCI*:

This appears problematic from a HCI perspective: ‘Finding measurable characteristics for the user experience criteria is even harder, though. How do you measure satisfaction, fun, motivation or aesthetics? What is entertaining to one person may be boring to another; these kinds of criteria are subjective and so cannot be measured objectively’ [p. 182] (Löwgren, 2002).

I have identified how HCI has overshadowed and curtailed the development of interaction design theory and practice and this includes minimizing the role of criticism (see 1.1 The visionary and status quo versions of interaction design). Despite the clash of an interpretive approach with scientific realism there is an activity in HCI and broader scientific practice that engenders all the critical attributes of quality criticism. This activity is blind peer review.

Blind peer review has all the qualities one would look for in criticism, an informed peer critically analysing the value of a research contribution or design. Blind peer review is the anonymous review of a journal or conference paper submission by several peers. The reviews range in formality but often under the dictates of a journal's editorial board or a conference program committee, there are minimum criteria to follow and this typically involves a mix of quantitative but primarily qualitative comments and analysis. In the case of journals, manuscripts, and some conferences, a shepherding process is used in which the reviewers maintain anonymity but continue to review changes and ongoing iterations of papers until publication. I have included a review from an early attempt of mine to publish on the ec(h)o project in 2003:

In general the reviewers found this work to be interesting, to build well on prior work (especially that of Woodruff), and to introduce the novel user interface concept of audio icons that invite further interaction at a specific museum location. However, the reviewers also agree that the work is too preliminary (design only), and not well-enough motivated to warrant publication. As it stands the work is a modest addition to existing work; full explication of the design rationale, and a thorough account of connections between the participatory workshops and resulting design features might add enough of a research contribution to make the work publishable, but the authors are also strongly encouraged to implement and test their ideas first.

Several of the reviewers provide important pointers to work not recognized or cited (see in particular the listings by Reviewer #2). The project does a nice job of building on specific related work in museum systems, but do not go beyond to consider the role of other gesture-related work with audio-based systems.

All of the reviewers were intrigued by the role of the conversation model in motivating the audio selection mechanism, so it seems likely the authors have hit upon a fruitful research direction. But this proposed motivation raised as many questions as it answered, so clearly more work needs to be done examining and better articulating the motivation provided by a conversational model. Reviewer #2 offers a detailed critique of the rationale that can be understood (or inferred), while Reviewer #4 describes difficulty in even seeing the connections between many of the proposed interaction criteria and a conversation model. Reviewer #4 also provides a nice summary of what is missing in this paper, namely what are claimed to be the competencies of the users the design is targeting, and what benefits are actually realized for such users in actual museum activities.

In general the writing of the paper was fine, though there were a few comments for improvement, e.g. more careful introduction and use of special vocabulary. The consensus is that the work has promise but must be more developed to qualify as more than a modest incremental contribution.

At the program committee meeting, there was agreement that the arguments summarized above were grounds for rejecting the paper, despite the general interest in this as a research area (ACM CHI 2004 reviewer comments – personal correspondence).

Evidently the paper was rejected but this is not the point of the example; suffice to say that a subsequent version of the paper was later accepted and was directly influenced by the comments of the review. The review presented here is a meta-review written by the review chair that consolidates and summarizes the comments by all the reviewers, in this case four other reviewers. The reviews have all the functional components of criticism:

- Overall assessment of the value of the work in general terms;
- Assessment of the relevancy of this effort with other research or practice efforts such as building on and extending existing practices or overlooking existing works;
- Identification of unique aspects or values in the work or identification of redundancies or derivative aspects or values;
- Assessment of the contribution value of the work in terms of strengths and weakness;
- Identification of promise latent in the work or not.



Lastly, the reviews offer multiple views that show differences in their assessments. The constructivist principle of multiplicity and interpretations reigns in criticism but this does not lead to relativism. The differences are negotiated through the public exposure of the reviews, at least among the reviewers and chairs. In addition, the quality of the reviews differs. At stake is a craft of constructing a review that supports one's impact in the implicit negotiation of the validity of the work. I have shown how in Dewey's view, the mediation itself (that is criticism) is subject to establishing its own value. Snodgrass and Coyne write: "Interpretation, then, is 'the working out of possibilities projected in understanding', that is, it is the working out of how something figured in the context in which it stands" (Snodgrass and Coyne, 2006, p.38). This view of criticism is very much in keeping with pragmatism. Rather than a retrospective view, criticism prospectively discovers possibilities in the work (positively or negatively) and therefore shares the potential risk as to whether or not these possibilities will either come to fruition or are equally perceived by others. For those who have reviewed other works I'm sure you have experienced a case where you champion a particular paper or work and therefore share the risk that the perceived value is or is not in fact valid or will or will not manifest. Conversely, you may have negatively reviewed a work but had thoughts that you were simply unable to see the value that will inevitably be unequivocal to others.

The functional qualities of blind peer reviews are directly relevant and supportive of critical practice, yet the principles and practice of blind peer reviews are antithetical or at minimum severely limit the practice of criticism in interaction design. In pragmatist terms, the strength of blind peer review is in its mediation of intended operations. Its weaknesses lie in its inability to mediate in the context of everyday experiences. This particular weakness limits the criticism to the inquiry and not beyond the inquiry. The summary of

the challenge is the lack of democratic practice within a blind review process. The access to and participation of the role of critic is limited and controlled, as is the distribution and audience of the critique. It is again a conflict of epistemological assumptions and safeguards. Blind reviews serve the needs of scientific realism and certainly have the same role in interaction design research as they do in HCI. However, if we look to the functional strengths of blind peer review, we can see how we can leverage the current knowledge and routines of current interaction design researchers. We can also see how the functionality of blind peer review can be modified to bootstrap a practice of criticism. This would involve:

- *Publicly declared authorship in reviews*: Reviews are classically authored and so they are not anonymous. This maximizes the shared risk in negotiating the values of interaction design practice and research. Additionally, the declared author establishes credibility in the criticism;
- *Reviewers are not blind to the designer inquirer*: The designer inquirer is an integral part of the interaction design inquiry and is part of the object of review;
- *Public dissemination of reviews*: reviews are public and are also publications in their own right. Criticism is itself a discursive object and so is open to negotiation and interpretation;
- *Critics are self-defined*: the role of critic is not predetermined; it is largely self-defined and emerges from a range of backgrounds of which interaction design is only one;
- *Broader definition of the object under review and the contributions*: blind peer review is focused on research and the publication of archival text. Criticism in interaction design by definition has a broader focus on practice, designers, research, and artifacts;
- *Developing the practice of writing beyond service writing*: criticism is a practice mostly manifest in writing. The act and artifacts of writing are central to the craft of criticism.

In many respects, criticism is the one validation strategy in which interaction designers are potentially most at home. In interaction design practice, inherited from the

traditions of design, there is ongoing negotiation and forms of criticism<sup>3</sup>. For example the design studio critique is a longstanding form of criticism that establishes interpretation, reflection, discursivity, and validation as part of a central ongoing routine in practice. Other existing forms of criticism include the use of heuristics, design exemplars, and on occasion critical theory from other design traditions.

Emerging discussions in HCI have argued for a reflective and critical stance in HCI research. For example, Paul Dourish argues that ethnographic approaches offer a path to theoretical and critical inquiry within HCI (Dourish, 2006). In various writings, Phoebe Sengers and colleagues argue for an interpretive and reflective practice in HCI grounded in intellectual traditions of design and critical theory (Sengers et al., 2005 , Sengers and Gaver, 2006). These strategies lay the groundwork for the validating strategies of criticism.

#### **6.1.4 Summary**

This chapter has discussed how the pragmatist interaction design theory comfortably adopts a range of validation strategies within a qualitative orientation. Emphasis is placed on the role of interpretation. The theory relies on a multiplicity of validation strategies that ultimately looks to open widely the interpretive space. In explaining the role of validity in our pragmatist theory of interaction design, I discussed and demonstrated the roles of strategies with the aims of securing knowledge across criteria of trustworthiness, validity, and criticism. This supports the fifth proposition that interaction design research is guided by qualitative and interpretive strategies to validation.

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<sup>3</sup> For a similar argument see Jeffrey Bardzell's blog *Interaction Culture: Musings on interaction design and culture* at <http://interactionculture.wordpress.com/>

The fifth proposition is that interaction design is guided by qualitative and interpretive orientations in validating new knowledge. The pluralism of pragmatism leads to the proposed theory promoting multiple strategies of validation that set out to be rigorous in interpretation and supportive of the practice of criticism, and inclusive of quantitative strategies where relevant.

The examples of trustworthiness show how credibility is achieved through prolonged engagement of the designer inquirer, collection and integration of diverse data, disinterested peer review in publications and interested peer review through collaboration, and negative case analysis, in order to establish the believability in the representation and findings generated by the research. Transferability is achieved through thick description and theoretical generalization. The descriptive auditing and other reflexivity mechanisms in the theory provide procedural support and a shared theoretical construct that together ensure dependability and confirmability of data and findings.

With respect to quantitative validation, the examples show how quantitative analysis and validation has been effective in different contexts: the internal validity check of a data collection instrument, the “mixed methods” approach that combines quantitative and qualitative analysis to support findings, and a quantitative analysis of video coding data. The underlying constructivism in qualitative research together with the multiplicity underlying pragmatism opens the theory to a broad use of validation strategies that includes quantitative validation.

Lastly I posited the importance of criticism in interaction design. This strategy of validation best assesses the value of interaction design inquiries beyond the inquiries

themselves into everyday experiences and over time. I described how criticism should be at home in a design discipline like interaction design as opposed to the contrary, and how blind peer review could be modified and leveraged into the beginnings of an interaction design criticism practice.

## **CHAPTER 7: IMPLICATIONS AND LIMITATIONS**

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The previous chapter brought to a close the demonstration of the theory by way of analysis of the two interaction design inquiries, ec(h)o and socio-ec(h)o. I now turn to discussing the implications and limitations of the proposed theory. I begin the discussion of implications by examining how interaction design can bridge with HCI in research practice. I follow with a discussion of the possible mobilization of the theory in interaction design research and education. I conclude the chapter with a contextualizing of the theory with the interaction design industry, interpretivist HCI discussions, and general approaches to design theories. Lastly I point out the limitations of the theory and study.

### **7.1 Implications**

The discussion of implications includes the relationship between HCI and interaction design, followed by an exploration of interaction design research and education.

#### **7.1.1 Bridging HCI**

A clearer conceptualization of interaction design makes more transparent the shared techniques and shared objects of study with other disciplines. HCI and interaction design are distinct fields yet they are bound by complementary constraints, not unlike architecture and engineering where there is an interlocking of complementary opposites. In addition, if we look closely, there is overlap between the disciplines, especially with respect to

interpretive and post-cognitive formulations of HCI. If viewing things on a spectrum, on one end HCI formalizes aspects of interaction in terms of cognition like mental memory, motor-skills, and cognitive perception; on the other end interaction design articulates aspects of interaction with respect to experiential accounts and socio-cultural influences. In the middle of the spectrum, both fields integrate systematic observation related to the social sciences as a means to fully explore interaction. One can see how the composite of the different types of analysis is the fuller story. The approaches are therefore complementary rather than mutually exclusive. The commonalities and complementarities show the potential for bridging approaches that tie HCI and interaction design together. At this juncture, I focus on the shared concerns that bridge HCI and interaction design and techniques that concretely show the interrelationships between the fields. These include prototyping, evaluations, stakeholder views, and designer intentions.

#### **7.1.1.1 Prototypes**

Daniel Fallman (Fallman, 2003) makes the point that interaction design research is at the centre of HCI for no other reason than the research results from studying interactive systems and artifacts would have been unattainable if these objects of study were not designed. Fallman aptly observes within HCI the false notions that the design artifact either occurs by sheer chance or that a direct causality can be found between for example, fieldwork data and the design artifact (Fallman, 2003).

The knowledge manifest in making the prototype is of deep concern for any interaction design or design researcher. This knowledge in the making of artifacts extends into HCI studies since the space of explanatory causes is wider than requirements gathering or user analysis. The pragmatic theory describes the process of making in ways that can be integrated into efforts of evaluation and analysis. In addition, a focus on the prototype itself

as a source of knowing reveals factors of materiality, aesthetics, and the history. This increases discoveries and supports findings in interaction studies (see 1.4 Context for the study) whether from HCI research, interaction design research, or both.

Prototypes play roles in research other than the role of object of study. Paying attention to prototypes and their making when prototypes are research instruments used to either collect data (or motivate designers) or to create a phenomena for study is a critical undertaking. In the case of designing prototypes for data collection, issues arise in validating the instrument and the integrity of the design process behind the prototype. Both issues are methodological concerns. A good example of this is the cultural probes designed by Bill Gaver and his colleagues (Gaver et al., 1999). Firstly, the cultural probe, which is an autoethnographic toolkit for end-users and is designed to engage people in creating and collecting inspiring material for designers, is a good example of bridging between design and HCI. While some readers may consider probes as more methodological than prototypes of design ideas, the probes, similar to prototypes, rely on design and making. The approach of cultural probes has been modified and applied by numerous HCI and interaction design researchers in a variety of contexts (Crabtree and Rodden, 2004 , Hassling et al., 2005 , Hutchinson et al., 2003 , Mattelmäki and Battarbee, 2002). Additionally, and more importantly in the context of this discussion, cultural probes have been the source of serious methodological and disciplinary reflection (Gaver et al., 2004 , Boehner et al., 2007 , Graham et al., 2007). In this example, it is constructive to view the methodological concerns of HCI in light of the concerns of design.

There are innumerable examples of a prototype designed to create phenomena of study. This is a traditional approach in HCI in which prototype systems recreate a problematic interaction situation or in which a theory is tested through its implementation



in a prototype. This same approach can also bridge HCI and interaction design issues when prototypes elicit situations as spaces for exploration and discovery. This was the case with socio-ec(h)o (Wakkary et al., 2005) in which the prototype environment was created to explore physical play and social interaction. Similar examples include the Home Health Horoscope (Gaver et al., 2007) in which Gaver and colleagues designed a prototype to explore interpretation in use, and investigations of public social interfaces and abstraction by Bilge Mutlu and colleagues (Mutlu et al., 2006).

#### **7.1.1.2 Evaluations**

Interaction design together with HCI can provide evaluations that assess a wider range of the experience of interactive systems and resulting phenomena. Interaction design incorporates multiple strategies to evaluation that include quantitative measures within a qualitative orientation. In Chapter 6, I described examples of mixed method approaches. Traditionally, the dictates of scientific realism behind HCI limit the evaluations to those phenomena or aspects that are quantitatively measurable. Evaluations typically assess the resulting phenomena of the system, such as user perceptions and user performance, or directly test the system or prototype through usability or system performance. While these approaches have a role in interaction design, the pragmatic theory offers two approaches to traditional HCI evaluation. Firstly, qualitative and mixed methods strategies provide rigor of interpretation that broadens the analysis of interaction phenomena. Secondly, the theory extends evaluation to its own design processes and discoveries in process. This increases the potential for discoveries and quality assessments of the making of prototypes and other outcomes.

There is a growing interpretive approach within HCI that I will discuss below (see 7.2 Interpretivist HCI and other design theories). Interpretive HCI together with the

dialogical and interpretive dynamic of interaction design can potentially allow a practice of criticism of interactive systems, practice and research to emerge. As discussed previously, criticism assesses the values of inquiries in HCI or interaction design in the context of everyday experience where such inquiries are potentially most relevant or have the most impact. Additionally, criticism acknowledges the temporal aspects of interpretation and contexts whereas current evaluation strategies do not.

#### **7.1.1.3 Stakeholder views**

Participatory design (PD) has influenced the practice of HCI for some time. It reframes the basic tenets of user-centred design that are central to HCI through the idea of participation. An additional benefit of PD is the illumination of the role of design in working with end-users. Participatory design, together with CSCW (computer supported cooperative work) extended focus to a broader analysis that was organizational if not more broadly social. The exact role of design processes emphasized organizational change and the facilitating role of the systems designer. Interaction design adds support by echoing the importance of PD and by incorporating in theoretical terms ideas of embodiment, interpretation, and knowledge exchange as being core to interaction design practice in ways that HCI does not. In addition,, interaction design emphasizes the role of making or creating as a dimension to stakeholder influence. This adds to existing approaches in HCI and more fully rounds out collaborative techniques with stakeholders.

#### **7.1.1.4 Conceptual models**

Conceptual models and heuristics are formalizations that aid researchers and mobilize ideas in practice. Models arise in HCI from a traditional applied science route of implementing scientific ideas into practice like Card, Moran and Newell's (Card et al.,

1983) Goals, Operators, Methods and Selection Rules (GOMS) model for analyzing human interaction based on cognitive science concepts of cognitive structures. HCI has diversified and made less formal its approaches to conceptual models yet psychology and social science theories or field research on users still drives most models. In our discussion it was shown how models like interaction models or audio display models can emerge from the practice of design. Additionally, such models can be substantiated within the interaction design process through a descriptive analysis, mixed methods or experimental studies. Interaction design adds another source and opportunity for conceptual models relevant to both fields.

#### **7.1.1.5 Designer intentions**

I devoted a lot of attention to the role of designer intentions in the analyses in Chapters 4 and 5. Designer intentions are pivotal in interaction design inquiries since they manifest the presence of the designer inquirer and initiate actions in the design process that typically engender interpretation and further actions of design judgment (see 5.2.2.2 The common pattern in interaction design). They are often framed or supported by design rationales. Designer intentions or as they are sometimes referred to, “design motivations” add an important qualitative dimension to the typically objective analysis of user needs that drives and shapes design process and outcomes in HCI.

#### **7.1.2 The practice of research in interaction design**

The dissertation has been devoted to a discussion of research and practice. Yet on a more practical level we can look at the implications of the theory with the intention of mobilizing it through the practice of research in interaction design. This topic merits a substantial and detailed discussion that is beyond the aims of this thesis. At this point, I will

limit my discussions to highlighting areas of the theory's potential impact on research practice.

Denzin and Lincoln (Denzin and Lincoln, 2005) describe five phases to the research process that are helpful in understanding qualitative research practices. I've adapted their description to interaction design in Table 28. I maintained the headings of each phase and I was inclusive of the many terms Denzin and Lincoln used originally but excluded those that did not apply to interaction design like "policy analysis" and added some particular to interaction design like "making as interpretation." Of the five phases, the main substance of three phases has already been discussed earlier in the dissertation: phases 1, 2, and 5. It is however worthwhile to briefly discuss each of these phases before focussing on the practical research matters in phases 3 and 4, which I will tackle in the remainder of the section.

Phase 1: *The researcher as multicultural subject* accounts for the socially situated researcher in qualitative research. The complexities of the setting, situation, and human interactions are part of the individual or individuals who conduct research in interaction design. This phase asserts a general reflexivity in the researcher who I describe as a designer inquirer. As discussed earlier, the designer inquirer's prior history and experience with design and research is critical to acknowledge since this history guides and constrains the acts and interpretations of research. In design as in any other human activity, the broader issues of ethics, politics and one's self-reflexive awareness in relations to others are part of the conditions of research.

Phase 2: *Theoretical paradigms and perspectives* describe what has been the single focus of this dissertation to describe a theoretical foundation based on pragmatism. In particular, details of the philosophical and research perspectives are discussed in Chapters 3

and 6. The importance of the aims of this thesis and this phase especially is that all else in the research practice (the remaining phases) flow from the philosophical and theoretical orientations. The paradigms and perspectives can be viewed as pragmatism. It is the foundational basis for research in interaction design and due to its multiplicity and inherent experimentation an epistemological space opens to include the interpretive views of constructivism and hermeneutics alongside postpositivism.

Phase 5: *The art, practices and politics of interpretation and evaluation* describe the crafts and strategies of a situated researcher in interaction design. The ongoing negotiation in interpretive approaches necessitates the range of awareness and skills from craft in writing to developed criteria for judgment. This aspect of research in interaction design was discussed in detail in Chapter 6.

<b>Phase 1: The Researcher as a Multicultural Subject</b>
History and design traditions History and research traditions Conceptions of self and other The ethics and politics of research and design
<b>Phase 2: Theoretical Paradigms and Perspectives</b>
Pragmatism Interpretivism, constructivism, hermeneutics Postpositivism
<b>Phase 3: Research Strategies</b>
Case Study Ethnography, participant observation Phenomenology, ethnomethodology Experimental studies Criticism and critical theory
<b>Phase 4: Methods of Collection and Analysis</b>
Interviewing Observing Artifacts, documents, and records Visual analysis Autoethnography Computer assisted-analysis Textual analysis Applied ethnography Participatory design workshops Focus groups Journals and diaries
<b>Phase 5: The Art, Practices, and Politics of Interpretation and Evaluation</b>
Criteria for judging adequacy Practices and politics of interpretation Writing as interpretation Making as interpretation Evaluation traditions Applied research

**Table 28 Five stages of the research process in interaction design based on Denzin and Lincoln (Denzin and Lincoln, 2005)**

#### **7.1.2.1 Research strategies**

Research strategies are connected to the theoretical paradigms in phase 2. The strategies mobilize the paradigms by guiding the researcher with methods that in turn govern the data collection and analysis methods. Denzin and Lincoln summarize the role of

strategies in the research design as specifying: “how the investigator will address two critical issues of representation and legitimacy. A strategy of inquiry comprises a bundle of skills, assumptions, and practices that the researcher employs as he or she moves from the paradigm to the empirical world. Strategies of inquiry put paradigms of interpretation into motion (Denzin and Lincoln, 2005, p.25).”

The research strategies in Table 28 under *Phase 3: Research strategies* shows that there is no one method in interaction design research. In fact this list is not meant to be exhaustive. I can well imagine and would invite experimentation with other strategies. Additionally, each methodology has variants and hybrids and these would equally apply. For example, the analytical approach of diverse data collection, identifying explicit relations among the data, and creating a holistic description of the experience utilized in the analysis of inquiries in Chapters 4 and 5 borrow heavily from case study methods.

Ethnography and participant observation are useful methods and were also relied upon in the earlier analyses. In particular, autoethnography on the part of the design inquirer or design team members ensures that the perspectives of the embodied inquirer(s) is acknowledged and incorporated. In a strict pragmatist sense, first-person inquiry is a default position given the dual effects of the inquirer to reflect and to shape the experience simultaneously. This also invites phenomenological strategies in which phenomenology would create insightful views of designers and stakeholders.

Research strategies in interaction design are largely dictated by the theoretical paradigms and perspectives that in the case of pragmatism look for strategies that acknowledge the dialogic inquiry and presence of the embodied inquirer, like ethnography and phenomenology. The qualitative orientation looks to strategies that provide thick description and reflexivity to guide and substantiate interpretations, like ethnography and

case study. Strategies that clearly and transparently describe the actions of design have analytical strengths to support dependability of findings. As such, strategies like ethnomethodology could be adapted to interaction design research. Experimental studies would form a targeted approach that is more technique than method since it is in support of qualitative or normative findings. Such studies though go beyond data collection since they incorporate unique analysis and validation strategies in comparison to qualitative approaches.

Criticism and critical theory together stand as a research strategy apart from the others, as this strategy is more humanities-oriented and does not necessarily follow the pragmatist dictates of an embodied inquirer. Criticism adds another dimension of interpretation and is therefore a promising avenue for interaction design research.

In the end an interaction design researcher would have a range of research strategies at his or her disposal that draw on existing research traditions. However, one would expect variants such as autoethnography in ethnography to gain some prominence and adapt to particularities of the interaction design inquiries. The advantage of cohering the discipline around an epistemological core is that the actual research strategies are open to their own level of experimentation and reflection in order to articulate new descriptions and discover new findings.

#### **7.1.2.2 Methods of collection and analysis**

It should come as no surprise that given the range of research methods in interaction design there is an even wider range of data collection and analysis methods. In the main, the many traditional qualitative techniques can be employed. These include many data collecting techniques and foci like interviewing, observations, artifacts, documents, and focus groups; as well as data analysis techniques like visual methods, computer assisted



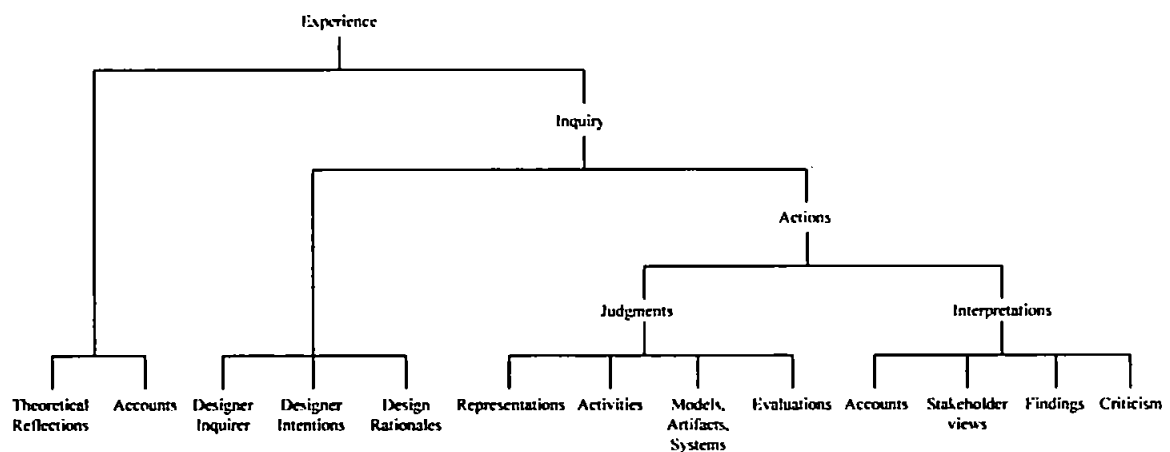
analysis; and techniques that combine data analysis and collection like autoethnography and applied ethnography.

Some techniques are either particular to interaction design or could benefit from a design perspective. For example, data collection and analysis can emerge from participatory design workshops. Interaction designers utilize workshops to explore problems and examine particular design issues. These can quite easily have a research dimension. An added value of participatory workshops is that objects of study can include participant activities and artifacts produced by participants in workshops.

Similarly, affinity diagrams, information models, mapping, sketches and other visualization techniques common to interaction designers can augment visual methods of analysis. In ethnography, fieldwork and techniques from design ethnography have a particular design focus and applicability. Ethnographic techniques can be turned inward and conducted throughout the design work and can extend the focus more broadly for a design view of the setting and actors. As previously mentioned, field studies in design have a long history that is parallel to ethnography and can distinctly be considered as design ethnography (Randall et al., 2007).

Reflexivity is critical in qualitative studies however it takes on an added importance in interaction design research due to the emphasis on first-person research. I discussed reflexivity in respect to confirmability in interaction design earlier in Chapter 6 (see 6.1.1.3 Dependability and confirmability). Ethnography incorporates reflexivity through self-disclosures, first-person narratives, transparency in informant relationships, and thick descriptions. Techniques like research journals or diaries can be particularly helpful in first-person approaches.

The descriptive capacity of the theory supports reflexivity through auditing as discussed in Chapter 6 (see 6.1.1.3 Dependability and confirmability). Additionally, the detailed categorizations aid data analysis by providing a template for coding data. Creswell (Creswell, 2007) advocates coding for use with computer assisted analysis however it can be a much more generic analysis tool that aids thematic analysis or visual mapping (the approach used in the inquiries in Chapters 4 and 5). Keeping the more generic use in mind, Creswell writes that codes “help the researcher to conceptualize different levels of abstraction in qualitative analysis. The process of qualitative data analysis...starts with the researcher analyzing raw data (e.g. interviews), forming the raw data into codes, and then combining the codes into broader themes” (Creswell, 2007, p.169). In the case of the theory, the code is embedded providing researchers with an *a priori* code that has sufficient flexibility to be customized with researcher’s own code labels at a more granular level or orthogonally. See Figure 46 for a coding template based on the theory.



**Figure 46 A coding template for the theory**

In addition to coding, the theory offered structural descriptors for analysis (see Table 22) and a measure of the structural quality in the concept of integrity (see 5.2.2 The experience view). These include the common pattern that can be used to determine the basic structure of an inquiry (see 5.2.2.2 The common pattern in interaction design). At a

more granular level the theory describes relationship among entities that include formative findings, mirrors and feedback loops, and cascading (see 5.2.2.1 The relationships in an interaction design inquiry). The assessment of integrity or missing relationships becomes clear when applying the anatomical structures of *inter-integrity*, *intra-integrity*, and *extra-integrity* (see 5.2.2.3 The dynamic structure of an inquiry). The theory offers a unique framework for analysis of the quality of the inquiry.

### **7.1.3 Education in interaction design**

Much like research, interaction design education is a substantial topic that deserves more attention than I can offer in this dissertation. My aim, not unlike the previous discussion on research, is to outline aspects of the theory that impinge on education as points for later investigations. It is important to note that interaction design programs are growing at a rapid rate. Less than five years ago employers were not hiring with job titles like interaction designers, this has changed dramatically in a short period of time. This points to the potential that there is a growing consensus on what an interaction design education should be that is at least consistent enough with a shared market perception of the discipline. It also points to the potential that there is a strong need in the marketplace; that our educational approaches need to meet.

Pragmatism offers foundational thinking for interaction design. In education this helps to tie understandings together but also offers the chance to separate the curriculum into distinct learning aims like the study of the field, its context including history and cognate disciplines, and issues of practice like methods and skills that are both disciplinary and inter-disciplinary.

#### **7.1.3.1 The study of interaction design**

The theory articulates an understanding of interaction design for those who practice it and those who don't. For practitioners or future practitioners, this level of understanding conceptualizes the field. It describes a holistic view that will help guide and aid students in making more sense of the methods and skills later learned. To those who will not practice interaction design, it offers a broad understanding of the principles, actors and concepts that constitute the field in a language and form that is comprehensible without the practice. The importance of this approach is that it helps to establish interdisciplinarity by making the field accessible to those whose main study lies elsewhere. It also increases the intellectual accessibility of the field to a wider audience of non-designers.

This approach to studying interaction design would focus on the outcomes at the experience view of the theory including theoretical reflections and descriptive accounts of interaction design. A descriptive account of the interaction design experience would include the overall dynamics such as the common pattern (see 5.2.2.2 The common pattern in interaction design), relationships (see 5.2.2.1 The relationships in an interaction design inquiry), and the idea of integrity among actions, intentions, and rationales (see 5.2.2.1 The relationships in an interaction design inquiry). At this level of learning, gaining an insight into the theoretical questions for the field is important in order to see interaction design in the same light as other fields. Questions concerning the main issues such as how we design, how and why we create interactive systems and artifacts, and how we define an interaction designer would be discussed and debated here.

Understanding the definitions and terms behind the main concepts of interaction design as experience and interaction designer as inquirer is equally important. The terms and definitions include concreteness, multiplicity, entities-in-interaction, embodied

inquirer, and the designer as a proactive inquirer (see Chapter 3). Experimentalism in interaction design would be another critical concept that would provide an introduction to the ideas of design actions. At a level of practice, the structure of interaction design inquiries (see 5.2.2.3 The dynamic structure of an inquiry) would be a basis for further understanding of practice without having to be a practitioner. The learning of these concepts could be aided by thorough descriptions and accounts of interaction design inquiries established as case studies or exemplars.

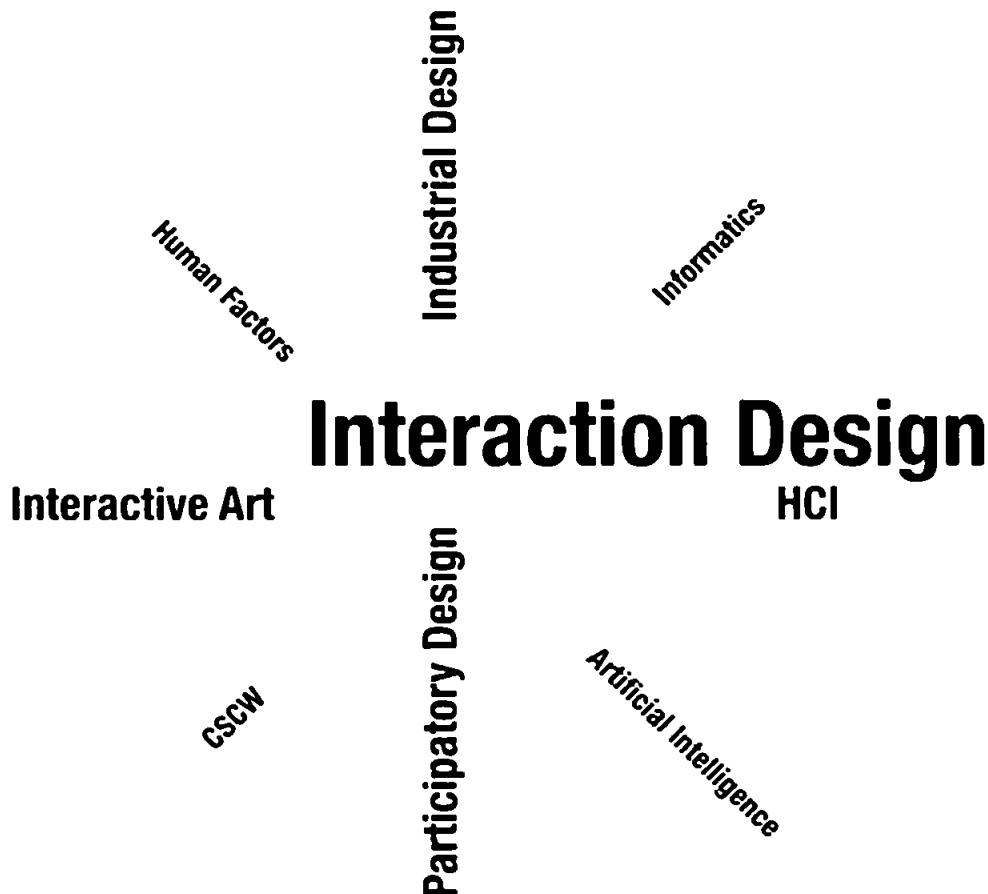
### **7.1.3.2 The historical and interdisciplinary context of interaction design**

The study of the field of interaction design for non-practitioners is fundamental in developing a practice of criticism that may also open the field to eventual historical investigations typical in art and design history studies. In this regard, a contextual study of interaction design could be focused on emerging history and cognate disciplines. This approach would serve both future practitioners and scholars of interaction design, as well as students from other disciplines like computing science and other design traditions.

The theory's conception of interaction design incorporates intellectual viewpoints, skills and methods from cognate disciplines. Figure 47 shows interaction design situated in relation to cognate disciplines. This is at best a provisional representation yet it shows how a contextual study of interaction design would establish historical and current linkages with other disciplines. The linkages could be defined in a myriad number of ways from shared methods to common intellectual ground to complementary dependencies like with HCI.

Historical investigations of interaction design would serve a scholarly and educational need. Such investigations would provide scholars with the intellectual and historical basis for investigating the field. For practitioners, they would help provide a rationale for techniques like participatory workshops and physical prototyping. Any history

would overlap substantially with a number of other histories and this would help broadly situate interaction design as part of an overall set of historical movements framed by design, technology, and culture. Such investigations would additionally buttress scholarly and educational outcomes in interaction design criticism.



**Figure 47** Interaction design situated in relation to cognate disciplines

#### **7.1.3.3 Methods**

Some readers, particularly those with an interest in design may feel that I have neglected design methods in my discussions. As I discussed in Chapter 2 (see 2.2 Strategies in interaction design), design theory and interaction design theory has focused considerable effort on methods resulting in more strategic directions, e.g. *Goal Directed Design* (Cooper et al., 2007) at the expense of theoretical directions. The intervention of the theory is at the level of theoretical paradigms and perspectives (see 7.1.2 The practice of research in

interaction design). Additionally, I proposed that a theory would not be prescriptive with respect to methods but would guide methods into experimentation and innovation with different ways of practicing design, not unlike HCI and its approach to methods (see 1.2 Role of theory in interaction design).

Having said the above, methods are the area that is the most stable in interaction design education. There is no shortage of texts that describe and detail different methods for design (Löwgren, 2008 , Cooper et al., 2007 , Bødker et al., 2004 , Krippendorf, 2006 , Kolko, 2007 , Preece et al., 2002). Almost all of these methods can be applied to interaction design including fieldwork, participant observation, focus groups, participatory workshops, personas, scenarios, role-playing, storyboarding, dead-sea scrolls, affinity diagrams and so on. This would also include the long list of evaluation methods and experimental study methods.

However, methods of reflexivity could be a critical new area for the development and teaching of interaction methods. These methods would aid interaction designers in documenting and reflecting on the actions of the design inquiry. The methods would cover formative reflection: accounts of reflections on action during the course of the design inquiry; summative reflection: reflective accounts after the inquiry, and long term reflection: accounts of reflection over the course of several inquiries that help in the accrual of experience over the course of a career in interaction design. The methods would support the auditing capacity of the theory discussed in Chapter 6 (see 6.1.1.3 Dependability and confirmability) that provides research dependability and confirmability, as well as diagnostic abilities for practice.

Reflexive methods would mostly be new but they could extend to traditional design practices like keeping a sketchbook and a notebook. More formal methods would be an

improvement. The qualitative techniques of research diaries and journals typically used by ethnographers would serve as a good starting point. I can imagine that codes, languages and taxonomies would also develop in line with new methods. It is also important that reflexivity as a practice is considered in terms of education separate from any given methods. Questions such as: what are the principles of reflexivity, what exercises and practices can be used to develop and hone the sensibilities, and how does one cultivate a practice of reflexivity would all be considered in the learning of interaction design students.

#### **7.1.3.5 Skills**

Skill acquisition in interaction design is not challenged by lack of knowing the possible skills required. Rather in education, the challenge is in making choices among the wide variety of known skills. From the perspective of organizing and designing a discipline, there is limited number of courses, teaching staff, and expertise available. From the student's perspective, there is limited time and ability to learn all the possible skills that can be used in interaction design. For example in prototyping alone, there is a vast range of skills whether the prototype is physical, software or both. The range of general skills and knowledge would include physical modelling and rapid prototyping skills drawn from industrial design, electronics circuitry and programming based in electrical engineering, as well as user interface, networking and programming skills for software prototypes. All too often students and faculty feel that most, if not all of these types of skills are needed, and try to take or offer whatever one can with the limited resources available. This typically results in a scattershot approach with several critical gaps in skills and abilities.

The pragmatic theory proposed offers guidance that supports students and curriculum design. The theory's descriptions of the actions of interaction design ensure that a student can secure broad and manageable sets of skills that are targeted to each outcome



of the inquiry. Table 29 show the outcomes of interaction design interpretations and Table 30 shows the outcomes of interaction design judgments. In each case, competencies and skills are mapped to inquiry outcomes. The tables are not definitive in terms of skills enumerated and mapping rather they both provide a provisional starting point that illustrates the educational value of the theory in relation to skills acquisition. The strength in this approach is that the structure of the inquiry offers guiding principles for the choice and priority of skills learning in interaction design. The principles are as follows: it is necessary for an interaction designer to have the potential to contribute in every judgment and interpretation outcome. This builds experience and ensures that each designer is sufficiently informed of the nature of the outcomes and possibilities in order to assume the responsibility of the inquiry and create actions. The priority then is to learn and to master at least one but as many competencies as possible across all of the outcomes, e.g. the ability to analyze information would serve as a basic competency for a number of outcomes. Skills are then seen in light of competencies. The skills needed are those that support a given competency and often a competency can be supported by numerous skills but not all are needed. For example, in meeting the outcome of representation (e.g. creating scenarios) with the competency of narrative abilities, a student may choose to focus on illustrations and sketching as his or her main skills. When faced with a choice of new skills to learn, the emphasis is on another competency rather than choosing in addition to illustration and sketching, video, photography etc. Students can later expand on their skill sets if all the competencies and a supporting skill have been learned. Additionally, in practice, designers tend to “specialize” given particular skills in which they excel at. The organizing principle mitigates this focus from being skill-based but ensures the focus is wider in terms of competencies and mastery of the interaction design inquiry as a whole.

Outcomes	Competencies	Skills
Accounts	Ability to collect information Ability to analyse information Ability to manage information	Sketching/Illustration Documentation (video, photo, audio) Writing Data management Data coding and analysis techniques
Stakeholder views	Ability to facilitate people Ability to collect information Ability to analyse information	Writing Documentation (video, photo, audio)
Findings	Concept development abilities Ability to analyse information  Knowledge of interaction design field	Writing Qualitative or quantitative techniques for analysis
Criticism	Knowledge of interaction design field  Ability to analyse information  Knowledge of interaction design and related theories	Writing

**Table 29 Competencies and skills mapped to interpretation outcomes**

Outcomes	Competencies	Skills
Representations	Narrative abilities Ability to analyse information Ability to design visually	Sketching/Illustration Video Photography Visual design Writing
Activities	Ability to facilitate people Ability to organize	Charettes Participatory design techniques User-centered design techniques Experimental studies Role-playing
Models	Concept development abilities	Writing Visual design
Artifacts, Systems	Build and construction abilities	Physical prototyping User interface design/information architecture Software development Hardware electronics Programming Web development Software prototyping Wood and metal fabrication
Evaluations	Ability to design evaluations Ability to collect information Ability to analyse information	Writing Statistics Observations Qualitative or quantitative techniques for data collection Qualitative or quantitative techniques for analysis Experimental design Documentation (video, photo, audio) Facilitation

**Table 30 Competencies and skills mapped to judgment outcomes**

## 7.2 Interpretivist HCI and other design theories

The discussions on the implications for education and research highlight new opportunities that arise from the proposed theory of interaction design. As I mentioned

earlier, the marketplace perception is that the field of interaction design is strong and growing without a crisis of theory. Design in the HCI community is also growing. At times it seems that there is a theoretical crisis looming, yet there are also clear and positive signs that a debate on the role of design in HCI is resonating within the community. This of course leads to the question of whether we really need a revised theory of interaction design. My answer of course is a resounding “yes” and I have devoted all of the preceding chapters to constructing the argument for and to present a revised theory of interaction design. However, I would be remiss if I did not consider the alternatives. The discussion in this section is not a resolution of the need for a theory or not; rather I aim to show the parallel investigations of design and interactive technologies. I aim to show the everyday experience in which a new theory of interaction design would live and be tested.

As a measure of the strength of the interaction design industry, the IxDA (Interaction Design Association) has over 10,000 members and over 70 local chapters worldwide. The IxDA began in 2005 with the aim to support interaction designers with the challenges they face in their professional lives. In 2008, the association began hosting annual conferences (see [www.ixda.org](http://www.ixda.org)). The strength of the IxDA community after such a short period shows that the field has quickly emerged as an industry and practice.

According to the IxDA’s definition of interaction design, it views user-centredness at the heart of its practice:

Interaction designers strive to create useful and usable products and services. Following the fundamental tenets of user-centered design, the practice of interaction design is grounded in an understanding of real users—their goals, tasks, experiences, needs, and wants. Approaching design from a user-centered perspective, while endeavoring to balance users’ needs with business goals and technological capabilities, interaction designers provide solutions to complex design challenges, and define new and evolving interactive products and services (Interaction Design Association, 2009).

In addition to user-centredness, interaction design is seen to draw on a range of design disciplines with a distinct focus on interactivity:

While interaction designers often work closely with specialists in visual design, information architecture, industrial design, user research, or usability, and may even provide some of these services themselves, their primary focus is on defining interactivity (Interaction Design Association, 2009).

The definitions of the field read as sensible and grounded. As an industry the requirements of “theory” are that it sufficiently guides practitioners in practice and business and that its language and concepts can be used to market services to clients. Suffice to say that an intellectually viable foundation that borrows from existing traditions in design and user-centred theories of interaction has been achieved to quickly mobilize a burgeoning practice and industry.

Reflections on the practice of interaction design that also reflect the viability of practice and industry can be found in several recent and excellent texts (Kolko, 2007 , Buxton, 2006 , Moggridge, 2007). Kolko’s account synthesizes HCI-oriented theories of usability, contextual design, and user research and grounds them firmly in design practices of scenarios, workflows, and prototyping streamlined to function in a business context. The text makes accessible design ideas of desirability and aesthetics and also makes these ideas compatible with usability and business in a deft manner. Buxton and Moggridge construct a view of designing for interactive technologies through highlighting practitioners and exemplar designs.

If theory as a practical matter is currently resolved in industry and practice (the question of course is for how long?), how is it playing out in research fields like HCI? In Chapters 1 and 2, I provided HCI views focused explicitly on interaction design. Yet a wider view of HCI shows emerging attention to issues related to the discussions of this

dissertation. These include design research and theory in HCI (Fallman, 2003 , Zimmerman et al., 2007 , Stolterman, 2008 , Fallman, 2008) and interpretive and reflective practices (Gaver et al., 2003 , Sengers et al., 2005 , Dourish, 2006 , Sengers and Gaver, 2006).

### **7.2.1 Interaction design research frameworks**

In Chapter 1, I discussed how Harrison and his colleagues argued for a third paradigm in HCI that is oriented around design and phenomenology (Harrison et al., 2007). The authors aim to evolve HCI through an extension of human concerns that centre on phenomenology, and important to this discussion, methodological advancement of HCI through an inclusion of design thinking and practice. The issues that an interaction design theory is lacking and that HCI theories need improvements upon have more or less been joined together. What follows in this discussion is that to understand interaction design research is to understand a missing facet of HCI theory.

Fallman's approach to interaction design theory is to disambiguate the role of design in HCI. In 2003, he argued that a design-oriented HCI begins with differentiating between the practices of knowledge generating *design-oriented research* and artifact generating *research-oriented design* (Fallman, 2003). In design-oriented research, the object of study is design itself, whereas in research-oriented design, design is in the service of producing artifacts and may or may not be related to research since the main objective is to produce new design artifacts. In 2008, Fallman adds to his view of interaction design theory by establishing a framework that differentiates three types of research activities: 1) Design practice: aims that are synthetic and context driven, e.g. design industry; 2) Design studies: aims that are descriptive and philosophically oriented; and 3) Design exploration: aims that are idealistic, socially oriented and subversive (Fallman, 2008). The framework animates the concepts of loops, trajectories, and progressions that describe the development

of design research. Fallman's contributions are in articulating models that condition and frame interaction design research. In many respects, Fallman aims to synthesize current and recent design research practices.

Jodi Forlizzi, John Zimmerman, and Shelley Evenson's writings on interaction design theory draw upon Christopher Frayling's idea of "research through design" (Frayling, 1993-1994). The authors propose and describe a model of interaction design research in HCI based on four lenses for distinguishing and evaluating interaction design research within HCI: process, invention, relevance, and extensibility (Zimmerman et al., 2007, Forlizzi et al., 2008). The authors argue based on Frayling that interaction design researchers focus on making the right thing by making transformative artifacts that move the world from the current state to a preferred state.

The models of Forlizzi et al (Forlizzi et al., 2008) and Fallman (Fallman, 2003, Fallman, 2005), focus their attention on descriptions on the process of design. Though these contributions are important, it is unclear how far a theory of interaction design can proceed through descriptive models alone. The risk is that the theory arising from descriptions is reactive and does not forge new insights and practices. What is lacking are theoretical principles or the start of theorizing through an investigation of principles.

Erik Stolterman argues that a theory of interaction design and HCI rests on understanding design practice and in particular, design complexity in practice (Stolterman, 2008). The complexity of interaction design practice is not reducible and therefore not amenable to the science-oriented design methods commonly found in HCI. Rather, Stolterman argues for a "designerly approach" to HCI education and practice. Such an approach can leverage existing design theory and design philosophy from the rich intellectual design history. Stolterman's contribution is to describe the uniqueness of

interaction design practice and point to the problem of leveraging past design thinking into a theory of interaction design. He sets the goals for such a theory to be both practice-based and philosophically sound.

### **7.2.2 Reflection and interpretation in HCI**

At the conclusion of the discussion on criticism in Chapter 6, I referred to the reflective and interpretive strategies emerging in HCI (see 6.1.3 Criticism). For example, Dourish is critical of current ethnographic practice in HCI (Dourish, 2006). He argues that ethnography in HCI is utility driven at the expense of theoretical and interpretive discoveries that *true* ethnography leads toward. HCI reduces ethnography to the status of techniques aimed at uncovering “design implications” for system improvements. Ethnography, Dourish argues couples analytic and methodological concerns (Dourish, 2006) that operate at a level of reflection beyond current HCI thinking. The implication for HCI theory is that it lacks the analytical and methodological (rather than methods) formulations to create the reflective and interpretive space required for understanding interactions.

Bill Gaver, Jacob Beaver, and Steve Benford argued for ambiguity as a resource in design (Gaver et al., 2003). They claim that ambiguity encourages a personal relationship with systems through interpretation. Ambiguity creates a level of reflection on the part of users that creates personal value through understanding an interaction artifact or system. The authors describe three types of ambiguity: “Ambiguity of information finds its source in the artefact itself, ambiguity of context in the sociocultural discourses that are used to interpret it, and ambiguity of relationship in the interpretative and evaluative stance of the individual” (Gaver et al., 2003, p.233). Gaver and his colleagues describe strategies to emphasize ambiguity for designers to incorporate into their own practice. Naturally, the



idea of ambiguity is antithetical to traditional HCI aims. HCI's inability to address ambiguity is perceived as a gap in HCI theories.

Phoebe Sengers and her colleagues investigate the idea that reflection on unconscious values embedded in computing is a critical concern for design. The authors put forward their analysis and the strategies that result in what they call reflective design (Sengers et al., 2005). The essential argument is that “reflection itself should be a core technology design outcome in HCI” and reflection is “bringing unconscious aspects of experience to conscious awareness, thereby making them available for conscious choice” (Sengers et al., 2005, p.50). The problem is that there are wider experiences of interactive artifacts and systems than can be accounted for with HCI theory. The authors build the idea of reflective design on design traditions of value design, participatory design, reflective practice and ludic design. They contribute a set of strategies, which among other aims creates space and encouragement for reflection and interpretation.

Sengers and Gaver collaborated to write on the role of interpretation in evaluation (Sengers and Gaver, 2006). They adopt a humanist view of HCI that positions interpretation and multiplicity at the centre of evaluation interactive systems. This turns upside down the scientific realism principles of HCI. In their view, there are no definitive accounts and no privileged roles of evaluation. The truth values of the systems are negotiable. In addition, not unlike ambiguity, designers need to encourage the heterogeneous readings and uses of the artifacts they design. Sengers and Gaver argue that designers need to downplay system authority and play up the interpretive space the designs create (Sengers and Gaver, 2006).

Rather than provide descriptive models of practice, the ideas and arguments of Stolterman (see 7.2.1 Interaction design research), Dourish, Gaver and Sengers discussed

here focus on principles to investigate. What emerge are investigations of reflection and interpretation that tend to invert classical HCI notions.

### 7.2.3 Reflective and interpretive practice

Not all of the authors from the previous section would consider themselves to be practitioners or designers yet many would fit in the loose category of “practitioner researcher.” As Stolterman argued, the credible road to interaction design theory is through theoretical investigations grounded in practice. A good example of this is Gaver whom I have cited above for his investigations of ambiguity, multiplicity, and interpretation (Gaver et al., 2003 , Gaver et al., 2004 , Sengers and Gaver, 2006). These are issues central to a pragmatist view of experience and related to the pragmatist framing of interaction design in this dissertation. These investigations carry over into Gaver’s research practice, an interesting example is the Video Window (Gaver, 2006 , Gaver et al., 2008).

The Video Window is what Gaver refers to as a “threshold device” (Gaver et al., 2008):

Threshold devices look out from the home, gathering information from its surroundings to suggest how *here* is connected to and situated within a *there*. In supporting appreciation of the home’s setting in a wider physical and social environment, the devices provide resources for inhabitants to think about where they are, what and who is around them, and may occasion their attitudes towards these facts. Such an appreciation may be rich and complex, potentially involving utilitarian, aesthetic and emotional elements, and thus the devices are best seen as *resources* rather than *tools* (Gaver et al., 2008, p.1429)

The Video Window is a flat screen monitor that is hung on the wall of Gaver’s bedroom next to an actual window. The monitor is connected to a camera perched atop a telescopic fishing pole creating a skyline view to be seen in the bedroom. Gaver describes the Video Window as using technology not to emulate the physical world but to conceptually and

aesthetically reframe for new forms of appreciation. For example, it integrates utilitarian concerns like knowing the weather with aesthetic concerns like viewing a sunrise, and thirdly it also creates a personal view of world (Gaver et al., 2008). The Video Window generates a reflective space on issues of technology, the home, and one's surroundings.

The design artifact is compelling in itself but what makes it most interesting in the context of this dissertation is a particular account of the work Gaver published in an article in the academic journal, *Personal and Ubiquitous Computing* in 2006 (Gaver, 2006)<sup>4</sup>. What is remarkable (and rare in HCI and interaction design) in this account is the quality of reflexivity and interpretation in the making and use of the design. This particular design account is a good example of how reflections of a designer inquirer create research value from a description of the making of a design artifact. The article is a first-person account in which Gaver discusses the making of the Video Window and how its experienced by his family:

About 6 months ago, I mounted a small video camera on a mast outside our bedroom window, oriented to pick up a view of the skyline down the hill from our house. The camera output is wired directly to a small flat-screen display hung on our bedroom wall, across from our bed, and is always left on (Gaver, 2006, p.60).

The author continues with an acknowledgment of the presence and personal history of himself as designer inquirer. The reader can gather that the inquirer lives with his wife and 3-year-old child in a house in London with a limited view from the bedroom. The designer inquirer, Gaver, has past interest and research in mediascapes and telematics.

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<sup>4</sup> The 2006 account (Gaver, 2006) is different from a later account in 2008 (Gaver et al., 2008), in which Gaver speaks of the Video Window in a combined field and case study approach from a third-person perspective. This hybrid approach of a field study analysis and data collection of case study designs has been a productive approach in design research, particularly in an HCI context. It utilizes many of the attributes of qualitative strategies discussed in Chapter 6 yet lacks the truly reflective descriptions of thick descriptions and first-person research exemplified in the 2006 article.

Additionally, he is an educator with regular encounters with colleague researchers and graduate students in a shared studio.

Gaver describes how the first Video Window was a temporary result of simple play that in hindsight held significant value and enjoyment for himself and his wife. Years later he was inspired to create a more serious and permanent version by a student's project of a camera attached to a weather balloon and a colleague's purchase of a telescopic fishing pole. The experimentation with designing Video Window was felt to be enjoyable tinkering. In the making, there was great experimentation with different types of cameras (four in all) and the particularities of the right view:

The video window is a very simple arrangement of technology, but it took a surprising amount of work to "get it right". In retrospect, "getting it right" involved both practical and aesthetic issues. But at that time I did not differentiate the two. Instead, they were intertwined in creating an experience we wanted to live with (Gaver, 2006, p.62).

This experimentation is like the design actions of judgment motivated by intentions and rationales that were intrinsic and influenced by his wife, colleagues and students. The account included many interpretive actions as well. The author's wife, Anne Schlottmann provided insights and a stakeholder view. She was not as "adamant" about the particular view as Gaver. She felt the Video Window was like having "a room with an ocean view, in which the sheer scope of the scene seems to extend one's feeling of living space to include the landscape and its subtle changes"(Gaver, 2006, p.62). An everyday aesthetic value was interpreted in the nuances of the augmented view through the camera. Gaver noted the view of a breaking sunrise not viewable through the window but plainly visible on the monitor when waking very early in the morning, or the lights of an airplane or distant fireworks. The qualities of the cameras were measured by the interpreted value of the clarity and breadth of view. The effects of snow, rain, and wind were noticed for the abstract patterns

created by refracted light through raindrops caught on the lens or “the giddy effect of seeing the landscape heaving onscreen like a ship on a stormy sea” (Gaver, 2006, p.64).

I have described at length Gaver’s account in order to provide a sense of how the experience was communicated through description and reflexivity. In the process, Gaver (knowingly or not) illustrates two dimensions of pragmatic experience. Firstly, the author describes the nuances and effects of everyday experience in explaining “my life with a ludic system,” the subtitle of the journal article. He articulates the simple aesthetic and usefulness of the artifact felt over time on a lived in basis. Interestingly, the system was not originally considered to be part of his research:

The video window is a simple system. Considered merely as a concept, it seems hardly worth discussing as a design at all. Its value, and the variety of experiences it offered, has only become clear because my wife, child and I have lived with it continuously over a period of time (Gaver, 2006, p.64).

It was this living with the design and experience, the everyday concrete nature that led to another order of reflection and interpretation that can best be described as a design inquiry of the experience. The second dimension is that of the designer inquirer’s pragmatic experience. Here Gaver renders the values or contributions of Video Window in the context of interaction design:

- Technology can offer ludic pleasure during all our waking hours (even early in the morning!).
- New views on the existing environment can be fascinating.
- Slight distortion can augment experience without distracting from the “natural” view.
- One’s own, non-arbitrary view may engender strong feelings of engagement.
- Physical causation can convey information (e.g. about the weather) in uncontrived and aesthetically pleasing ways.

- (Some) technological artefacts and constraints can be aesthetically pleasing.
- Systems can seamlessly mix resources for task-based pursuits, ludic engagement and aesthetic pleasure.
- Tinkering is enjoyable, but maintenance is a chore (Gaver, 2006, pp.64-65).

I argue that these values would only be evident and realizable by the particulars of this design inquiry and designer inquirer yet are transferable and credible in relation to similar designs of ludic and threshold devices.

In this discussion of reflective and interpretive HCI and practice it is evident that concerns are shared between the theory articulated in this dissertation and the authors above. Whether a new interaction design theory is required to advance the investigations further is not a matter of conclusive evaluation at this stage. It is however evident that the issues and goals that can lead to a theoretical understanding of interaction design are more broadly shared and articulated in practice.

### **7.3 Limitations**

There are several limitations to the study and theory in this dissertation. These include the theoretical nature of the contribution, the relationship of the theory to the interaction design inquiries, and the scope of the theory in respect to design and other professional practices.

The central limitation is that the contribution of this study is theoretical. As a theory its trustworthiness is firstly a matter of interpretation. The extent and value of the theory can only be assessed over time through criticism and discussion among other researchers, practitioners and theorists. The degree to which a theory merits discussion is also a measure of its contribution or lack of contribution. Interpretation would also include ongoing

refinements and changes to the theory. For example, Schön's reflective practice stands as the most trustworthy of design theories given its influence on subsequent theories (this one included) and discussions on design and its adaptation. Another contribution of the theory is its eventual normative impact on research and practice. This will be measured by the degree to which other researchers and practitioners use the theory to support research cases, diagnose practice or substantiate formative findings. The measures of interpretation and normative effect can only happen over time. Thirdly, the contribution of the theory could be measured by its transferability in the qualitative sense to other interaction design projects. In this measure transferability would need to occur through another researcher. In all instances the measures are beyond the scope of the dissertation.

Another limitation is that the inquiries (ec(h)o and socio-ec(h)o) in the dissertation were conducted parallel to the development of the theory. In this sense they were good but imperfect examples of the theory since they were neither informed by the complete theory nor did theory emerge wholly from the practice in the inquiries. From the perspective of establishing the theory, if the inquiries were informed by the complete theory they could illustrate all the points more clearly, e.g. reflexivity methods and criticism. In this case, generalizing the theory through logic would be stronger since the full dimensionality of the theory would be more evident. If the theory wholly emerged from practice of the inquiries, the inquiries would be less illustrative and more substantial in relation to the development of the theory, like in the case of grounded theory, where the inquiries would be theoretical data and not illustrations. A good example of this in HCI is Beyer and Holtzblatt's Contextual Design (Beyer and Holtzblatt, 1998). The theory was built over a period of time through cases that substantiated the theory. Additionally, the developed theory was applied to several cases that served as clear illustrations.

The dissertation focused on interaction design. While I discussed other design theories I did not investigate the disciplinary boundaries of the theory. The theory is aimed at interaction design yet does it extend to other design disciplines? The theory argues that interaction design is distinct from HCI yet is it distinct from other design disciplines? This is a compelling question for a fuller definition of interaction design. Additionally, the approach of the dissertation, limiting the study to interaction design, foregoes the opportunity for a broader theory of design or even professional practices as a whole (e.g. nursing, education, etc.) as with reflective practice. The significance of investigating the scope of the theory is that the theory is an important test for the epistemological strength and quality of pragmatism. As an example, does pragmatism apply to industrial design and if not, is there value in determining the difference and comparing it against the philosophical foundations of industrial design? As it stands, the epistemological assumptions of pragmatism could bear further investigation at the boundaries of interaction design.



## **CHAPTER 8: CONCLUSION**

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I close the discussion and study of the new theory for interaction design in this chapter. At the outset of the thesis I arrived at a criteria to assess an interaction design theory (see 1.2 Role of theory in interaction design). In this chapter I examine how the theory I propose meets the criteria.

### **8.1 A revisionary view of interaction design**

In concluding the argument for the role of theory in interaction design, I provided criteria by which to judge any new theory (see 1.2 Role of theory in interaction design). I will here recount this criteria and I will follow with a discussion of how I have addressed each criterion. 1) Provide epistemological orientation: an underlying philosophical grounding that is appropriate to design and that will guide the development of core concepts and defining principles; 2) Establish coherent principles to guide the development of research methods, design methods, and evaluation methods; 3) Provide standards of validation that provides a means to credibly communicate and verify claims; 4) Mobilize the theoretical ideas and actions in a way that is accessible in practice and open to revision through practice.

### 8.1.1 Provide an epistemological orientation

I argue in Chapter 1 and conclude in Chapter 2 that a shortcoming in theorizing interaction design is that current discussions lack a philosophical centre that is appropriate to design. A clear epistemological orientation would guide the articulation of the core concepts and principles behind interaction design. By contrast, HCI theory is well grounded in scientific realism and as a result, HCI views of interaction design overshadow critical design aspects with principles of user-centeredness and scientific empiricism. Interaction design theorists and practitioners have foregone epistemological concerns and abstract notions for design. Instead many have chosen to focus on methodological issues of how best to describe the methods of interaction design.

I argue in Chapter 3 that Dewey's philosophical pragmatism is an appropriate philosophical orientation for interaction design. It provides an epistemology, a way of knowing the world that acknowledges critical aspects in design such as the designer, practice, and reflection. Pragmatism's notion of experience is of particular importance in theorizing interaction design. Dewey's central tenet that knowledge is rendered in embodied experience (Dewey, 1929a) positions *doing* design by designers at the centre of knowing in design. Where it illuminates in respect to interaction design is in the synthesis of thinking and doing. Pragmatism guides the articulation of the practice of design together with knowing in design.

I discuss the relevancy of pragmatism to design by citing three intellectual traditions in design practices that either directly or indirectly incorporate embodied experience as knowledge. Foremost among these is Schön's theory of reflective practice (Schön, 1983). Schön argues that we know in design *by doing*. He manifests this idea of knowing and doing in the concept of reflective practice whereby designers reflect-in-action, e.g. consider

the effects of action while performing them. The principle sets forth a dialogic approach of querying and reflecting through actions that constantly frame and reframe the design situation. Another tradition is participatory design (PD) and in particular, Ehn's understanding of PD (Ehn, 1989). Ehn's claim for PD is that design is a matter of tradition and transcendence. He sees in stakeholders in any given design situation, the embodiment of known expertise. The aim of the designer is to create a shared embodied space for designers and stakeholders that allow for an exchange over time of their respective skills and knowledge in order to co-design solutions. This is illustrated well in Ehn's notion of design games (Ehn and Kyng, 1991b) in which designers facilitate participatory workshops that enact and role-play as a means to simultaneously exchange knowledge and generate design solutions. The remaining tradition is design ethnography (Randall et al., 2007 , Button, 2000). Ethnography incorporates two key attributes in respect to pragmatism and design, an embodied inquirer and thick description (Geertz, 1973). Knowledge in ethnography is constituted in self-reflexive accounts of experience. Inquirers that are part of the inquiry setting describe the accounts. These three traditions show the existing threads of pragmatism in design. Evident are the shared concerns of embodiment, reflection, and interactions that are part of the philosophical formulation of experience in pragmatism.

I discussed in the latter half of Chapter 3, how the philosophical formulation of experience is directly transferable to the idea of interaction design as experience. Key philosophical concepts and principles of pragmatic experience are readily applicable to interaction design. These include at the most basic level that interaction design experience is approached as an inquiry. An inquiry is comprised of actions and interpretations by an embodied inquirer whose experimentalism both shapes and derives knowledge from the experience. In interaction design we can see how the instances of practice can be seen as an

inquiry, e.g. each interaction design project is an inquiry. I show how the actions and processes of interaction design can be defined as experimentalism that both investigates and shapes the interaction design experience and design outcomes. A design inquirer motivates and animates the inquiry.

In pragmatist terms, the elements of experience interact to address the key attributes of an experience: *concreteness*, an experience is as it can be described; *multiplicity*, experience is inexhaustible; *entities-in-interaction*, experience is constituted by the dynamic interaction between entities in the lived world. This set of principles and concepts is lastly informed by the attributes of the designer inquirer. These include *embodiment*, design experience is both constituted by the interactions of the designer in the world and rendered comprehensible by the same actions; and *proactiveness*, an interaction designer actively shapes an experience to imaginatively create the multiple possibilities latent in the experience.

### **8.1.2 Establish coherent principles**

In the concluding sections of Chapter 3, I describe the theoretical framework based on the idea and implications of viewing pragmatism as the philosophical orientation for interaction design. I devote Chapters 4 and 5 to demonstrating how this framework guides a description of two interaction design inquiries. The framework provides coherency among the principles and concepts. Its primary aims are to provide clear conceptualizations of the aspects of interaction design and to provide a clear taxonomy of descriptors that provide a holistic view of an interaction design inquiry and help inform the wider field.

The framework is comprised of three components, *experience*, *inquiry*, and *actions*. This structure helps to organize the concepts. The different parts each represent a different scalar view of the field. For example, the experience view represents the whole field of

interaction design. It establishes the principles of interaction design as experience and the role of the designer inquirer that I discussed above.

Within the experience view is the design inquiry. The design inquiry describes a particular instance of the field like an interaction design project. It is governed by the principles that interaction design is an inquiry of experience and that a designer shapes the design inquiry through experimentalism. The design inquiry defines the designer and products of an inquiry:

- *Designer inquirer*: who is (are) the inquirer(s)? What past experience is relevant to the particular inquiry?
- *Designer intentions*: explicit statement of the intent or intents of the inquirer with respect to the design inquiry. How will the shaping of the experience be guided and what are imagined outcomes?
- *Design rationale*: explicit reflection on the whys and hows of the inquiry. Rationales support the designers' intentions.

Within each design inquiry are actions. Actions describe the acts and outcomes of interaction design. In a sense this, actions detail the practice level of design; the acts and actual outcomes. It is defined by the two concepts of judgment and interpretation. Judgment comes in two forms: formative in the moment of design actions, as well as summative in the evaluation of outcomes. This ongoing decision-making and constant judgment are the mechanisms that keep the inquiry progressing, enabling it. Interpretation is a result of the multiplicity of the inquiry. This means that the pluralism of the situation must be negotiated and interpreted. The actions and outcomes are bound within each of the two concepts. In the case of judgment, the products range from representation of design decisions to results. They include:

- *Representations*: externalizations of design decisions and imagined possibilities such as sketches, storyboards, scenarios, models, and prototypes;

- *Activities*: externalizations of processes to aid or model design judgment like workshops, role-playing, and design games;
- *Models, artifacts, and systems*: results of judgment and design actions that are final products;
- *Evaluations*: range of formative and summative evaluations from expert reviews, informal evaluations to formalized user testing.

In the case of interpretation, this concept is manifest in engagement with stakeholders, findings, and criticisms:

- *Stakeholder views*: formative engagement in design through co-designing or assessment in for example, participatory design workshops or user-centered focus groups;
- *Findings*: formative and summative conclusions based on interpretations of actions and results of evaluations;
- *Criticism*: formative and ongoing critique of design decisions and outcomes during the design process in the form of critiques to ongoing formal criticism from external critics.

The framework is a set of integral concepts (see Figure 4). The experience view encompasses all parts of the framework. It can be seen as a result of a limitless numbers of design inquiries, with each inquiry made up of actions.

In the latter part of Chapter 5, additional principles and concepts emerged from the analysis at the experience view of the two inquiries, ec(h)o and socio-ec(h)o. These help to describe common analytic features of interaction design inquiries. For example, the relationships among actions of judgment and interpretation can be characterized in a number of ways including *formative* and *summative findings*, when interpretations of actions are conclusive enough to act on within the interaction design process or substantiated through a number of validation strategies that than can be seen as reliable information in other inquiries. Other relationships include *mirrors and feedback loops* that

are interpretations of actions that then spawn new actions, and *cascading* relationships where actions like judgments lead to a sequence of other judgment actions.

I describe a repeating set of relationships that I refer to as a *common pattern*, which is a pattern of actions found in any inquiry. The mechanics are as follows:

1. An intention is required to initiate the design inquiry. Ideally it is supported by a design rationale.
2. The intention initiates a judgment that is the first interaction design action.
3. The action is interpreted and the reflection is mirrored or fed back into the inquiry in the form of another judgment.

The common pattern describes the inner mechanics of the inquiry. To describe the overall structure of interaction design inquiries we can look at the different types of relationships:

- *Inter-integrity (Mirrors and feedback loops, formative findings, and initiations)*: relationships across types of actions like interpretations and judgments; relationships across the design inquiry to actions like intentions; and formative findings that prescribe judgment actions.
- *Intra-integrity (Cascades)*: relationships that connect similar actions together like a series of judgment actions leading up to a final prototype, or a series of design charrettes to orientate the design team.
- *Extra-integrity (Findings and criticism)*: a series of findings that cascade into forms of criticism external to the designer inquirer. Criticism takes on the form of a “meta feedback loop” that influences subsequent design inquiries. The theory provides a series of useful concepts and principles in a consistent framework and set of descriptors.

### **8.1.3 Standards of validation**

I discuss in Chapter 6 how the theory comfortably adopts a range of validation strategies within a qualitative orientation. Interpretation is at the heart of understanding validation in interaction design. The theory does not prescribe methods rather the theory

sets out a paradigmatic focus that guides principles for validation. In explaining the role of validity in our pragmatist theory of interaction design, I discuss and demonstrate how strategies address the aims of securing knowledge across criteria of trustworthiness, validity, and criticism. The examples of trustworthiness show how credibility is achieved through prolonged engagement of the designer inquirer, collection and integration of diverse data, disinterested peer review in publications and interested peer review through collaboration, and negative case analysis. Together these commitments establish the believability in the representation and findings generated by the research. Transferability is achieved through thick description and theoretical generalization. The descriptive auditing and other reflexivity mechanisms in the theory provide procedural support and a shared theoretical construct that together ensure dependability and confirmability of data and findings.

I discuss how quantitative validation is a definite strategy even within a qualitative orientation. The examples I discuss in Chapter 6 shows how quantitative analysis and validation have been effective in different contexts: the internal validity check of a data collection instrument, the “mixed methods” approach that combines quantitative and qualitative analysis to support findings, and a quantitative analysis of video coding data. The multiplicity underlying pragmatism opens the theory to a broad use of validation strategies that includes quantitative validation.

I argue for the importance of criticism in interaction design. This strategy of validation best assesses the value of interaction design inquiries beyond the inquiries themselves into everyday experiences and over time. I describe how criticism should be at home in a design discipline like interaction design despite that not currently being the case. I discuss how blind peer review could be modified and leveraged into the beginnings of an



interaction design criticism practice, and how considerations of the role of criticism and cultural theory are emerging in interpretive and reflective approaches to HCI (Gaver et al., 2003 , Dourish, 2006 , Sengers et al., 2005 , Sengers and Gaver, 2006) that directly relate to interaction design.

#### **8.1.4 Mobilize the theoretical ideas**

In many respects, the degree to which a theory can mobilize its ideas and actions in ways that are accessible in practice and open to revision through practice is the sole measure of a normative or pragmatic theory like the one I propose. Its value is in the degree to which it effects positive change in the normal day to day occurrences of interaction design. Throughout the thesis I've aimed to demonstrate or illustrate the many points of access and use of the theory. Specifically, I argue that the theory's focus on philosophy and description supports interaction designers' abilities to experiment, generate, and reflect. In Chapter 7, I discussed how the theory makes clearer the practical concerns shared with HCI, and the implications of the theory on interaction design research and education.

The philosophical orientation steers the theory away from prescribing how the field is practiced and researched. The theory describes actions and principles rather than describing methods and skills. This approach invites innovation and experimentation of methods and means on the part of practitioners and researchers rather than prescriptive adoption. The theory describes patterns of interactions of entities of the inquiry rather than particular sequencing of phases or methods. The focus of the theory is aimed at making clearer how we know in interaction design and not defining how we conduct interaction design.

Yet within the latitude of a philosophical framing of interaction design, the theory does set out to describe interaction design in detail. In Chapters 4 and 5, I showed the

descriptive capacity of the theory. The aim of the descriptive approach is to support intellectual way finding in practice and research. Accurate descriptions provide diagnostic abilities for interaction designers that help to differentiate between inquiries and make clear the value and use of actions like findings or stakeholder views. The descriptions create a clearer reflective space for both practice and research to guide interaction designers in future actions. The descriptive framework provides the interaction design researcher with analytical strengths to establish findings, contributions, and transferable research outcomes.

The interpretive nature of pragmatism makes the point that the descriptive taxonomy is itself negotiable, it is as much a discursive object as the things it describes. This allows for the theory not to become prescriptive within its own empirical reasoning. The aim is to provide descriptive tools that are at the discretion of the designer inquirer. The theory claims that the interaction designer inquirer bridges the gap between descriptions of how interaction design occurs and how it *should* occur.

The value of defining interaction design more clearly is that its relationships with other disciplines become equally clear as well. In Chapter 7, I discuss how interaction design can productively bridge HCI in particular areas of shared and mutual concern; these include prototypes, evaluation, stakeholder views, conceptual models and designer intentions.

In respect to prototypes, the main claim is that interaction design can show the knowledge manifest in the making of a prototype and this adds to the space of explanatory causes in HCI. Additionally, in HCI, prototypes are either the object of study, e.g. usability tests or the tools to create phenomena for study, e.g. instruments for data collection or to verify theoretical claims. In the latter case of designing prototypes for data collection, issues arise in validating the instrument and the integrity of the design process that is

behind the prototype. In the former case, there is considerably more to understand in the role prototypes play in creating phenomena, and importantly there are innumerable interaction design strategies in considering the relationships between artifacts and people that would be helpful to HCI.

In Chapter 6, I describe different validation strategies including quantitative approaches within the qualitative orientation of interaction design. The qualitative and mixed methods strategies provide a rigor of interpretation that broadens the analysis and findings of interaction phenomena. Additionally, as discussed with respect to prototypes, interaction design extends evaluation to its own processes thus opening the possibilities of discoveries in practice. In Chapter 7, I discuss that the need for criticism in interaction design is acknowledged in the emerging discussions of the role of interpretation in HCI. These shared concerns advance the role of criticism. Arguably, criticism extends the assessment of the value of HCI and interaction design research in everyday contexts and over time.

In Chapter 7, I discuss other points of practical and mutual interaction with HCI with respect to research that will help mobilize the theory. For example interaction design adds to the practice of considering stakeholders in design by providing insights into the role of design in eliciting stakeholder views, and the value and knowledge embodied in artifacts produced by stakeholders in participatory design workshops. The role of the designer provides additional insights into the motivations behind the making and reasoning of systems. Designers mediate user requirements and other analyses and their role in this mediation could be made more explicit. Design activity is a source of conceptual models and heuristics and such models are often generated and tested within an inquiry. Overall,

interaction design adds another disciplinary source and opportunity for conceptual models relevant to both fields.

Later in Chapter 7, I turn my attention to the practical aspects of research and issues of education in interaction design. Both practice and education are critical measures to the degree of mobilization and accessibility of the theory. The biggest impact of the theory is due to its epistemological focus. This brings a degree of clarity that informs decisions rather than defines them. In research, the theory fills the gap of a theoretical paradigm from which to base research strategies and data collection methods. The discussion of validation strategies in Chapter 6 helps to inform decisions on relevant strategies like case study, ethnography, phenomenology, experimental studies and criticism, all of which contribute to discovering qualitative values in interaction design research. There is space for diverse strategies and room for further variations and experimentations with strategies. I discuss how data collection and analysis techniques follow relevant research strategies, validation approaches and philosophical orientation. The theory shows how current design techniques like participatory workshops, visualizing techniques, sketching and role-playing can quite easily have a research dimension, in addition to the many qualitative and quantitative techniques.

In education, the philosophical view opens the field to be studied by non-practitioners and potential interaction design scholars and critics. This occurs through the studying of interaction design at the level of pragmatic experience that describes the main principles and concepts of the field and shows how it contributes to knowledge. Further, a field with a clearer intellectual centre reveals its own history and related histories. This is an interdisciplinary story and involves a contextual understanding of interaction design

with respect to cognate disciplines like HCI, industrial design, participatory design, interactive art and others (see Figure 47).

The theory informs research and education on more practical levels as well. In both cases the theory makes clear the need for more research and education in reflexivity that can result in new methods and routines. In other examples, the descriptive strength of the theory supports research with an immediate template for coding data gathered from interaction design projects and ready descriptors for the relationships among actions like the *common pattern* (see 5.2.2.2 The common pattern in interaction design). In interaction design education, the theory supports informed decisions on skill and methods acquisition (see 7.1.3.5 Skills). I argue that the choices in where to invest time in either learning or teaching skills and methods is dictated by the goal of ensuring that interaction designers have the competency to play a role in every type of outcome related to actions in the interaction design inquiry (see 7.1.3.5 Skills).

### **8.1.5 Concluding remarks**

The theory set out to shed light on the overshadowed field of interaction design. Interaction design by default was shaped by HCI theory and in the process, principles of user-centrism and scientific realism dictated research efforts in the field. Design theorists rested with strategic discussions of method and designerly techniques that could nuance HCI pursuits. In this sense, the theory proposed in this thesis is revisionary. The revisions stem from redefining the relationships of the designer as a protagonist and site of knowledge, and that knowledge is embodied in the experience of practice. Interaction design can be said to be designer-centric and rigorous in its interpretations and negotiations over knowledge.

The revisionary understanding of interaction design holds two emphases. Firstly, the epistemological emphasis of the theory avoids a prescriptive approach to how the field should be practiced and researched. A revisionary theory offers programmatic goals for experimenting and describing the experiential space of interaction design. The knowledge of interaction design is contradictory, multiple, concrete, embodied and dynamic yet this does not mean it cannot be rendered possible. Within these principles the theory operates on actions that invite innovation, risk, and experimentation on the part of practitioners and researchers. The second emphasis on the interaction design inquirer points to the fact that the designer is the locus of design, the source of creative action and reflection. This emphasis ensures that theorizing and intellectualizing are intrinsic to interaction design and not a result of external impositions or importations.

## APPENDIX 1 – EC(H)O SOURCE ABBREVIATIONS

Abbreviations	Sources
CLV	Workshop 1, video, May 14, 2003
DC 2005	Wakkary, R., Framing Complexity, Design and Experience: A Reflective Analysis (2005), Digital Creativity, Volume 16, Issue 2, 65-78
DC 2005	Wakkary, R., Framing Complexity, Design and Experience: A Reflective Analysis (2005), Digital Creativity, Volume 16, Issue 2, 65-78
DIS 2006	Wakkary, R., Hatala, M., ec(h)o: Situated Play in a Tangible and Audio Museum Guide, Designing Interactive Systems 2006, pp. 281-290.
DS	Design Specifications document - Sept 11, 2003
EC 2006	Wakkary, R., Hatala, M., Newby, K., "ec(h)o: ecologies for designing playful interaction," (2006) in Designing effective communications: creating contexts for clarity and meaning (ed. J. Frascara), New York, NY: Allworth Press, pp. 235-243.
FCC	Foam core cube, June 2003
FP	Final Prototype, March 2004
M&W 2004	Wakkary, R., Newby, K., Hatala, M., Evernden, Droumeva, M., Interactive Audio Content: An Approach to Audio Content for a Dynamic Museum Experience through Augmented Audio Reality and Adaptive Information Retrieval (2004). Museums and the Web 2004: Selected Papers from an International Conference (eds. J. Trant and D. Bearman), Toronto: Archives & Museums Informatics, pp. 51-60
M&W 2005	Wakkary, R., Evernden, D., Museum as Ecology: A Case Study Analysis of an Ambient Intelligent Museum Guide (2005), Museums and Web 2005: Selected Papers from an International Conference (eds. J. Trant and D. Bearman). Toronto: Archives & Museum Informatics, pp. 151-162
MOAI	Museum of Anthropology Interactive, Sept 13, 2003
PUCJ 2007	Wakkary, R., Hatala, M. Situated Play in a Tangible Interface and Adaptive Audio Museum Guide (2007). Journal of Personal and Ubiquitous Computing, Vol. 11, Number 3, March 2007, pp. 171-191.
SB	ec(h)o storyboard - April 22, 2003
TP1	Technical prototype 1, Nov 2003
TP2	Technical prototype 2, Feb 2004
TPPP	Trivial Pursuit paper prototype, June 2003
UMUAI 2005	Hatala, M., Wakkary, R., Ontologies-based user modeling in an augmented reality system for museums (2005), User-Modeling and User Adaptation Interaction, The Journal of Personalization Research, Vol 15, Issue 3-4, pp. 339-380
VS 1	Video Scenario 1, May 1, 2003

VS 2	Video Scenario 2, June 28, 2003
VS 3	Video Scenario 3, Nov 17, 2003
VS 4	Video Scenario 4, March 02, 2004
WB	Wooden ball, Oct 2003
WC	Wooden cube, Jan 2004
WS 1	Workshop 1, How do you catch butterflies, May 14, 2003
WS 2	Workshop 2, Sticks and Stones, May 21, 2003
WS 3	Workshop 3, House of Cards, June 12, 2003
WS 4	Workshop 4, Serious Play, July 30
WS 5	Workshop 5, No Buttons, Sept. 18, 2003
WS 6	Workshop 6, Prefaces, Oct 3, 2003
WS2A1	Workshop 2, artifact 1, May 21, 2003
WS2A2	Workshop 2, artifact 2, May 21, 2003
WS4O	Workshop 4, Play Doh objects, July 30



## APPENDIX 2 – SOCIO-EC(H)O SOURCE ABBREVIATIONS

Abbreviations	Sources
CHI2006	Droumeva, M., Wakkary, R., Sound intensity gradients in an ambient intelligence audio display, Extended Abstracts CHI 2006, pp. 724-729.
CV2007	Wakkary, R., Hatala, M., Lovell, R., Droumeva, M., Antle, A., Evernden., Bizzocchi, J., "socio-ec(h)o: Ambient Intelligence and Gameplay" (2007) in Changing Views: Worlds in Play (eds. S. Castell & J. Jenson). New York, NY: Peter Lang Press, pp. 207-219.
DIGRA2005	Wakkary, R., Hatala, M., Lovell, R., Droumeva, M., Antle, A., Evernden., Bizzocchi, J., socio-ec(h)o: Ambient Intelligence and Gameplay (2005), Selected Papers from Digital Games Research Association's International Conference 2005 (eds. S. Castell and J. Jenson), Vancouver, B.C.: DIGRA, 217-226.
ESDoc	Document: Environment Workshop Schema, Feb. 15, 2005
GPCDoc04	Workshop: games & play, Oct. 1, 2004
ICAD2006	Droumeva, M., Wakkary, R., Participatory Design for an Ambient Intelligence Audio Display, International Conference on Audio Display 2006. pp. 36-43.
ICAD2008	Droumeva, M., Wakkary, R., Understanding Aural Fluency In Auditory Display Design For Ambient Intelligent Environments (2008), International Conference on Audio Display 2008, Paris, France, in press, 7 pages (awarded Best Poster Prize).
IEDoc04	Workshop: information ecology, Oct. 7, 2004
IntDoc04	Interviews: team members on play, Nov. 23, 2004
IPDoc04	Workshop: infinite play, Oct. 4, 2004
MDDoc04	Meeting: metaphors discussion, Oct. 22, 2004
MM2005	Wakkary, R., Hatala, M., Lovell, R., and Droumeva, M., An ambient intelligence platform for physical play (2005), Proceedings of the 13th annual ACM international conference on Multimedia, Singapore, pp. 764-773.
MPGDoc04	Meeting: play group, Oct. 29, 2004
MWDoc04	Workshop: metaphors, Nov. 5, 2004
PEV	Evaluation: preliminary testing, June 14, 2005
SC1Doc04	Document: socio-ec(h)o description, Nov. 23, 2004
SC2Doc	Document: bigtoys scenario, Oct. 3, 2005
SDoc04	Workshop: sensors, Oct. 7, 2004
St1Doc	Document: states, March 5, 2005
TEI2008	Wakkary, R., Hatala, M., Ying, J., Droumeva M., Hosseini, M., Making Sense of Group Interaction in an Ambient Intelligent Environment for Physical Play (2008), Tangible Embedded Interaction 2008, Bonn, Germany, pp. 179-186.

W1Doc	Workshop: sticks & stones, Feb. 8, 2005
W2Doc	Workshop: environment, Feb. 15, 2005
W3Doc	Workshop: movement, Feb. 18, 2005
W4Acc	Workshop: trading game, Feb. 18, 2005
W5	Workshop: here there, April 1, 2005
W6	Workshop: narrative, April 8, 2005
W7	Workshop: puzzles, April 22, 2005
W8	Workshop: lights out, April 30, 2005
WHDoc04	Document: walk home accounts, Nov. 10, 2004

## **APPENDIX 3 – DVD LIST OF CONTENTS**

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### **Video Chapter 1: ec(h)o**

- Final prototype (3:04)
- Scenario 1 (6:13)
- Scenario 2 (4:34)
- Scenario 4 (4:30)
- Workshop 1 How do you catch butterflies (8:59)
- Workshop 2 Sticks and stones (2:25)
- Workshop 3 House of cards (2:18)
- Workshop 4 Serious play (6:14)

### **Video Chapter 2: socio-ec(h)o**

- Final evaluation (3:13)
- Preliminary evaluation (3:28)
- Workshop 2 environment (5:24)
- Workshop 3 movement (5:44)
- Workshop 5 here there (4:43)
- Workshop 8 lights out (4:49)

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