INTERFACES WITH THE INEFFABLE

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In recent years, Human Computer Interaction (HCI) designers and researchers have shifted focus from a primary concern with procedural, generic, and task based applications to applications that address messy, personal, and aesthetic experiences. These difficult to formalize experiences, such as feelings of intimacy, spirituality, or a sense of place, are conceptualized as experiences of the ineffable. In this work, I use a reflective design practice to look at two primary approaches to designing interfaces with the ineffable, one emphasizes reduction and the other openness to interpretation. I discuss issues of control and reification that result from the reduction approach and develop the interpretation approach as a viable alternative requiring a re-thinking design and evaluation strategies and criteria. These issues and approaches are explored in detail through the development of two case studies. Case study one addresses the ineffable experience of art and presents a series of applications for interfacing with the ineffable in the art museum. Case study two details the ineffable experience of affect and presents a system designed for augmenting affective presence in an office environment. To further this work, I examine new thinking in both HCI and Communication for understanding every day interpretive acts and the implications for design. In addition, I advance reflective design as a new process based practice for the field of Communication.

BIOGRAPHICAL SKETCH

Kirsten graduated from the University of Notre Dame in 1993 with a degree in Psychology and a concentration in the field of International Peace Studies. Her interest in advancing transformational dialogue led her first to Washington D.C. to work with non-profit conflict management organizations and then to graduate school in Communication at Cornell University in 1994. Fortuitously, she stumbled into the HCI lab and despite being perplexed by the word 'interface,' she was captivated by the promise of multimedia and the Internet for learning and new forms of expression. Her master's thesis explored computer mediated communication and the development of efficacy, defined as the belief and skill to participate fully in a community of practice. Due to relocation, she took a leave of absence after receiving her Master's of Science in 1996 and began work as a project manager for Eduprise, a learning technology software company in Chapel Hill, North Carolina. She coordinated the user requirements initiative for Eduprise's international learning technology standards efforts, a post she continued after moving to Brussels, Belgium in 1997. In 2000, she moved to London, England where she switched career tracks from higher education to Fortune 500 companies. She worked with Strategos, a leading strategy innovation firm, as a consultant primarily developing their technology platform for innovation. In 2002, she returned to Cornell to complete her Ph.D. working on many of the same museum technology issues that she and her advisor Geri Gay initially explored almost ten years earlier. Aside from her academic and career trail, Kirsten is married to her best friend, Ken, and currently awaiting the birth of their first daughter.

This work is dedicated to my parents, Dee and Bob Binda, who fostered the curiosity necessary to become inspired and tolerated the stubbornness necessary to keep going.

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We can touch more than we can grasp.
-- Gabriel Marcel

This work examines the concept of the ineffable and the paradox that arises when designing technological interfaces with the ineffable. The ineffable is considered as a phenomenon and a process of movement between the unknown and the known, between invention and convention, between transformation and standardization. It suggests the mysterious and magical but also relates to the seemingly more mundane but still remarkable every day achievement of people's meaning making practices. Yet, in designing technology for experiencing the ineffable, the dominant approach is to remove the mystery and the unknown – to render the ineffable understandable and replicable. This is the paradox of interfaces with the ineffable. We aspire to understand the ineffable even as it continues to allude us, and as we attempt to define it, we ultimately define ourselves.

This chapter begins with a personal case study of designing for innovation that illustrates what I will demonstrate as the larger recurring pattern of reducing the ineffable to something codifiable. I will suggest how this pattern persists in current areas of interest in Human Computer Interaction (HCI) but how breaking this pattern provides a compelling new perspective, one rooted in providing space for multiple interpretations, for the design and evaluation of computing technology. Following this introduction, I provide two case studies of defining, designing for, and evaluating interfaces with ineffable experiences. These case studies ground the inductive development of new ways of thinking about and approaching interpretation in design. Although HCI

has a rich but changing history in the role of interpretation, this dissertation adds the voice of communication theory. In addition to adding to the discourse in HCI on interpretation, I propose to add to the field of communication from the practice of HCI. In particular, I present this work as a new method for communication inquiry: design as theory. This work concludes with a return to the ideas described in this introduction of the ineffable, interfaces, and interpretation.

A Personal Case Study: Innovation Practice and Technology

Toward the end of the 1990s, I worked as a consultant and technology designer with Strategos, a leading strategy innovation company, founded by management consultant and professor of business Gary Hamel (Hamel & Prahalad, 1994; Hamel, 1996; Hamel 2000). Strategos promoted innovation by arguing that whereas the Total Quality Movement (TQM)[1] once provided competitive advantage for companies, it now serves primarily to optimize existing products and practices rather than generating new ones. TQM provides for efficiency, but innovation provides for new growth and regeneration. The process of innovation is presented as overturning standard practices and static knowledge and replacing them through a rich discovery process founded on the principles of active learning (Argyris 1993; Schön, 1983). My role with Strategos was to help develop technology tools for spreading the competency for and practice of innovation throughout a company. It was through this design project that I first encountered the paradox of interfaces with the ineffable. Although Strategos presented innovation as a process of change, we ultimately coded for a process of convention.

[1] For more on TQM, see the work of W. Edwards Deming (Deming, 1986).

A quick example of our work at Strategos will help illustrate this paradox. On one engagement, I worked with a client to develop new growth opportunities in the leisure industry. As a large corporation with a market capitalization of more than $40 billion, the client could afford hiring not one but two consultant companies for this effort. Our companion would be one of the most prestigious and largest consulting companies worldwide, known internally and externally as 'the Firm.' On the first day of a week-long workshop, the Firm presented their contribution: a binder of market research (later nicknamed by the client as "the Brick") for every workshop participant with 300 pages of charts and graphs depicting industry players, forecasts for product segments, and related trends. On the second day, Strategos introduced our contribution: teams of five to six people in the workshop each received an envelope of money, a street map, an instant camera, and instructions to experience an assigned borough of London. Upon their return, participants were to illustrate their experience with pictures, purchases, and stories. This day-long excursion became a solid basis for animated discussions and insights throughout the week, but the Brick was consulted only on rare occasion for verification. At the end of the week, most of the client participants left the Brick behind for the bin, whereas all the participants carried away their memories of experiencing leisure on the London streets.

It is for such experiences of active learning, and turning this discovery into new growth opportunities, that Strategos wanted to create a technology platform for innovation. The platform would include tools for: ideation (generating new ideas), attraction (team building around opportunities), valuation (tracking and evaluating ideas as they became viable business ventures), and commercialization (a marketplace for ideas, capital, people,

and projects). Furthermore, I was to explore with my colleagues how we might use technology to extend our own reach. As a smaller consultancy outfit with a prestigious client list, we competed for work against much larger consulting companies (such as the 'Firm'). Therefore, we hoped to use computer technology as both an online learning space and as a toolkit for managing innovation processes.

To a large degree, many of these design efforts were successful in that we created and deployed tools that met our objectives to teach about innovation as a process. Where a company may not have had an innovation process or at best an ad-hoc sporadic process, our tools provided companies with a tested means for pursuing innovation on a more systematic and larger scale. Despite the success of our tools, however, I noticed a discernible shift from our active learning perspective on innovation and our application of technology. For example, during our discovery days in London with the client described above, participants came back from their experience energized and the flow of ideas and conversations during the workshop were animated by the richness of their experience 'in the field.' Yet, translating the sharing process online with pictures and captured anecdotes felt more like recreating 'The Brick.' Capturing the richness of the day was proving to be elusive.

Furthermore, part of our definition of innovation involves the process of constantly identifying conventions and recognizing when these conventions have exceeded their usefulness and flipped into blinders to new insights. However, application of technology seemed to do the very opposite. It supported a process of innovation, but it supported a defined process of innovation. Why wouldn't this process be subject to the same precepts of active learning and discovery that every other business process is? Whereas

we proposed the ‘world’ is ever changing and requires innovation to stay relevant, the design of our technology systems to support innovation seemed to suggest that innovation itself stayed largely the same. To continue with the TQM analogy introduced earlier, when technology was introduced into the Strategos toolkit, it was for streamlining, standardizing, and making the process of innovation scalable. It was for the *efficiency* of innovation, not the innovation of innovation.

In critiquing our designs from this perspective, I questioned whether our success came at some cost as well. I began to compare this experience with previous experiences of working with knowledge management systems (Boehner, 1996) where when we boiled down expert experiences into best practices suitable for a database, something was lost in the translation. This same phenomenon seemed to be at play with our technology tools for innovation. In systematizing a process through technology design, whether for knowledge management or innovation, the process becomes more formulaic and seems to lose “something.” What this something was I could not articulate or pinpoint. I questioned if perhaps we were simply using technology systems for what they were best at: e.g. scale, speed, standardization. Perhaps the best application of technology was indeed for the part of the innovation process that relied on conventions, but the part that was difficult to codify would happen outside these systems or even in spite of them. This would require a slight shift to approach the tools we were designing for innovation capture and documentation rather than stimulating and enhancing new practices.

The observation that technology is good for promoting efficiency spurs the immediate counter reaction that perhaps our thinking around technology

had been too narrow. Technology not only codifies practice but can revolutionize practices as well, yet that was not the initial direction when we set out to make the tools for innovation. We wanted to help revolutionize how companies defined and operated within their industry but we didn't think to provide ways to continually revolutionize the process for doing this. This question about what technology was useful for with regards to the innovation process spurred a meta-question as well: who is in control, and what are the implications, of making this decision? I reflected that as my colleagues and I set out to design the tools for innovation, we implemented our own vision both of what innovation as a process is about and what we thought a useful application of technology would be. We drew the line between what would be in and what would be out of our technical specifications and requirements.

In summary then, as a designer for Strategos, I worked with my colleagues to first articulate and systemize the innovation process we used with clients to a degree that it could be readily operationalized. We sought to capture some of the unpredictability and inspiration that emerged through workshops such as the one described in the beginning of this section and re-create the same scenarios through using different technology applications. After all, the workshops themselves were simply a ritualized practice, so why should the application of technology prove any different? To some degree this approach was successful but it spurred important questions: what parts of the innovation process are codifiable and what is left behind? What happens to innovation in the process of codification? Who draws the line between what can and cannot be codified? And finally, how could technology support innovation beyond codification?

From Innovation to Interfaces with the Ineffable

My personal work experience with Strategos uncovered a paradox of designing for innovation as an ineffable, complex, dynamic process. Our first step in the design was to make innovation describable, componentized, and static. In designing the technology this way, something was lost in this translation: something escaped our codification. Yet, this paradox is not specific for innovation. This same paradox of coding for what seems to escape codification plays out across the history of HCI. In this section, I will both broaden my scope but refine my questions as I define the constructs in this study.

The Ineffable

The first broadening step is to move from examining the relationship of technology and innovation processes to examining the relationship between technology and the ineffable. There were many terms I could have chosen to describe this concept, for example: the indescribable, the non-discursive, the irreducible, or the un-formalizable. What I wish to focus on are the messy and complex experiences that are currently a central focus for HCI design. I chose to use the term ineffable after first encountering this term in Karen Armstrong's History of God (Armstrong, 1993). As a descriptor of that which is unknown in the discursive sense but experienced, the ineffable is an apt phrase for the aspects I wish to explore. The ineffable includes the 'something' that is often left behind in the process of codification. This reading of the ineffable fits with new movements in HCI focusing on experience design because of the relationship between the ineffable and experience. The ineffable cannot be fully known or understood through explanation alone but must be experienced. John McCarthy and Peter Wright (2005) discuss experience as the "irreducible

totality of people acting, sensing, thinking, feeling, and making meaning in a setting" (p. 54). Because experience is personal and felt, it cannot be fully explained to another.

The ineffable is not the same as the term 'tacit', popularized by Michael Polanyi (1983) and often described synonymously with implicit knowledge – what we know but cannot tell. Tacit knowledge also often escapes codification and describes the expert knowledge generated through repetition and intimate experience. Tacit knowledge is known but difficult to articulate because it has become second nature. The ineffable is experienced but difficult to articulate because the articulation always falls short. Furthermore, the ineffable is experienced by everyone, it is not limited to a kind of expert status. It may be possible to identify component parts of an ineffable experience, but the actual experience of the ineffable is more than the sum of its parts.

The ineffable is an important construct for understanding in HCI for three inter-related reasons: practice, politics, and personhood. In terms of practice, all academics must contend with the relationships between their abstracted or simplified theories, models, and constructs and the lived, complex phenomenon of study (e.g. Geertz, 1973; Hayles, 1999; Latour & Woolgar, 1979; Robinson & Bannon, 1991; Wittgenstein, 1958). Likewise, the practice of design must also struggle with translating the ineffable from something formless into a form. For instance, I have already described some of the challenges in designing systems for the process of innovation where the critical component of change and transformation was left behind.

With our practices, we must consider politics, as any action will bring intended and unintended consequences. Katherine Hayles brings the political implications of representing the ineffable into sharp relief with her description

of the “Platonic forehand and backhand” (Hayles, 1999, p. 12-13). Hayles examines the shift between an embodied, rich, and complex reality to abstract representations of this reality as information. In the Platonic backhand, a situated experience, for example participating in a brainstorming activity, is simplified into an abstraction of this experience, for example identifying the stages or the rules of a good brainstorming session. It is the Platonic forehand that Hayles suggests needs more consideration because of its generative, and therefore political, power. In the Platonic forehand, the abstraction shifts to becoming the stimulus, the guide, or the source for later situated experiences. It not only shapes the later experience but is also positioned as the cause.

As another example, more closely related to Hayles’s work, consider the popularity of the information-processing model in cognitive studies. Developed partly in response to behaviorist and Piagetian stage models of how our mind works, the information-processing model relies on the language of computers and machines, with input and output, encoding and decoding (Flavell, Miller & Miller, 2002). It is difficult to pull apart which is the overriding metaphor, our brains as human computers or our computers as human brains. But, the important point is that the models drive our research. To use a Strategos metaphor, the research lens of our brains as a computer influences how we approach the brain as an object of study. The research lens of the computer as a brain influences how we study and design computers.

This example brings us to the final reason for understanding the ineffable: personhood. Lucy Suchman (2004) describes how we design and describe our machines in our own image and how in this process, we define not only our machines but what we believe it means to be human. In other words, she argues, in our drive to create human-like computers, we

'configure', as in figure together, the human and the computer. This configuration consists of drawing and redrawing the boundary between humans and non-humans, an activity that brings us to the interface.

The ineffable therefore provides an umbrella term for describing rich, complex experiences that are difficult to fully articulate or understand through a mere explanation. This concept of the ineffable is very relevant for HCI as interest has shifted from more narrowly defined problems such as task completion to designing for experience. The thrust of this work is not to create a theory of the ineffable: an exercise that I doubt is even possible. I will touch on the evolving nature of the ineffable through the case studies, but I am not proposing to deconstruct and reconstruct this phenomenon or process. Instead, I am using the ineffable as an area of interest for design in HCI. The main focus of this work is to argue that there are experiences which we consider ineffable (and this changes over time) and there are contrasting approaches for designing interfaces with the ineffable in HCI. This leads to the second term requiring clarification: interfaces.

The Interface

The interface is at once both an appropriate term and an unfortunate one. I believe for today's audience it immediately suggests digital technology and probably more specifically computer technology. This is appropriate as the focus of this work is on the design of computer applications for aspects considered ineffable. However, the 'interface' is also unfortunate because of current response to its use during the early 1990s regarding graphical interface design. Because of the predominance of desktop computing and the preeminence of the screen, several critics (e.g. Winograd, 1996) have suggested that interface design became a superficial process focused only on

the surface interactions of input and output. This concern is still raised today. When McCullough states “building better interfaces remains the goal of much of the CHI community” (2004, p.20), this is a critical accusation not a casual observation. The term interface design, and interest in the interface, has thus given way to calls for interaction design or experience design, something I will take up in a later section.

I wish to use the term interface, however, for its dual meanings of a digital meeting point and a boundary. My use of the term is more in line with current interests in the human computer interaction community for identifying seams, boundaries, and borders whether these are in designs themselves or in the practice of design (Chalmers & Galani, 2004; Rudström, Höök & Svennson 2004; Sengers, 2006; Sengers et. al., 2004). The construct of the ineffable causes first the question of what is considered ineffable and what is not considered ineffable. This line has often set the agenda for new developments in computing. Whereas intelligence was once considered an unapproachable black box, for example, pioneers in cognitive science have redrawn the boundary between what we know and don’t know about intelligence. With this new frontier, computer scientists began the pursuit of artificial intelligence. In a somewhat different articulation of Suchman’s configuration argument, where the line of the ineffable is drawn gives insights into what we consider essentially human, what separates us from machines, in other words what sets us apart as opposed to what draws us together. This is the nature of a boundary: it both divides and joins, it is the site of difference and the site of union.

Furthermore, as a boundary, the interface suggests that it is something contestable and therefore malleable. Phil Agre’s metaphor of centers and

margins (Agre, 1997) is a useful analogue for this concept. Agre describes a historical shift in the research and practice of artificial intelligence as an inversion of what was once considered on the margins versus the historical focal point for the field. Traditional approaches to artificial intelligence had prioritized the process of representing the 'world', in other words creating all the players and the stage upon which they would act for the duration of the play. The secondary concern was the interactions that would eventually transpire during each scene. The focal point then was getting an accurate and comprehensive model of the world right. Agre suggested however that the show never made it out of rehearsals (to continue with the theatre metaphor) as more sets continued to be required. This breakdown stimulated an inversion of positions around the boundary – what was focal became marginal and vice versa. The new play for artificial intelligence was about the immediate and local interactions, the scenes, as opposed to the modeling the entire story. For the purposes of this work, I will be examining where we currently draw boundaries for the ineffable and how we approach this boundary with regards to the design, use and evaluation of computer technology.

Designing Interfaces with the Ineffable

In the above sections, I defined the terms for this investigation. I will now turn to the methods. For this work, I will examine how the ineffable is demarcated and subsequently approached with computer technology by both examining existing systems and by building new systems. It is this latter part of building that is the heart of this investigation and the primary research method: research through design, and in particular through a new practice of reflective design (Boehner, David, Kaye, and Sengers, 2004; Sengers, Boehner, David, and Kaye, 2005). Reflective design draws from a number of

existing practices including critical technical practice (CTP) (Agre, 1997), participatory design (e.g. Greenbaum and Kyng, 1991), reflection-in-action (Schön, 1983), critical design (e.g. Dunne and Raby, 2001), and value sensitive design (Friedman, Kahn, and Borning, in press).

The uniqueness of the reflective design approach is in its emphasis on reflection as an on-going process, not simply something that happens at an impasse or at the bookends of a project. Reflection in the reflective design approach refers to a continuous critical examination of design choices and the socio-cultural factors and assumptions influencing these decisions. For instance, CTP argues for reflection on existing practices when there is a technical impasse, when the technical problems from a particular approach outweigh the benefits. Likewise, participatory design may be invoked as a method to anticipate and avoid social impasses between different stakeholders (for example between those funding a software design and the eventual users of the software). Reflective design argues for maintaining a critical perspective on technology design even when no impasse seems to exist.

The second important distinction of reflective design is its stance not only on when reflection occurs but also on who engages in the reflection. Reflective design is not simply a process for designers to follow in questioning design choices but it is a process for engaging users as well in a critical examination of technology, its design, and its implications. This engagement of users in reflection may occur through engaging users in the design process, such as in participatory design and user-led design approaches, but it also occurs through the use of the eventual design. In this way, the goal of reflective design is different from many current trends in technology design

where the aim is to hide the technology from the user, for the complexity of the technology to become invisible. In reflective design, how the technology functions, and inferences of why it functions in one way as opposed to another, are highlighted for reflection.

Just as Agre proposed building new technologies and experimentation as a form of technical research, I see reflective design as a useful method for social science to gain new insights into human behavior. Whereas experimental social scientists design experiments to create a testing environment from which to make observations and draw inferences, I will follow an emerging approach of designing systems for use in real world situations (e.g. Gay and Hembrooke, 2004). In other words, these systems are not designed for laboratory studies but will instead be introduced into contexts for use by people in their daily interactions and environments. As another analogy, consider how work in a field such as neurology advances by studying conditions of impairment. A brain with a damaged frontal lobe, for example, is a useful condition for scientists to discover not just the how a damaged lobe compensates or the impact of a damaged lobe, but in comparison, how a healthy frontal lobe operates. In a much humbler way, building new technology systems as a form of research is akin to designing for different, i.e. 'not normal or status quo' experiences of the world. How people respond to non-traditional designs offers insight not only into how they appropriate novel technologies but into how and why they maintain practices and perpetuate expectations with more familiar technologies.

The importance of building systems as a form of research is motivated partly from the work with Strategos outlined in the beginning of this chapter. The act of trying to match what we could do with the technology, or our

expectations of what technology can do, with how we understood the innovation process was an act of discovery. Even if in my critique of this translation we drifted away from our original perspectives of innovation, the exercise of design and subsequently evaluating these designs generated further discussion and analysis within the firm about how innovation actually happens. This reciprocal connection between theory and design continues to arise for me in human computer interaction studies. Although the ideal sequence is often presented as a linear one with designs being informed by theory, I believe the practice of design being informed directly by the environment and subsequently informing theory is also valid. In this model, the designing is a form of theorizing.

Therefore, I am proposing to use the act of design both as a method for theorizing and as a method for conducting research. Again, a very brief comparison with a traditional empirical social science will help to clarify. For example, to understand the phenomenon of equivocal communication, i.e. ambiguous and indirect communication, Janet Bavelas and colleagues (Bavelas, Black, Chovil, and Mullett, 1990), begin with phenomenological observations and theoretical perspectives. Whereas rule-based cognitive theories indicate how individuals may construct or understand equivocal speech, Bavelas proposes a situational theory for understanding the rules of a social situation for predicting equivocal acts. This conceptual work, as well as observations of equivocal acts, leads to a theory for explaining why equivocal communication occurs, namely in response to situations that could be categorized as avoidance-avoidance, where the safest most desirable response is to avoid direct communication in order to avoid negative consequences. This is the heart of the theory, outlining the constructs for

modeling and the predictions for testing. In order to test their theory, Bavelas discusses possible approaches of exemplification, i.e. finding existing equivocal acts and comparing the situations in which these occur, and field studies, i.e. looking for avoidance-avoidance situations and seeing if equivocal acts result. Ultimately, Bavelas outlines what she refers to as the 'creation' approach of designing a series of experiments in order to control as many variables as possible. In this way, Bavelas's design of experiments is similar to designing different communication systems: both constrain activities and through these constraints offer opportunities for research.

The role of equivocality and ambiguous language use will be discussed later in terms of its relationship with the ineffable, but at this point, I am using the example as an analogue for design as a method of theory and research. Suppose as a designer I wish to create a communication system to support equivocal communicative acts. Two useful starting points would be to examine theoretical perspectives (e.g. Bavelas et al., 1990) and to observe people communicating equivocally. These are the same starting points as for Bavelas and colleagues. An additional step for a designer would be to look at other systems designed for equivocal and related communication acts. These insights would all be drawn together and just as Bavelas creates a model for why equivocal communication happens, a designer would also create a conceptual model of what type of communication it is supporting, when, and why. Just as with models of language use, design models will also vary greatly in terms of scale and goals. Once a model for a system is developed, this model is then tested by instantiating the design. For a systems designer, this could be a prototype or an actual designed system for use within a laboratory setting with tight controls or out in the field. For Bavelas, her conceptual model

is instantiated through an experiment conducted through lab settings. The results of the experiment reflect on the veracity and generalizability of her theory, and in turn reflect back on the phenomenon of equivocal communication. Likewise, analysis of how a designed system for equivocal communication is used provides evidence not only about the system (e.g. its usability) but about the underlying model or theory of equivocal communication. Whereas Bavelas creates experimental designs in the form of scenarios to invoke avoidance-avoidance situations, I will propose technology designs that invoke experiences with the ineffable.

Designing systems as a research method works with both typical social science objectives and human computer interaction design objectives, but I would like to add a new objective as well. A social scientist might study the use of a new technology, such as computer mediated communication, in order to understand some aspect of the human condition. For instance, in previous work, I examined learning conversations as a means for developing efficacy in communities of practice (Boehner, 1996). I looked at how computer mediated communication influenced these conversations and in turn influenced the development of efficacy. As a designer, I might look at some aspects of the human condition in order to build better designs. For example, given a better appreciation of learning conversations, this might influence how I develop computer mediated communication systems to support this. But I would like in the designs created for the work described subsequently to take one more step. In addition to the designs being used for myself as a social researcher to understand the human condition or myself as a designer to improve designs, I want the designs to provoke users of the technology to reflect on aspects of the human condition and the role of technology. Returning to the previous

arguments about both the ineffable and the interface being contested domains, I recognize my privileged position in articulating where I see the line and designing to meet this. Therefore, I want the designs to draw attention to and reflect this demarcation to allow for people's own critical examinations of their own condition.

Approaching the Ineffable

As indicated above, the ineffable has presented a design and research agenda throughout the history of HCI and computing. Whatever was once considered out of reach, because it either escaped the codifiable requirements or the tolerable roles of a computing system, becomes the bar for progress. Creating a computer system that could think strategically and logically, the epitome of human processing, was once a singular focus of artificial intelligence. Creating a computer that could mimic conversation, to the point where a human conversant could not tell the difference between a computer-generated response and a human one was another benchmark. This goal continues to evolve into not just wanting a conversant, but a friend, a true other with autonomous thoughts and feelings. New frontiers for the ineffable as a point to interface with in HCI include an interest in designing for creativity (Boden, 1991; Wilson, 2002; Mitchell, Inouye, and Blumenthal, 2003), for a sense of place (Boehner, Gay, Hembrooke, 2005; Harrison & Dourish, 1996), spirituality (Muller, Christiansen, Nardi, and Dray, 2001; Bell, 2005), and enchantment (McCarthy, Wright, Wallace, and Dearden, 2005). In all of these frontiers a complex, rich, and difficult to demarcate experience sets the agenda for new technology design.

Both Suchman (2004) and Paul Dourish (2001) have recently explored the history of HCI development along these lines, from an initial interest in

simply mechanizing and replacing identifiable human actions to addressing fuzzy and less discrete phenomenon. They both identify three areas for future development: embodiment, sociality, and emotion. By arguing that what we know we know through being or acting in the world, a focus on embodiment entails moving away from abstracted and generalized views of the world to building systems that allow for contingencies and local peculiarities. By recognizing that the world we live in is constructed, a focus on sociality emphasizes not static rules and preconditions but emergent interactions. Finally, by demonstrating that reason divorced from affect is an untenable relationship for living in the world, a focus on emotion requires addressing this omission in designing our computing systems.

Exploring the Frontier

In the frontiers described above, namely work in HCI on creativity, sense of place, spirituality, and enchantment, a variety of approaches exist for design and evaluation of interfaces. Technology may be designed to support practices considered ineffable, such as the increase in applications for creative production. Ben Schneiderman (2002) suggests for example that since we have cracked the code for supporting tasks based on efficiency and usability, the new focus will shift toward support for tasks requiring creativity and imagination. Technology may also be designed for an experience of the ineffable, such as Bill Gaver and Heather Martin's (2002) Prayer Device, a device for communicating wishes, prayers and desires with the realm of spirits. A third goal appearing is one where the technology itself embodies the ineffable – where the technology is able to take on the experience of felt life. In this last goal, we aspire to build technology that can take on the irreducible qualities of being human.

How one sets out to explore these frontiers impacts the design and evaluation choices for the technology. One may set out to design the ineffable into the technology or to design for approximation to it. The evaluation choices follow in a similar vein – if the ineffable has been designed in, then presumably it can be measured, but if the design only approximates the ineffable then the evaluation will not focus on precision as a metric of success. For example, one aspect of experience design that has become popular is designing for ludic (Gaver, 1999), hedonic (Brown, 2005), or fun (Blythe et al., 2003) experiences. Hassenzahl, Beu, & Burmester (2001) discuss how one could assess these types of experiences resulting from new technology designs.

One approach is to bolt on these new overlooked aspects into existing evaluation methods – for instance in a questionnaire about a web site experience adding questions regarding how much fun or enjoyment the user had. Yet, the authors argue that capturing a sense of fun or enjoyment along a Likert scale or semantic differential misses the important questions of how or why something was experienced as enjoyable. In the following section, I will examine these tensions and trade offs between alternate approaches to building and assessing interfaces to the ineffable.

Reduction versus Augmentation

Although a variety of approaches exist for interfacing with the ineffable, this range can be simplified into two broad categories. The first categorical approach is what could be considered the reduction or the codification approach. The method here, once something ineffable is identified, is to first make the ineffable effable, i.e. to take a complex, amorphous phenomenon and to break it down into identifiable or discrete components. As described by Hayles, it is the Platonic backhand where a particular phenomenon is

abstracted into a general model or representation and this in turn is used to shape or control the phenomenon. This is the approach, for example, in attempting to engineer joy into a system or attempting to design an affective computer that accurately detects and adequately responds to a user's frustration level. In the reduction approach then, an interface to the ineffable requires pinning the ineffable down. Furthermore, it depends upon getting the ineffable 'right' as the system response depends upon the accurate measurement of the ineffable as input. For example, in the subsequent case study, I will explore approaches to modeling affect, such as frustration, by computers. The success of the computing application depends upon being able to correctly model the users' frustration levels.

In the second approach, what I have referred to in other work as the augmentation approach (Boehner, Sengers & Gay, 2004), the ineffable is allowed to remain complex, particular, and non-discrete. In the augmentation approach, attention is drawn to the uncertainty and malleability of the ineffable. For example, an affective computer might detect and display changes in biometric information that may or may not indicate changes in frustration level. The user is alerted to these biometric changes and can choose to label this change as frustration or perhaps excitement. In this example, the user assigns the meaning to the detected change. The difference between the augmentation and the reduction approach is that in the former meaning is not embedded in the system's computational model but negotiated with the system.

The reduction approach dominates over the augmentation approach in HCI. Despite claims that we live in a post-modern age, or even a post-post-modern age, our technology design is largely still directed by modernist

pursuits of finding order in chaos, standardizing away variance, and pursuing greater efficiencies of scale (McCullough, 2004). The deep roots of the reduction approach are philosophical, practical, economical, and cultural. From the philosophical side, we have the pervasive legacy of mentalism. The ability to retreat seemingly into a mental abstract world is often held as a defining characteristic of humans[2]. From a practical perspective, this ability to create abstractions and use them to guide behavior works and makes intuitive sense, at least much of the time. To repeat a successful experience, such as the innovation workshops at Strategos, the logical step seems to be to break down what happened once and then repeat this same sequence of activities.

Suchman also explores the common sense prominence of and reliance on abstract models in her discussion of plans (1987). It seems counter intuitive to suggest that action does not follow plans and instead brings plans into being. This is partly because we can all probably remember an experience of making plans – an activity that preceded our ensuing actions. What we often fail to notice, however, is how often we divert from these plans and create new ones on the fly. From an economic perspective, the drive for scale and efficiency favors this type of standardization through abstraction and modeling. A model or representation acts as a template – once the work of modeling has been complete, it becomes a generative form without much additional cost or effort. All of these ideas lead to the cultural resonance of the reduction approach. As a generative form, representations and models create culture, meaning they create and reify our ways of thinking and doing, just as our

[2] As Wittgenstein (1963) argued, for example, a cat navigating through a city's streets can only see the world from the cat's current point of view, whereas humans can remove themselves from their specific place and time, to survey and draw an overview or cognitive map of the city.

culture in turn creates models. The recursive nature of this loop suggests why it is difficult despite post-modern rhetoric to escape the modernist ideals.

However, this critique of the reduction approach does not suggest there is no value to abstract representation. Language as a system of abstract representation, for instance, that does not necessarily limit our ability to engage in rich communicative exchanges. Furthermore, technology design based on abstraction has been wildly successful in terms of new communicative potential, scientific discoveries, educational opportunities, economic development, and a host of other advancements. However, I wish to argue that the reduction approach needs a balance. The danger I believe is best expressed by Hayles's argument of the Platonic forehand and the recursive nature of representations and models. Once a model has taken hold it is very difficult to see beyond it or to challenge it, and without new models to draw from we run the risk of cultural stagnation.

This dynamic between models as both generative and restrictive is the same interplay we identified at Strategos under the rubric of orthodoxies. Orthodoxies, as discussed earlier, were defined as the conventional business practices and perspectives that identified a company and an industry. The mobile phone industry, for example, was once defined and directed by its market of primarily business workers. The mobile phone was either designed as a tool for extending the office or perhaps a personal safety device to be kept in the car for emergency phone calls. Thinking about the mobile phone as a fashion accessory flipped this conventional view and led to whole new markets and practices. Now, new conventions for conceptualizing the mobile phone as a device for enchantment, leisure, and game playing are beginning to take hold (McCarthy & Wright, 2004). Conventions are not inherently bad.

Conventions provide a ground on which common and shared practices develop, but conventions can eventually become limiting. Representations and models, which are the abstract articulation of conventions, must therefore be balanced with methods that evoke change.

The augmentation approach described above is one suggested balancing method to the over dependence on reduction. In an augmentation approach to the ineffable, the interface acts as a mirror or an amplifier drawing attention to complexity and uncertainty rather than trying to explain it away or simplify it. However, although a useful strategy, the construct of augmentation is perhaps not the right conceptualization of the balance I wish to strike. I originally thought of augmentation as the obvious counter approach to reduction, but just as the reduction approach depends upon abstraction and representation, so too does the augmentation approach. Let us return to the previous example of an affective computer that detects indices of frustration. In the reduction approach, the affective computer contains an internal model that defines what frustration looks like (in terms of discrete information like biometric impulses) and how to respond to it. In the augmentation approach, the affective computer is less prescriptive and instead only provides feedback to the user that some change in emotional indices has occurred. However, the augmentation approach also depends upon representations. The augmentation approach requires taking a point of view in terms of what indices may be meaningful to the user and must then taking a point of view in terms of how to represent this information back to the user.

I originally chose the term augmentation because it suggested a heightened awareness, a directing of attention toward something that was always there but perhaps had faded into the background. This then suggests a

design strategy, something that the designer is in control of and can manipulate. It is this locus of control that gets to the heart of what is required in contrast or balance to a reduction approach. In both the reduction approach and the augmentation approach, the designer is in control of how the ineffable is defined and experienced through the technology interface. In the reduction approach, the designer also maintains control over the meaning or the interpretation of the ineffable, whereas in the augmentation approach, the meaning or interpretation of the ineffable is co-interpreted between the designer, system and user. It is the opening up of interpretation that provides the needed balance to the reduction approach. The openness to interpretation acts against representations that only work in one direction to codify meaning and ultimately restrict new meaning, practices and perspectives from developing.

The Interpretation Approach

The development of the interpretation approach as a method for HCI is currently being explored in the work by Phoebe Sengers and Bill Gaver (Sengers and Gaver, 2005, 2006). Sengers and Gaver propose that the interpretation approach is not just critical for interfaces to the ineffable but all interfaces of interaction. Traditional HCI approaches tend to take a narrow view of interpretation, where interpretation is a problem to be resolved. Much of the past research in HCI, for example, is directed toward making the user's interpretation of a system coincide with the designer's intent, or making the system's interpretation of a user's actions coincide with the user's intent. Sengers and Gaver argue that interpretation is not a problem of matching interpretations but a process of constructing meaning.

As an example of the interpretation approach, Sengers and Gaver discuss the development of a project called the Home Health Horoscope, a sensor based system that provides daily readings reflective of the emotional climate or well-being in the home. Home Health Horoscopes is designed partly in response to smart home initiatives that follow what Intel Corporation refers to as proactive computing. Proactive computing follows the closed representation approach outlined in the previous section, where sensors are embedded in an environment, such as the home, with the purpose of learning inhabitants' patterns and eventually anticipating inhabitants' needs. A proactive home would conceivably be able to tell, for example, if grandma fell in the shower or forgot to take her medicine. As with other representation systems, the control is placed in the designer's hands and the intelligence or interpretation of the system is prioritized over that of the user.

In contrast, Sengers and Gaver propose using 'shy sensors', sensors that are shy not only in what they sense but in the control they are afforded to respond to this information. In the Home Health Horoscope system, idiosyncratic sensors are designed for a family's current way of detecting the well-being of their own home. The sensors are well known to the family and become part of the material for deducing what is happening – just as a closed door that is usually open is a signal that something is different and an invitation to speculate on what it means. The combined input of the sensors will produce a horoscope, coded for emotional content, at the beginning of each new day. The selection of horoscopes as one of the interfaces with the system is a deliberate nod to the shy sensing and interpretation approach. We all have experience reading into fortunes or horoscopes while at the same time holding a degree of skepticism for them. In other words, we can choose

to find meaning there or not: we (in general) tend not to take horoscopes as literal predictions or proclamations of truth.

The Home Health Horoscopes project uses both representation and augmentation in its effort to allow for more open interpretation. In terms of representation, certain indices are chosen to be proxies for emotion or well-being. These indices, such as amount of water used throughout the day or pressure sensed in a particular love seat, are given an emotional code based on what these events 'usually' mean. In other words, the emotional codes are abstractions or representations of typical practices. The fact that sensors are added to this everyday information amplifies or augments their importance in the home's daily rhythms. Also, the appearance of a slip of paper every day can stimulate reflection on the role of rhythms or patterns in the home and their contribution to the home's well being. However, interpretation is firmly established as a collaborative process. The ambiguous nature of a horoscope gives license to the inhabitants of the home to either question or accept the opinion of the sensor system.

The Home Health Horoscope system suggests there are design choices we can make in HCI that allow for more open interpretation. However, the idea of interpretive flexibility as advanced in the field of Science and Technology Studies (STS) undermines the role of the designer in this process to some degree. According to an STS perspective, the desire to design for interpretation may be construed as redundant (Pinch & Bijker, 1995; Oudshon & Pinch, 2003). All systems, according to the idea of interpretive flexibility, are re-interpreted and re-configured by users. Yet, the degree of interpretive flexibility appears to be qualitatively different in Intel's proactive home and the Home Health Horoscope. The implication of this qualitative difference is

apparent when the systems are evaluated. As discussed above, a proactive home must be right in its modeled inferences in order to be successful. The Home Health Horoscope is successful if it causes reflection on and active interpretation of the well-being in the home. However, this evaluation is less clear cut than the proactive home's benchmarks of accurate responses. Is the benchmark of success for the Home Health Horoscope that it created 'more' reflection than before? Or 'better' reflection? How would 'better' be defined? More engaged? More accurate? More longevity of interest? Would a sign in the kitchen asking "What is the emotional climate of the home today?" be considered more similar in spirit to the Home Health Horoscope or the Proactive Home? Would a random horoscope generator tied to no sensors at all be just as effective in causing reflection on the well being in the home?

Sengers and Gaver outline that although the idea of interpretation is not new to the field of HCI, considering it as a fundamental perspective requires new practices in design and evaluation. In this effort, they look to lessons from psychoanalysis, philosophy (particularly the fields of hermeneutics), and critical theory. I propose to add to this exploration theoretical approaches and perspectives from the field of communication. There are a number of reasons why communication should be included in this exploration of interpretation. Many designers for instance characterize the interaction between humans and computers as a form of conversation and communication theories provide insight into how conversations are maintained and negotiated. Secondly, communication theories offer insights into the conversations that not only happen with a designed system but the communication that happens through or around a designed system. The main reason in this work for including perspectives from communication is because of theories of communication as

a process of interpretation, a balancing act of convention and invention, syntax and semantics. We adeptly use language in everyday conversations and engage in everyday acts of meaning making and interpretation. Understanding this collaborative process of language use should provide insights into the design and use of technology systems for interpretation.

Driving Questions

The motivation driving this work began with an exploration of how interfaces to the ineffable are established and move through the development of new computer technology. Therefore, through the case studies I will illustrate how the ineffable is defined for two different experiences: art and affect. The application of technology for experiencing art has a long history whereas the application of technology for experiencing affect is a relatively new area of interest. By looking at both, I can describe how the dominant approaches to technology persist regardless of the maturity of the technology or the specific instantiation of the ineffable. The first set of driving questions concern how the interface to the ineffable is constructed and the implications of this configuration:

> Q1: How have the boundaries of the ineffable been configured for the experience of art and for the experience of affect? What is the dominant approach of interfacing with this configuration? What are its practical, political and personal implications?

I have argued that once an interface is established, a common approach is to try and formalize the ineffable into a codifiable representation. In the best case scenario, this approach can ultimately be limiting and in the worst case scenario the codification of the ineffable kills the very quality one is

trying to address. In contrast, I propose following the alternate emerging approach of designing for interpretation. The second set of driving questions then are concerned with a particular design approach to the ineffable:

> Q2: How do we design for co-interpretation? If systems are ultimately interpreted by users, what strategies enable the designer to play a role in anticipating or contributing to this conversation?
>
> Q3: How do we evaluate designs for co-interpretation? How can we move beyond one-off descriptive accounts of design and use and work toward a more systematic understanding of this design space?

The third set of questions looks at the interplay between communication theory and approaches to interpretation from this field and parallel or contrasting approaches in HCI:

> Q4: What insights from communication theory, particularly studies of language use, can we draw from for insights into the design, use, and evaluation of systems designed for openness to interpretation?
>
> Q5: What insights from the process of designing and evaluating systems designed for openness can we draw on for the field of communication?

These questions are all related to the topic of concern: interfaces with the ineffable. However, a final question revolves around evaluating my approach to tackling this question within a social science framework. As I am proposing to use design work as a research method, part of my analysis will be to evaluate and critique the effectiveness of this approach.

Overview of Work

This chapter outlines the area of concern by first explaining my personal connection to the motivating question of designing for the ineffable. I have subsequently defined the constructs I will explore and presented a number of areas where these constructs are currently under review. I have proposed that in order to design interfaces with the ineffable, an approach allowing for co-interpretation is required. As this is a new approach, more work is needed for understanding what this entails for design, evaluation, and ultimately theory development.

Summary of Approach

This work is an inductive approach toward exploring design as a process for critical reflection and research. I will begin with two case studies that each explore how technology is traditionally defined for a particular experience of the ineffable and through the application of reflective design, I will propose alternate design goals, strategies, and evaluation methods. The first case study looks at interfaces for the ineffable experience of art and results in designing applications not for dictating an experience of single art object but opening up the experience of art in the highly scripted environment of the art museum. I will provide a detailed account of two installations created by myself and colleagues in the HCI lab and discuss their iterative progress and responses both from visitors, curators, and ourselves as designers. The second case study revolves around the ineffable experience of affect. In this case study, I play the role of an evaluator but one who is very close to the design process as well. This case study looks at a particular installation for supporting the construction and interpretation of affective presence in an office environment. Therefore, the first case study will focus more on designing

interfaces and the second case study will focus largely on evaluating interfaces although both case studies contain elements of the whole process from inception to implementation to final review and future considerations. The importance of including both case studies is to attempt to draw more general lessons about designing and evaluating an interpretive approach to the ineffable. For each case study, I will review relevant literature, detail the design process, present evaluation results, and discuss implications.

Both case studies introduce issues that must be addressed for the interpretation approach of designing interfaces with the ineffable to advance in HCI. In particular, both case studies struggle with the goal of designing systems that are open to interpretation, and therefore open to unique and personal experiences where meaning is not dictated or determined a priori. I describe a resulting tension, for example, between the desire to be open and yet to still provide footholds for uptake. Furthermore, the goal of designing for openness challenges existing roles of the designer (of being in control and orchestrating experience) and goals of evaluation (of defining success as matching some pre-determined experience). In an effort to answer these questions, I take a step back to look for more theoretical grounding. In particular, I outline current changes in the HCI field for conceptualizing interpretation such as ideas of interpretive flexibility from STS (e.g. Bijker, 1995) and the idea of designing for multiple interpretation advanced by Sengers and Gaver (1996).

However, the view of user interpretation in STS tends to be one sided, looking at how stakeholders other than the designer appropriate designs in a multitude of ways that potentially diverge from the designer's original intent. This work does not pick up the question of what the designer should or could

do in order to work with (as opposed to shut down) this constant appropriation. The work of Sengers and Gaver makes advances in addressing new roles and practices of designers and to add to this perspective, I look to the field of communication. The reason for this turn is because of communication's own history in addressing ideas of interpretation and meaning making but in particular because of research into the design and use of everyday tools by everyday practitioners, namely the use of language in our everyday lives. By looking to the field of communication, I explore what this field adds to the new directions in HCI as well as suggesting how this new approach to interpretation in HCI can provide a process of inquiry for communication.

Intended Audience and Contribution

This work is presented to the field of communication but with a special emphasis toward researchers and practitioners in HCI. As a work that will draw across a range of disciplines (from communication, sociology, anthropology, cultural studies, computer science, and the arts and humanities) it will find most resonance with scholars who value an interdisciplinary approach as opposed to an in depth pursuit of an established tradition. It is also directed toward researchers interested in new qualitative methods for understanding acts of interpretation in communication. Although several methods are used and several iterations run with the systems, this is not an experimental study of main effects and significant differences. I believe experimental studies may be useful in later stages, but at this point of the research, the work is still largely exploratory and directed more at theory grounding and development.

As such, the main contribution of this work is to advance alternate design and evaluation strategies for interfaces with the ineffable as well as to

illustrate a new approach to research for the field of communication. Approaching the ineffable as something open to interpretation requires a fundamental rethinking not just of standard HCI methods but of what it means to design and what it means to evaluate systems in the first place.

Outline of Chapters

The goal of this chapter has been to provide the background motivation, define the focus of study, and present the driving questions behind the case studies and their approach. In chapter two, I introduce the first case study on designing technology for the ineffable experience of art. I will begin with a historical review of how the ineffable is conceptualized and debated in art museums, art, and regarding the role of technology in museums. I then present an interpretive approach toward developing a series of alternate types of designs that transform the visitor from passive recipient of information to an active participant in the construction of the museum experience. In chapter three, the case study is about the ineffable experience of affect and the design of technology for this experience. Again, I present a historical trajectory of conceptualizing affect and designing for affect before describing the design and evaluation of an open-ended system called Affector.

A key result from the case studies is the need for further exploration and theory development regarding designing for interpretation. Therefore in chapter four, I begin with an overview of work in the field of HCI on interpretation, drawing from the fields of STS, the arts, and the humanities. In particular, I look to studies in the field of communication for understanding everyday interpretive acts. I explore new understandings of interpretation in communication and the implications for design and evaluation methods in HCI. I conclude this chapter by reversing the discussion from what the field of

communication can add to HCI to identifying what the field of HCI, and in particular the practice of reflective design, can add to the study of communication. The concluding chapter provides an overall summary of and themes emerging from this work as well as looking forward to future studies and practices.

Chapter 2. Art and the Ineffable

"The emergence of mixed-reality technology marks a further step in our quest to control our own evolution, to redefine what it is to be human and to become actively responsible for the construction of our own realities."
– Roy Ascott

The quote above from interactive artist Roy Ascott reflects a belief in both the transformative potential of new technologies as well as in the distinctly human capability to engage in the creative and artistic pursuit of constructing new realities (Ascott, 2004, p. 113). This presents a view of new technology as supporting the ineffable capability of humanity for transformation. However, there is an alternate view of technology as well, one where technology prevents us from pushing toward new experiences and instead codifies existing standard practices. It is this tension between supporting new experiences and codifying existing practices that is at the heart of this chapter.

This chapter will survey how technology has been introduced into the art museum as art, as a tool for understanding art, and as an interface for reconstructing the experience of the art museum. The first two categories examine how technology is designed for experiencing the 'ineffable' communion with art, i.e. how technology influences the interaction with art, interactions that have been described as experiences of the sublime or the transcendent. The third category looks at the transformative potential of technology to support new experiences in the art museum, not necessarily experiences of an artwork, but new roles and practices for the visitor in the tightly scripted environment of the museum. In this study, I will draw out how

and why some new experiences are taken up in the art museum and others are not.

The case study for this chapter was inspired from an initial review of how new technology was designed for museum visitors. Despite rhetoric of communing with art as a transcendent experience, the design of technology aides was one primarily of information transfer. Supporting only information transfer positioned technology not as Ascott's tool for creating new worlds but as the alternate view of technology as a reification apparatus. Therefore, this case study details an approach, its obstacles, pitfalls, and eventual lessons learned, for building technology in the art museum environment to support alternate experiences.

Framing the Art Museum

Before turning to the case study, I will begin with a closer look at the context in which this case is situated, specifically in the art museum, and reintroduce the issues of the ineffable and interpretation. It is important to situate this work with an appreciation of how these issues have played out, and continue to evolve, within the confines of this particular institution. As Bell (2002) notes, there are enormous differences between the mission and experiences of different museum types, or ecologies in Bell's terms, such as art museums versus science and natural history museums versus cultural heritage sites. Since this case study takes place in an art museum, this is where I will focus my review, although occasionally I will draw from the insights of other museum literature where relevant. Just as there are enormous differences between types of museums, there exist vast differences between types of art museums as well in terms of focus, funding (i.e. private or public), size, location, and a host of other variables. In reviewing the art museum, I will

draw out major themes but will gloss over some of the distinguishing characteristics until discussing the specific museum where this case study is situated. In sum, this review will not be an attempt to present an exhaustive history or critical analysis of the art museum, but an attempt to highlight some of the important discourses with regards to the different roles and practices in the museum before turning to the role of technology.

The earliest collections of art resided in monastic buildings or houses of worship and aristocratic palaces. The term museum is thought to derive from the Greek mouseion, a “temple dedicated to the Muses, the nine goddesses of inspiration, learning, and the arts.” (Pitman, 1999, p.1). Eventually, art artifacts housed in religious institutions made their way to the public, for example the Capitoline Museum was founded in 1471 from artifacts donated by Pope Sixtus IV. Collections from artistocrats began their journey to the public sometime later culminating in the ‘paradigmatic turn’ from princely palace into a public art museum of the Louvre at the height of the French Revolution in 1793 (McClellan, 2003, p.5). Besides being a traditional place to start a history, namely at the beginning, this origin story and etymology introduces some of the main themes that have continued throughout the art museum’s history, namely issues of access, connection with the divine, and learning.

From these auspicious beginnings of privilege, during the Renaissance, art museums were the ‘cabinets of curiosities’ and the parlor room art of individuals. The cabinets of curiosities, as the name suggests, tended to be an odd assortment of man-made artifacts, jewels, and natural specimens, high art and mere trinkets, all combined together. One of the first examples originated with the private collection of the Tradescant family in the 1600s, which was gifted to Elias Ashmole and subsequently passed onto Oxford University in

1659 to establish the Ashmolean Museum. Two important details that historians of museums often point out regarding this period were the lack of labels and the conversations stimulated around the objects (Hunt, 1998; Kester, 2004; Pitman, 1999). The lack of labels is often referenced as an example of letting the objects speak for themselves and arouse wonder and curiosity naturally whereas the conversations engendered around the paintings are generally held as drawing room conversations among people with similar backgrounds and experiences. “Painters and landscape artists,” Kester writes, “shared a symbolic vocabulary with their patrons. The objects and environments they created facilitated exchanges that were central to the life of an (admittedly elitist) community of viewers.” (Kester, 2004, p. 26). In this context, there was no need for labels or aides for interpretation as viewers and artists shared a common ground for communicating through art. In other words, art objects were considered ineffable in the sense that there was no need for explanation, the communion was considered immediate. A final detail to note of this period is that most of these collections were restricted to aristocrats, wealthy individuals, members of the clergy, and scholars (Pitman, 1999). It is not until the mid to late 1700s that societies such as the Salon in Paris and the Royal Academy in London began to present their members’ collections to the general public.

As collections grew and access to the public expanded, the perceived need for ordering the collections crept in, the mandate of the museum was refined, and the professionalization of the museum curator began. Values of order and hierarchy identified with Enlightenment and later Victorian values began to appear through clear labels, spatialized divisions, and concerns with traffic flow through the demarcated space (McClellan, 2003). In terms of

mandate, art museums differentiated themselves from the commercial art houses providing entertainment[3] and from applied art museums. As an institution reportedly open now to the general public, the mission for the art museum was to contribute to the moral and intellectual refinement of all people.[4] The method of this refinement process was still viewed as a transcendent, or ineffable, experience - mere exposure to refined objects would lift people to a state of enlightenment (McClelland, 1993). As Matthew Prichard, assistant director of the Boston Museum of Fine Arts in the early 1900s, stated: "The Museum is for the public and not for any caste or section of it, whether student, teacher, artist or artisan…Joy, not knowledge, is the aim of contemplating a painting by Turner or Dupré's *On a Cliff*…in accordance with the teachings of Aristotle, who recognized that the direct aim of art is the pleasure derived from a contemplation of the perfect" (cited in Wallach, 2003, p. 103).

Because of the dominant belief that authentic works of art could serve as "messengers of universal truth and beauty" (McClelland, 1993, p. 19), the main thrust for curator scholarship and standardization then revolved around the quality of selection and methods of display. Most of the aides for interpretation provided to visitors were aides in the sense of promoting the gaze or beholding: a holy communion between the viewer and the art. Although labeling increased throughout the collection, these were largely for

[3] In the U.S., these museums were called dime museums (Pitman, 1999) and P.T. Barnum had a famous variation of these with a mass of collections and curiosities acquired from various sources. Pitman (1999) suggests that Barnum's sensibilities for shock, intrigue, and scale anticipated the contemporary museum's blockbuster movement.

[4] From a 1953 UK Parliamentary report regarding museums, as reported in (McClelland, 2003, p. 8). Note that this report drew from the sentiments of John Ruskin who felt the museum should provide examples of 'perfect order and perfect elegance…to the disorderly and rude populace.' (ibid.)

classification purposes and the architecture and interior design began a progression toward the 'white cube' mentality in an attempt to provide a neutral backdrop for the art itself. The connoisseurship or appreciation of art, what is also referred to as an essentialist position (Pierroux, 2005), was valued over developing an understanding of art history in general or an individual art object's context in particular.

The distinction between essentialist and contextual positions regarding art became embodied in both separate museums and in separate museum departments. In the early 1900s, critics of the elitist development of art museums formed alternate institutions with a social and activist outlook, concerned with their relevance for the particular community's interest and needs. Likewise, within art museums themselves a split developed between the curatorial and the education departments. Although most museums claimed to value each equally, the education departments were often relegated a secondary status, "often housed in basements and staffed by women [only], [while the male] curators became increasingly concerned with refining conditions of display." (McClelland, 2003, p.25). The view that masterpieces could speak for themselves and that providing too much information about an object would get in the viewer's way dominated museum sentiment throughout the first half of the 1900s and continues through to today. In other words, the dominant point of view was that the ineffable nature of art defied explanation.

Partly in a move to redress the balance of essentialism over contextualism, partly in response to declining museum attendance and questions of relevance, and partly due to the zeitgeist of social and political activism of the 1960s and 1970s, changes in the declared orientation of the art

museum began to appear around this time. Museums began making new efforts, mandated to some degree by government funding agencies, to expand and diversify the museum visitorship, through varied programs and exhibits, educational offerings and public outreach. One such effort involved adding more temporary exhibits, shepherding in what Wallach (2003) calls the Blockbuster age of the art museum, beginning in 1963 with the *Mona Lisa* at the Metropolitan Museum in New York City. The expense of staging such shows led to the need for more corporate sponsorship and, according to McClellan, an interest in shows with a high selling profile, "namely Impressionists, mummies, and anything with gold in the title." (McClellan, 2003, p. 33). Blockbusters would eventually take the shape of universal crowd pleasers, such as Monet's and Vermeer's works, or alternatively crowd dividers such as the provocative *Sensation* exhibition, with cut-up sheep, portraits of child killers, and soiled bed sheets, at the Royal Academy in London in 1997. Crowds are drawn to the 'Yes, we all agree this is art' as well as the 'I can't believe this is art' shows. The ineffable seems to shift here then from the sublime to the uncontested or the controversial.

Throughout this introduction so far, the voice of the visitor has been absent, or only indirectly referred to as a mass public. This is largely reflective of museum studies literature, where the visitor comes after discussions of art and the unique role of the art museum as an institution for collection, preservation, and education. Visitor studies literature is often focused on the numbers and profiles of visitors, and one common charge is that the growth of visitor attendance is due to increases in the educated middle class, but that the profile of visitors has not changed much over the years (Rice, 2003). Behind the presentation of statistics, the visitor appears as a faceless mass,

referred to during the Enlightenment as the poor downtrodden wretches living on the edge of anarchy for whom the museum would be a refuge. This perception of visitors en masse continues in more contemporary critical studies, ostensibly attacking the power elite of the museum, where the visitor is portrayed as moving inside the modern panopticon (Bennett, 1995), behaving as swarming locusts around masterpieces or as cultural livestock corralled through exhibit halls (Baudrillard, 1994), or building their cultural capital and status as a member of the in-group (Bordieu, 1984). In contrast to these accounts, Rice (2003) and Prior (2003) both argue against portraying the visitor as a mindless dupe, claiming that visitors just as likely come in with their own agendas and will pick and choose the experiences and messages of interest to them. The visitor's agenda may range from studying a particular piece, seeking the transcendent experience, eating lunch, finding a quiet space to meditate, ticking off a tourist check list, killing time, or simply looking for a clean lavatory.

Falk and Dierking (2000) argue that one reason why museum education studies have not made more progress is because of the predominant reductionistic view of both the visitor[5] and the process of learning. Most studies have approached the visitor as a blank slate entering the museum and the learning process as one of information transfer. There is a new emphasis on expanding the learning studies approach to recognize individual viewer motivations and prior experiences as well and approaching learning as a durational process, not a self-contained visit. Falk (1999) references science-

[5] During a visit to the Smithsonian American Art Museum's label writing department in 2003, I learned that the writers are instructed to produce copy for the average eight year old. Therefore not only are visitors generally faceless but they also haven't reached puberty. There are obvious reasons why this guideline is helpful but it further underscores how much of the work in visitor studies is about the 'mass' and not the individual.

center director Tom Krakauer's comment that museums teach the public "what they almost already know" (Krakauer, 1999, p. 7). Although Krakauer refers to science museum visitor, the comment echoes experiences in art museums where people draw from their existing backgrounds and experiences. Critics of the essentialist approach to art appreciation argue that this works for a limited population who enter the museum with an understanding of art history (McClellan, 2003). More to the point however, is the idea that the museum as an institution and the art it holds is more open to interpretation and a variety of experiences, and that the visitor is also more complex than many studies acknowledge.

To this point, just as social critics have caused a rethinking of the art museum and its role, and just as new critics are calling for a more qualitative understanding of visitors' active roles in museums (Prior, 2003; Rice, 2003), so too are there critics calling for a more complex understanding of the art museum beyond the view of the repressive and "evil political side" (Rice, 2003). In Rice's examination between the gap of museum theory and practice, she notes that by the time a theory has formed, practitioners have moved onto new practices both informed from their own experiences and drawing from such critiques. She acknowledges the gain from greater awareness of the power and politics of an art museum's role as an institution, but she also affirms that just as the visitor is not a mindless dupe set to play out a predetermined script, so too are museum practitioners more empowered in their ability to challenge and work within or around imposed constraints (Rice, 2003). Curator's today are just as saavy about the criticisms of museums and language of power discourses with an increased awareness due to not only social critics, but art that began in the mid 60s to take the institutions of art as

their subject. Diamond (2005) argues that many new curators have arrived in their positions from the periphery of the established art world, often influenced by digital art, and bring with them new ideas on the role of the curator acting as a producer, facilitator and even co-collaborator with artists and visitors as opposed to arbiter of art and non-art. Prior (2003) and Gere (2004) both argue that curators are aware of pursuing a more dynamic role, acting not as historical conservators lagging behind and merely reflecting society, but playing a performative role as well in creating the collective past and therefore influencing the future.

The debates and issues marking the birth of the art museum as an institution continue into today, namely questions of access, roles of participants, the primacy of an art object, and debates regarding how to support the ineffable communion (if it even exists) with art. McClelland (2003) and Rice (2003) remind us that the essentialist and contextualist positions, the argument for the non-discursive nature of art and the drive to provide more interpretive aides is an ongoing tension. Rice points to a perhaps curious flipping between the traditional proponents of such views with curators beginning to present more and more information on museum walls, for instance, and educators adopting movements such as the Visual Thinking Strategies (VTS). Rice characterizes VTS as "an anti-information movement…founded in research and fueled by a frustration with the perceived inadequacy of information to help visitors decode and derive meaning from works of art" (Rice, 2003, p. 91).

One primary conclusion from this brief historical account is the need to continually recognize the complexity of the at museum context. Visitors are not categorically cultural dupes, nor are curators the wicked arm of the institutional

elite. Perhaps more interesting is to ask where these characterizations come from and why they persist. In the subsequent section on technology design, I'll demonstrate how the designs often tend to pick up on conventional, categorical views of the art museum rather than its rich complexity of paradoxes and tensions. As Boniface and Fowler summarize (2003): "Museums are wonderful, frustrating, stimulating, irritating, hideous things, patronizing, serendipitous, dull as ditchwater and curiously exciting, tunnel-visioned yet potentially visionary. The real magic is that any one of them can be all those simultaneously" (Boniface and Fowler, 1993, cited in Prior, 2003, p. 64). Finally, the introduction of new technology both as art and as a tool or interpretive aide has added new dimensions to the ongoing debate about the role of art museums.

Technology and Art in the Museum

Perhaps the one continually defining characteristic of an art museum in the face of shifting curatorial, educational, and visitor roles is the simple fact that the museum houses art. Although many critics may today argue that more art exists outside the museum than inside, and although consensus may not exist over a given individual object's status as art, what remains is that objects inside the museum have been stamped as art by the establishment. Before examining the influence of digital technology[6] on art, it is important to review some of the important transitions in what objects enter the museum and become art. Just as a brief history of the art museum cannot pretend to be exhaustive, a cursory history of art, and a fragment of that history as well, will

[6] One could argue that all art is made through technology of different forms, in fact, Clement Greenberg, modern art commentator during the 1950s and 1960s, suggested that the progression of art is actually defined by the technology (or medium) of the day – for example, modern art's progression was its ongoing reaction to dismantling or breaking out of the 2 dimensional structure (Kester, 2004, p. 27).

leave many passages unexplored. I will start with a focus on art that troubles the boundaries of the museum but eventually becomes assimilated before moving into a discussion about the introduction of digital technology and its implications for the roles and practices in the museum.

Artists have been challenging the role of the art museum and the canon of art it cultivates since the early 1900s (Rice, 2003). For example, Marcel Duchamp, who referred to the museum as a mausoleum, created one of his most famous works in jest for an exhibit of avant-garde art. His “Fountain”, an actual urinal, so angered the panelists of the exhibit that the piece mysteriously went missing. Ironically, the same piece now holds an iconic place in the art museum, currently on display at the Tate Modern in London. Contemporaries of Duchamp, the Dadaists and the Surrealists, created art not only in reaction to the atrocities of the first World War, which some attributed to the culmination of the Industrial Age mentality, but they also created art in reaction to the predominant view of the Enlightenment aesthetic cultivated by museums at the time. The Surrealists positioned themselves against reason and dualism. Instead, they created art from or to represent the subconscious, dreams, and chance in order to evoke the imagination of the viewer. Artists of this persuasion seemed to be saying that if there is an ineffable communion with art, the interface is not met not through reason or cognitive processes separate from the body and emotion. Examples of Surrealist work include André Masson’s automatic drawing, where his hand would move randomly across the page as a means of expressing the subconscious, and René Magritte’s *La trahison des images* (The Betrayal of Images 1928-9), a picture of a pipe with the words underneath: “Ceci n’est pas une pipe” (This is not a pipe). Kester refers to this as a growing movement of the avant-garde against

objectification and normalization in the experience of art and a view that art should “radically challenge the very possibility of rational discourse” (Kester, 2004, p. 12).

In contrast to the art of Renaissance and Enlightenment ideals that promoted communication between artist and viewer around a shared symbol system, artists of the avant-garde sought to challenge the viewer’s expectations. This provocation, denial of a common language, and resistance to easy assimilation had the added benefit, or so it was believed, of eschewing the commodification of commerce (Kester, 2004). However, although proposed as a break from the past, the view of art that can speak for itself shares with its predecessors echoes of a type of elitism. The abstract expressionist Mark Rothko and his fellow contemporaries[7] wrote that “critical exegesis” were for the “simple minded” and that “no simple set of notes can explain our paintings” as they resisted translation and were from “the world of imagination, fancy-free, and violently opposed to common-sense” (cited in Kester, 2004, p. 39-40). It is only through abandoning the familiar (e.g. familiar modes of communication, familiar means of security) that, according to Rothko, “transcendental experiences become possible” (cited in Kester, 2004, p. 40). Here we have the idea of the transcendent again, although not through cognitive or discursive means, and the idea of exclusion or accessibility to only an elite. The elite in this case are the anti-establishment, those who are aware of the establishment and comfortable with railing against it.

Another example, offered by Kester, of artists not trying to ‘say anything’ or communicate with the viewer their own intentions but let the art

[7] From a statement issued to the New York Times in 1943 by Mark Rothko, Adolph Gottlieb and Barnett Newman.

stand on its own is the work of Jackson Pollock (Kester, 2004). Kester argues that Pollock was inspired by community art murals, a form of expression that relied heavily on shared symbol systems and communication between artist and audience. What Pollock took however was the scale of the mural and placed it in the gallery – where the form of the art itself was to immerse the viewer into the painting. "For Pollock and Rothko the painted image became an elegy for the lost promise of a more fully public and collective art practice (rendered impossible by the failure of communism and the unfettered advance of the market system)" (Kester, 2004, p. 40-41). However, the claims of non-discursiveness did not stop critics or curators from writing about abstract expressionism and eventually these forms found their way into popular museum exhibits, drawing a crowd due not only to its form but to the story around the form. Furthermore, its non-discursiveness did not save it from the commodification of post-cards and tee shirts.

A number of movements in the 1960s and 70s including minimalist, conceptual and performance art[8] began to bring the idea of communication between artist and audience back into the picture. The work of minimalist and conceptual artists often referenced the context of the gallery in which they were situated or required the visitor to take different positions in order to engage with the piece. Wen-Ying Tsai's sculptures of stainless steel rods, for example, with a light strobe flashing across them responded to the proximity of the visitor and sounds like the clapping of hands (Popper, 1975, p. 214). Critics holding onto the tenets of abstract art discounted this type of expression as it gave visitors cues in terms of how to participate and therefore distracted viewers from the transcendent (Kester, 2004). Many conceptual

[8] These classifications are slippery and artists and their work slide between them.

artists used their art to evoke change, and change specifically of institutions such as museums. Hans Haacke, for instance, famously proposed (and was denied) an exhibition showing the real estate holdings of all the museum trustees at the Guggenheim Museum in New York City in 1971 (Gere, 2002). Around this same time, in 1967, Herbert Marcuse, then a professor at the University of Berkeley, proposed that the role of art should be for the "total reorientation of life in a new society…not political art, not politics as art, but art as the architecture of a free society" (cited in Popper, 1974, p. 272) – a quote reminiscent of the one from Roy Ascott that introduced this chapter.

This is the same time period, shortly after World War II, when the theories of cybernetics, information, and structural linguistics that were influencing the development of computer technology were also influencing artists (Gere, 2002). Gere specifically points to the work of John Cage as being concerned with the same ideas as mathematicians Shannon and Weaver who were separating the message from the medium and concerned with signals, symbols, and noise. As a musician, much of Cage's work takes place outside of the art museum yet his work is important to highlight because of its influence on all forms of art. Gere, for example, traces the interactivity of today's digital arts to Cage's composition 4'33", premiering in 1952 at the Maverick Concert Hall in Woodstock. Throughout the three movements of the piece, the pianist, David Tudor, sat at the piano guided by a stopwatch and turned the pages of the written score (which simply said "Tacet" -- silence on the part of the performer). In other words, Tudor played not a note. The inspiration for the piece, according to Cage, came from an earlier visit to an anechoic chamber at Harvard where he could hear only his heart, suggesting to himself that there is never true silence (Gere, 2002). Gere, and others,

interpret this piece as interactive because it requires participation from the audience to fill in the void with the sound of their own heartbeats and other ambient noise. This reliance on the audience is a hallmark of other works of this period such as the all white canvases of Robert Rauchenberg and the rise of happenings and performance art that played deliberately with the relationship between artist and audience. Whereas in abstract art, the artist diminished into the formalism of the art, in minimalist, conceptual and performance art, this formalism moves more into the background and the role of the view moves into the foreground.

This more active role of the viewer however is not immediate or a given. In this new space of defying conventions and explanations, the challenge is in bringing viewers into this process in a meaningful way and without alienating them. Cage for example talks about losing many friends over 4'33" – people who were sympathetic to the aims of avant-garde art but still felt this piece had gone too far[9]. Whereas in the ineffable experience of art in the Enlightenment people were assumed to 'get it' because of a common sense of beauty and the aesthetic, in the avant-garde, the ineffable experience of art suggests there is no common sense. Yet, people are still presumed to 'get it' through the experience, not through explanation. Rice suggests that in the 1980s artists began "to not only question collection, installation, and fundraising practices but the interpretive practices of the museum as well" (Rice, 2003, p.81). Rice gives the example of performance artist Andrea Fraser's persona, Jane Castleton, who would give 'tours' at the Philadelphia Museum of Art in 1989. During the tour, Fraser as Castleton would lead visitors around to

[9] Cage conversation with Michael John White (1982), in Kostelanetz 1988, 66, in: Solomon, Larry J.: The Sounds of Silence, in: http://www.azstarnet.com/~solo/4min33se.htm)

explore the museum's highlights including places such as the restroom or coat room all the while affecting a typical docent's speech using language from art history critiques, the museum's catalogue, and her own additional commentaries from people such as Michel Foucault. Rice points out that Fraser eventually abandoned her performances as she became uneasy about the distinction between those on the tour who 'got it' and came to see the performance or who clued in during the tour and those who 'didn't get it' and were subsequently the butt of the joke.

This tension between implicitly getting something or indirect knowing and understanding comes up again in the work of Joseph Beuys an artist associated with the Fluxus movement and famous for the slogan 'everyone is an artist.' In an interview regarding his work Beuys stated, "Art is not there to provide knowledge in direct ways. It produces deepened perceptions of experience. More must happen than simply logically understandable things. Art is not there to be simply understood, or we would have no need of art. It could then just be logical sentences in a form of a text for instance. Where objects are concerned it's more the sense of an indication or suggestion" (Shellmann, 1977, p.20). Knowledge without understanding is another way of describing art as ineffable. This still begs the question however of how a viewer gets into this indirect but deepened experience. The role of language and symbol systems as a common path to understanding and communication is challenged through other artists of this period as well such as Sol LeWitt's work from the late 60s entitled "Ten thousand random straight lines drawn by one draughtsman, 1,000 lines a day, for ten days, within a 120" square". The title of the work constituted the work itself in perhaps an exaggeration of

Beuys' comment and the extreme of conceptual art that suggests the idea of art itself is enough to classify as art.

LeWitt's instructions could be viewed as a commentary on the emptiness or futility of explaining the ineffable nature of art or alternatively it could be viewed as an early precursor to algorithmic art. Gere places this piece at the end of the decade, the 1960s, when cybernetic thinking, computer art, and collaborations between artists and technologists had enjoyed a brief period of ferment. The first computer art exhibition was held in Germany in 1965 for example and in 1967 artist Robert Rauschenberg and engineer Billy Kluver formed Experiments in Art and Technology (EAT) (Gere, 2002). In 1968, EAT hosted a competition in technological art and the first prize went to Jean Dupuy's Heart Beats Dust which was an apparatus that worked only in response to the visitor's heart beat. (Popper, 1974, p. 219-220). Dupuy wrote: "Is there not a basic difference between an object which is presented as a physical experiment in the Palace of Discovery (Science Museum) and the same object presented by an artist in a gallery or art museum? If some artists, when they acquiesce in making 'technological ready mades', manage on occasions to achieve this basic difference, others go much further and adopt with regard to technology that distance which often allows them to happen upon amusing, absurd or occasionally mysterious relationships" (in 'Pourquoi l'art et la technologie cited by Popper, 1974, p. 220). Dupuy's quote presages the question asked by many curators today in terms of whether digital art is more science than art[10].

[10] For instance as of March 2005, in the city of London, the only museum with a permanently installed collection of digital artworks is the Science Museum (Graham, 2005).

Around the time of Dupuy's installation, in 1968, the Institute of Contemporary Art in London curated a show titled Cybernetic Serendipity: The Computer and the Arts with three sections of work on display. Section one had painting, art, animations, and music all generated by computers built by engineers. Section two had technological machines, cybersculptures, and robots built by artists. Section three had machines demonstrating the use of computers, such as an IBM computer for making airline bookings[11]. This stratification of the installation is interesting in terms of defining art. The first section appears to define art by the product, i.e. engineers producing artifacts in a familiar art form. The second section, by the artist, i.e. the product of an artist's work is art. The final section however seems to define art through the gallery walls, i.e. what is selected by a curator for an exhibit becomes art.

The ideas and fashion of cybernetics during the 1950s and 1960s, however, soon became the target as opposed to the inspiration of artists. Just as artists reacted to the order imposed on complexity and chaos during the Industrial Age, artists also began reacting against the order and instrumentality imposed through the systems based thinking of cybernetics (Gere, 2002). Cybernetic artists or technology artists were beginning to be sidelined in favor of conceptual artists[12] and artists such as Roy Ascott began moving from cybernetics to theories of second-order cybernetics and ideas of poeisis. From this period, into the 1970s and 80s, computer art and practices combining art and technology became more marginalized (Gere, 2002), although there

[11] for an account: http://www.akademie-solitude.de/stuttgart1960/3_text_reich.html

[12] Gere (2002) relates the anecdote of an exhibit titled 'Software, Information Technology: Its Meaning for Art' at the Jewish Museum in New York in 1970 with conceptual artists such as Hans Haacke and Joseph Kosuth alongside multimedia and computer specialists such as Ted Nelson and Nicolas Negroponte. Later in the same year, the MOMA in New York curated a similar show yet only the conceptual artists were present.

remained room on the margins for growth from organizations supporting new media such as the Ars Electronica Festival founded in 1979 and the Zentrum für Kunst and Medientechnologie (ZKM) founded in 1980. These efforts focused largely on video arts but were well placed for the resurgence of interest in digital technology during the mid 1990s with the explosion of the World Wide Web.

With the rise of the internet, net.art began exploring many of the same issues and using similar methodologies of their predecessors such as the correspondence art of the Fluxus movement and the randomness of Surrealism. As the name suggests, net.art takes place through the internet and therefore not in the museum, but its developments are beginning to challenge some of these boundaries. An illustrative example of net.art is Silophone, started in 2000, by [the User], a collaboration between architect Thomas McIntosh and composer Emmanuel Madan. Silophone takes place by connecting the net to an abandoned grain silo in Montréal that has been reclaimed for public performance. People from around the world can submit, via their phone or the web, sound files to the silo and then listen to their choice of sound as it reverberates through and is transformed by the interesting and unique acoustics of the abandoned space. As of December 2005, there were over 15,000 sound contributions that could be played at any time ranging from Vivaldi's La Primavera to original music to recorded dog farts. As [the User] explains, Silophone "combines sound, architecture, and communication technologies to transform a significant landmark in the industrial cityscape of Montréal."[13] Silophone represents many of the characteristics of net.art: collaboration between artists across disciplines, collaboration with the

[13] http://www.silophone.net

distributed audience, an open-ended or durational performance, a site-specific creation of place and a nod toward social activism. It is many of these characteristics of net.art that challenge its inclusion in a museum space.

Beyond the net, other digital arts practices such as robotic art and art that plays with the concepts of artificial intelligence and artificial life also tend to elude the museum walls. Natalie Jeremijenko's Feral Dogs for example works as a type of activist art, or a social sculpture in the Beuysian sense. Jeremijenko works with local communities to appropriate robotic dogs toward community goals such as locating and documenting toxic wastes in the local environment[14]. The dogs are fitted with sensors for their task, but this is a performance as well and one additional critical modification is a camera to document the community event of releasing the dogs into the wild. Unlike most robots who take after their 'real' counterpart and use cameras for optical like perception, in the Feral Dogs, the camera sits at the opposite end in the dog's hindquarters in order to film not what the dog sees but the people following the dog and their narration about what is happening. The role of the dog as a collaborator in the performance is similar to the idea of alien presence that Michael Mateas uses in his systems for Expressive AI (Mateas and Romero, 2005). Alien Presence, rather than artificial intelligence, suggests that the role of the agent or system is markedly as an 'other', not simply a computational machine returning expected results and not an authoritarian system that vies with our own intelligence. Instead, the work of many digital artists such as Jeremijenko and Mateas requires collaboration between the artist, the audience, and the system.

[14] http://xdesign.ucsd.edu/feralrobots/

In sum, avant-garde art, and specifically the introduction of technology, has challenged the institution of the museum from the inside and outside. Digital art specifically challenges existing taxonomies, crosses museum departments (and therefore is difficult to find a home or champion), and its open-ended durational nature requires a different type of exhibition (Graham, 2005). Gere notes that although digital art tends to be excluded from the art museum (Gere, 2004) it explores many of the same issues and techniques of its predecessors who have since earned a passport stamp into the museum (Gere, 2002).

Two important new threads however underscored by Kester (2004) are the dialogical and the durational emphasis of this new art form. As Ascott states, “Ours is a work that is dialogical…canons of Connectivity, Immersion, Interaction, Transformation, and Emergence. Meaning is created out of interaction, and dialogue can transform attitudes and behaviors” (Ascott, 2004, p. 112). The dialogical suggests a different type of interactivity than that first explored by Cage between artist and audience, one where gross demarcations between those who get it and those who don’t seems more troubling. Yet at the same time there remains a spirit of not simply explaining art in the didactic sense but in meaning becoming constructed through use. This durational and performative nature of art suggests further challenges for how this could be communicated, in a non-didactic fashion, within the confines of the museum and a museum visit. It may be that digital art resists the constraints of the art museum or it may play out that the museum also continues to evolve with new forms of expression.

The notion of the ineffable and art during the Enlightenment was one where an essentialist meaning could be communicated and known through our

common sense of cognition. It was recognized that the ineffable of art would not be understood by all, but that the universal potential was there. Those who did understand it were aided by a shared symbol system with the artist for communicating the Englightenment values of order, precision, and harmony with nature. The idea of the ineffable and art shifted during the diverse period of avant-garde art. During this time, communion through a common sense of cognition was contested and art began challenging shared symbol systems. The artist's intent or message ostensibly faded into the background and the form or idea of the art became preeminent. As John Cage said, "I have nothing to say and I am saying it, and that is poetry." Although this form of art may still require a shared symbol system, for instance knowing what canon it is reacting to, the emphasis is a move from cognitive knowing to bodily or affective knowing. But it is again a kind of knowing where the meaning is universal – perhaps not knowable by all but a universal meaning even if this meaning is 'nothing.' Dialogical art however has become more concerned with meaning that is constructed, not necessarily communicated. The ineffable in this sense then is the unknown of what could be – a potential that perhaps remains open for each new encounter. In the following section, I will now turn to how technology enters the art museum as a tool for understanding the range of art from the Enlightenment through to the Dialogical.

Technology for Art in the Art Museum

Digital technology has played a role in redefining the art museum through its influence on art practices but also through its uptake as a tool in the art museum, whether as a tool for preservation and collection management or as an interpretive tool for visitors. I will focus on this latter development, and although technology as an interpretive aide in the art

museum has taken many forms[15], I will focus on the most recent addition of digital technology to the art museum's toolkit in the form of context-aware computer guides. Whereas early laserdiscs and CD-ROMs and later the use of the World Wide Web focused on supporting virtual visits to the museum, and providing additional interpretive assistance to the visitor at a remote location, context-aware systems generally focus on the presence of the visitor in the physical art museum space. Although information kiosks and on-site micro-galleries also support information and educational needs inside the museum, context-aware systems provide the added benefit of moving with the visitor rather then being rooted to one spot.

In this way, context-aware computer guides most closely resemble the audio guides, in particular the digital audio guides, that allow for viewing objects in any order as opposed to a pre-defined sequence. Context-aware guides extend this functionality with the added feature of maintaining some sense of the visitor's context, variably defined to include things such as location, path, and preferences. Some context-aware guides will also include a visual element in addition to the audio channel. In sum, the context-aware guides in museums can be marked by their characteristics of portability, multi-media support, and some degree of customization and personal choice. In this section, I will describe a characteristic context-aware guide and then introduce some of the issues regarding interpretation and the ineffable that the introduction of such guides has introduced into the space of the art museum

[15] A broader definition of technology would require looking at use of lighting, space configuration, signage, brochures, etc. that have been part of the curators, designers, and educators trade to manage and shape the visitor's experience. Anderson (1999) notes that some of the earliest visitor manipulated technology in the museum existed in the mechanical form of spindles and levers used to rotate statues in order to see them in different light or from different positions.

as described above. I will outline a number of recent attempts to address these issues and end with how the case study of this chapter approaches the issues from a different angle.

Just as artists kept pace with developments in new technology as described in the previous section, museum professionals have also been at the forefront in the adoption of technology as tool. Preservationists began using database technology in the early 1960s to help with the tracking and organization of collections and new technology continued to be explored behind the scenes and on the floor. The first handheld interactive tour for visitors, the iGo on an Apple Newton was piloted at the Minneapolis Institute of Art in 1994, just one year after the Newton was launched (Amirian, 2001). Perhaps because of their high profile within the community (providing good marketing and PR value) and because of their somewhat closed conditions, museums are a popular playground for the showcase and exploration of prototype technology tools. The Smithsonian American Art Museum's Renwick Gallery in Washington D.C., for example, was among one of the first art museums, and public spaces in general, to test the latest advancements in handheld technology with a context-aware guide for their contemporary craft collection in 2000. I worked with the Renwick Gallery through the Cornell Human Computer Interaction Group during this time and it is this project that will provide a prototypical example of context-aware guide design, use and evaluation in the art museum[16].

The Renwick Gallery Handheld Education project began with the objectives of wanting to help the casual visitor learn more about the 'hidden

[16] This example is drawn from a much longer evaluation of the Renwick's design and use of their handheld guides, see: (Boehner, Gay, and Larkin, 2005).

secrets' of the objects. The casual visitor was described by the staff as someone going through the motions of the museum visit, wandering from piece to piece but not really sure what to look for or how to connect with the objects on display. In terms of the 'hidden secrets', these would be revealed in two ways. First, many of the objects must be manipulated in order to be understood but the goal of conservation prevents inviting visitors to handle the objects. For example, the "Bureau of Bureaucracy" by Kim Schmahman is a large bureau cabinet with fake doors and drawers that open into each other at cross-purposes. By providing an animation on the handheld device, visitors can now experience the piece as opposed to having a text description explaining what the piece represents about bureaucracy.

The second type of hidden secret revealed by the guides is the voice of the artist and a view into the piece's beginnings. As a collection of contemporary craft, the Renwick had the opportunity to work with the living artists to interview them and often film them in their studio creating their crafts. Because of the multi-media support of the handheld guides, these video clips could be provided to the visitors. One of the metaphors the designers of the system used was that they were creating mini-TVs where the programming featured the artists themselves. In addition to revealing the hidden secrets, the designers also described the manner in which these secrets would be imparted. On the one hand, they wanted people to 'experience' the secrets, suggesting an active and exploratory role for the visitor, and on the other hand they wanted it to be like 'television', suggesting a somewhat more passive role for the visitor. But they also discussed wanting the guides to use their location-aware functionality to act as a "magical mind reader" (Boehner, Gay, & Larkin, 2005, p.222). In this sense, the device was meant to surprise the visitor by

providing the appropriate information or potential for exploration at the right time.

The evaluation of the Renwick handheld guide measured its success against the original design objectives. In particular, the designers sought evidence that the guide did in fact appeal to a general visitor where general in this case was measured as universal. They wanted the device to appeal to young and old alike, people familiar with arts and craft and people with no background knowledge, and to people with varying levels of technology experience. For this objective, based on the wide range of visitor profiles for people who used the guides (e.g. young to old, tech savvy to tech newbie, etc.), the project was successful. Furthermore, the designers wanted survey and interview questions to tease out whether visitors enjoyed the experience and if they thought the guides added value to their visit. As the guides were expensive to produce and required additional administrative support in use, the design team needed to know if their investment was returned or if more traditional interpretive aides such as docent led tours and catalogues were sufficient. For these questions, the evaluation revealed high degrees of visitor satisfaction based on responses to scaled rating questions (e.g. How usable was the guide? How much did you learn from using the guide?). However, contrary to the design objective of creating a mini-TV, several of the interviewed visitors expected the guides to act more like a web portal and were subsequently disappointed when more information or the ability to find more information was not available. Overall, however, visitors appreciated the visual nature of the device, they liked finding the hidden secrets and enjoyed hearing the artists' stories.

The above description is not meant to provide a full account of the Renwick handheld education project but to give an example of a typical context-aware guide, how it is designed (i.e. for what purposes), and how it is evaluated (i.e. what constitutes success). As I was the interviewer in this process, I would like to reflect on one of the interviews in particular. One of the visitors who had taken a handheld and was subsequently approached for an interview by chance happened to be an artist with a piece being exhibited by the Renwick Gallery at that time. As an artist, his concern with the guided tour was that it added a second selection filter in terms of what objects a visitor would see. He worried that people would only visit objects on the guided tour and ignore or downgrade others that did not have additional information. This suggests the guides may have an interesting twist on the curatorial and selection process, where art is what makes it in the museum but some art deserves additional attention. Several other visitors also commented that the guide tended to dictate what they would see rather than letting something simply catch their eye. When the artist spoke about his experience using the guide as a visitor, he had a different concern. Contrary to all the other visitors interviewed, he did not like the style of many of the artist interviews. As someone versed in reading an object, he was accustomed to listening to a curatorial point of view and either agreeing with it or disagreeing with it. In other words, the information provided from the curators on the tour he took as a resource to be used or not. However, when the artist spoke, he felt this could not be challenged as much – it therefore closed the object to interpretation for him. If the artist said, “This piece means X, Y, Z” then he felt he could not look for new meaning in it.

I highlight this remark from the artist because of its resonance with the tension described in the previous sections regarding interpretation. The artist's reaction echoes Beuys' comment that art is not about being understood or explained and echoes the essentialist position of art appreciation, that explanations get in the way of the art speaking for itself. His comment sparked the realization that the artists being interviewed for the handheld guide could choose how to use this channel of communication. They could choose to describe their work in closed terms, "it means X, Y, Z", or they could choose to use the channel less didactically. Perhaps they could pose questions instead of providing answers for example. Imagine, for instance, if René Magritte created *La trahison des images* during a time when handheld guides were pervasive and he was given the opportunity to provide additional information about the piece for the guided tour. Would he use this as an additional canvas to play with the juxtaposition of words and images? Or would he simply explain the incongruity between the words and the image in the painting? The question here is whether the device is seen as an extension of an artistic experience or if it is separate from it.

These hypothetical questions led to further reflection about the typical design of a context-aware guide as a tool for information transfer about the objects in the museum. When viewed as part of the essentialist versus contextualist debate, the device seems to be employed for contextualism, describing what a piece means, how it was created and why. Proponents of essentialism charge that this closes off what the piece could mean to the individual viewer. To put this sentiment in terms of approaching the ineffable, the technology as a tool for understanding art favors explanation over experience. A further criticism of the devices is that they not only close down

the possibility of new interpretations but they swap the object of contemplation from the art object to the device itself. This is often referred to as looking down instead of up (Boehner, Gay, and Larkin, 2005) and it resembles similar criticisms against earlier interpretive aides such as extensive label text. However, if viewed as an extension of the artist's canvas, the design of such devices could perhaps take a different shape. The interesting question being posed here is why the devices have been designed primarily for the transfer of information. Elsewhere I have argued that in designing technology tools for the museum only for the dominant practice of information transfer, we reinforce this dominant practice (Boehner, Gay, Sengers, and Chen, 2004; Boehner, et al., 2005). This led to the impetus motivating the following case study, namely exploring other aspects of the design space possible for enabling new experiences in the art museum.

I am not alone in questioning the narrowness of this space for technology in the art museum as a tool for information transfer. Before finally turning to the case study of this chapter, I will look briefly at how others are expanding how technology may be designed for this space. This work can be categorized into efforts for increasing immersion and engagement, exploring new forms of access, personalizing the guides, and addressing social participation. I will address each of these in turn briefly before introducing how this work has informed the case study.

Immersion and Engagement

In terms of immersion and engagement, several projects focus on the richness and presentation style of the information available. For example, by using the living stories of artists, the designers at the Renwick Gallery hope to create another hook through which visitors could connect with the objects, if

not through their form then through their maker. This is similar to the approach taken by the Tate Modern (Wilson, 2004) and both museums also explore the use of games as a way of drawing attention to different parts of the objects on display. Another approach to improving the level of a visitor's engagement is through modeling the richness of interaction from a docent tour or a tour led by an expert passionate about the subject (Halloran, et al., 2005; Wakkary and Evendon, 2005).

A slightly different approach to immersion is one pursued by project ec(h)o, an ambient soundscape system for museums developed at Simon Fraser University (Wakkary and Everndon, 2005). Ec(h)o was prototyped at the Canadian Museum of Nature, but the design idea has implications for art museums. In this project, a visitor carries a sensor tagged object (in this prototype, a small wooden box) that communicates with embedded sensors and receivers in the physical space of the museum. The purpose of this connection between the visitor's sensor and the sensor in the environment is to trigger appropriate soundscapes when the visitor enters different zones, for instance triggering the sounds of birds when approaching a display of quail eggs. This provides peripheral or ambient information to the visitor. In all of these cases, the emphasis is still on providing information to the visitor about the object on display but in a more evocative, engaging, and multi-sensory way.

New Forms of Access

The ec(h)o project's soundscape provides an example of another class of enhancements in context-aware guides: providing new means of access. In the case of ec(h)o, there are three novel access means, first the soundscapes are ambient and zone-based as opposed to keyed with one object. Secondly,

the visitor carries a wooden block or ball that triggers this information by passing soundmarks, or at a particular exhibit, the visitor can access information by manipulating the block. Turning the block clues one set of information, turning it another way accesses a different set. Thirdly, the ec(h)o project looks toward providing novel interfaces to an array of information, some of it not directly controlled by the museum such as other scholarly archives such as a scientific database on natural habitats.

A variety of different technical interfaces are explored for handheld guides in terms of how information is technically accessed and this has implications for the visitor experience as well. In the ec(h)o case, the visitor is turning a lightweight wooden box. In Microsoft's Aura platform (Smith, Davenport and Hwa, 2003), the visitor swipes the bar code of the object past their bar code reader on their device. In MIT's Museum Wearable (Sparacino, 2002), the visitor wears a headset and carries a CPU in a backpack and information is trigged through a triangulation of WiFi nodes. The issue of access is also taken up by projects addressing the problem of maintaining equipment and managing equipment costs. Nickerson (2005) presented a prototype for delivering museum tours directly to visitors' own cell phones and the ArtMobs[17] group at Marymount College has experimented with podcasts of tours that visitors download to their iPods before entering the museum. These advances take on the issue that access to the information on the guides is limited to the number of guides available (and functioning). All of these various projects, and similar ones, are concerned with how access to information is supported efficiently, seamlessly, and to the largest group of people.

[17] http://mod.blogs.com/art_mobs/

Personalization

The third theme of developments in the context-aware museum guide space is support for personalization. The Museum Wearable (Sparacino, 2002) provides a characteristic example. As mentioned above, for this system, a visitor wears a set of headphones with an attached 'private-eye' display positioned over one eye. After a period of adaptation, the viewer's brain combines the information provided about an object shown on the private eye display with the object that is viewed by the unencumbered eye. Also connected to the headset is an infrared receiver for communicating with terminals around the museum in order to determine the visitor's location. Connected to the headset is a CPU carried in a backpack. The computer is used to not only serve the stored information about the objects on the tour, but also to calculate visitor style profile based on the visitor's path and information consumption pattern. The visitor develops a profile throughout the tour as being either busy, selective, or greedy and information is subsequently presented to fit this style. Part of the success of such a system depends upon the accuracy of the personal profile and typing algorithm used to subsequently tailor the presented information.

Several groups are playing with refining algorithms for predicting information seeking behavior, often modeling visitors after other foragers such as ants (Jaén, et al., 2005). Many of these projects attempt to create these patterns of preferences somewhat implicitly based on how long a visitor spends in front of an object or how much information is accessed. Other programs ask for more direct intervention from the visitor to establish their profile, for example asking them to rate how useful or how much they liked the information they received (Goren-Bar, et al., 2005). In these examples of

personalization, it is primarily the system that is responsible for developing a greater sense of awareness of the visitor's context and therefore adjusting the amount and type of available information to match the visitor profile.

Social Participation

The final theme for pushing context-aware guides in new directions is the theme of social participation. Several critics of handheld guides or wearable computers with audio headsets have pointed to the support for individual experience at the cost of social experience. One response has been to tie people together through the communication network, for instance providing a messaging function on the devices for communicating with peers (Wilson, 2004) or facilitating communication between people who are online but away from the museum and people who are in the museum and using a context-aware guide (Galani and Chalmers, 2004). Another approach is simply to remove the headphones from the context-aware guides and concentrate on sound as a medium that affords greater numbers of participation. For instance, Sotto Voce, a project by researchers at XEROX Parc, described how visitors to a cultural heritage site used a portable audio guide without headphones to increase interaction with their group as well as 'eavesdrop' on content being explored by other groups (Aoki, et al., 2002). This is similar to the findings of Jeremijenko's (2006) analysis of sound cones in a museum space: compared to wall labels, when people activate a sound cone of information about an object, the number of interactions between people increases.

Installations in science museums often seek to design for more collaborative learning experiences, particularly experiences where spectators may watch others interact with an exhibit before taking their turn (Bannon, Benford, Bowers and Heath, 2005; Reeves, Benford, O'Malley, Fraser, 2005;

vom Lehn, Heath, and Hindmarsh, 2005). Vom Lehn and Heath argue that the museum is a social place, with people often traveling there in pairs or groups, and most context-aware guides prioritize an individual experience of information transfer over a social experience of this information (vom Lehn and Heath, 2005). Furthermore, vom Lehn, Heath, and Hindmarsh (2005) argue that the context-aware guides tend to replace the object itself in terms of focus. Although well founded, these criticisms all revolve around a single visit, in other words, we do not know if use of the traditional context-aware guides actually creates more social interaction or more prolonged engagement with the object for an individual on a subsequent visit (for instance, later taking a friend to share what he or she learned). Overall however, there is a growing concern about designing the context-aware guides to support social interaction in groups as well as individual contemplation.

All of the above themes, however, still advance the dominant practice of transferring information from the 'expert' voice curated by the museum to the visitor about the art object on display. In other words, all still approach the ineffable experience of an art object as something to be explained, and generally as having a preferred (expert) explanation. There have been some moves to push on this one-way transfer. The ArtMobs project described above has the potential if taken up on a wide scale to allow for anyone to add their voice as the role of 'expert'. In its current form, the podcasts contain the discussions of Marymount College art students discussing paintings and other works with their art history professor. To some extent, this is similar to the eavesdropping experience of Sotto Voce where one could imagine happening upon a tour in progress and following it anonymously. It will be interesting to see if the casual visitor feels compelled enough to share his or her opinions

about an object through recording his or her own podcast. Based on our own experience with adding the voice of the visitor to the curator's voice, described below, we believe this introduction may encounter challenges.

In a project called MUSE[18], the Human Computer Interaction group at Cornell tried to allow non-curators to comment on a piece of art and therefore challenge the one way transfer of information on the guides. Visitors were able to leave a comment with the handwriting feature[19] on the handheld device. We found, however, that the uptake of this channel for participation was used to a very small degree. Comments from visitors suggested that the reason for not using the channel was often due to feeling like they had nothing to say or that what they had to say was of no value. It is this latter response that we chose to question more since it suggested that visitors felt they lacked the license to participate in this kind of expression (Boehner, Gay, Sengers, Chen, 2004; Boehner, et al, 2005). Anecdotally, we have seen a similar experience happen with the new comment channel being tested with the second version of the Renwick Gallery's guide. Visitors in our earlier experiment did participate in rating the objects on display in terms of favorites or preferences, and a similar experience at the Tate Modern (Proctor and Tellis, 2003) also suggests that this level of participating is non-threatening. We wanted to explore this type of participation more however as it begins to push in a different way on expanding the narrow design space of using context-aware technology for information transfer about objects.

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[18] http://www.hci.cornell.edu/projects/muse.htm

[19] One very plausible explanation for lack of comments would be the onerous nature of the input mechanism. However, we were testing a similar application at the time, with the same input mechanism, for a campus tour and for that tour uptake was spectacular. Nearly every person who used the tour left a comment somewhere around campus (Burrell, Gay, Kubo, and Farina, 2002). In comparing these differences, it became apparent that students feel ownership and expertise regarding their experiences on campus.

Reflective Design: An Interpretation Approach for Art Museums

The previous discussion provides a socio-historical look at the culture of the art museum and in particular the view of experiencing art as an ineffable phenomenon. Articulating this context is an important step in the practice of reflective design. It begins by questioning the cultural factors, influences, and implications of existing designs. In this case, my observation that technology is introduced into an art museum as an aide for explaining the art on display, and more specifically for providing expert information from the curator to the visitor, led to speculation on why this was the dominant form of design. If the experience of art and perhaps even the production of art is considered ineffable, as the history here suggests, then why is technology as a tool for understanding art being primarily employed for explanation rather than experience? This review suggests that the tension between mediating an experience of art through explanation and presuming that a transcendent experience of art can occur either cognitively or viscerally without mediation is a long-standing debate within the art museum. In this sense, designing technology as a tool for providing explanations about art follows existing patterns. Furthermore, when technology enters the art museum as art itself, it perpetuates the same question of how to design to support the visitor experience of the ineffable if not through explanations. This question becomes more imperative in the move toward participatory art when the visitor involvement and engagement becomes more critical.

The second step then in reflective design once dominant patterns are articulated and examined is to question what new patterns might be designed for and how to do so. In this case, I have pointed to the complexity of the museum and the range of activities that take place there as a starting point for

thinking about an alternate design space. Bell (2002) for example argues that the museum is not just a place for information about art but it is also a unique ecology that fosters a kind of liminality, or being apart from everyday life, and a hybrid form of sociality where people can be both alone and together at the same time. At any given time, the museum not only houses art objects but it houses a diverse array of people as well, all with different agendas and expectations and all engaging in a host of different types of communion, or non-communion, with the art or with each other. In this view, some people may be engaging in an ineffable experience, whether with an art object or with the unique ecology of the museum itself, whereas others may simply be seeking a more mundane experience such as eating in the café, reading about an artist, or killing time. Therefore, I chose to use technology to draw attention to these different experiences and by using the interpretation approach to allow people themselves to determine the meaning of these experiences. This is a shift then from mediating or representing the ineffable to increasing awareness of the potential for experiences of the ineffable.

Finally, I was inspired in the review above by the distinction between technology as art itself in the museum and technology as a tool for understanding art in the museum. Whereas the former continued to trouble the role of the museum, the art, and the visitor, the latter tended to reify a view of the visitor as passive receiver of information. I felt another way of supporting interpretation of the ineffable experience as opposed to simply didactically explaining it would be to try and think of designing for the space between art and tool. The following case study will therefore pick up on the idea of highlighting existing visitor experiences and trying to bridge art and tool functionality.

Technology design that supports what we already know, i.e. the dominant practices in the museum, faces primarily challenges of usability, in other words, does it work and does it do what it set out to do? Reflective design for new experiences faces a different challenge – one of value and appropriation. Awareness of the limits or constraints of a domain space is only part of the work toward developing something new. The hardest and more elusive part is anticipating how something new will be valued, or not. We had a taste of the difficulty in designing for new experiences with our initial attempt to push on technology for one-way transfer of information in the museum. The poor reception of our two-way channel suggests that designing for new experiences in a tightly scripted environment such as the art museum is more difficult than simply noticing conventions and trying to upend or overturn them. In the following section, I will detail two attempts to tackle this issue of designing for new experiences within the constraints of both traditional views of technology and traditional views of an art museum.

Case Study: New Technology for New Museum Experiences

This section presents a case study in three stages of designing for interfaces with the ineffable in the art museum. The first stage presents the results from a pilot study where we first engaged with visitors and museum staff to brainstorm about the potential of designing for alternate experiences of technology in the art museum. The second stage and the third stage are presented in more detail and follow a design from the drawing board, to installation, and to final evaluation.

Stage One: Expanding the Design Space

For this first stage, I worked with various members of the Cornell HCI group and Cornell Culturally Embedded Computing Group including Geri Gay, Helene Hembrooke, Phoebe Sengers, Yevgeniy 'Eugene' Medynskiy, and Joseph 'Jofish' Kaye in addition to working with Tim Brooke (then an interaction designer with the People and Practices Group at Intel), Claire Larkin (Head of Special Projects and the Renwick Gallery Handheld Education Project for the Smithsonian American Art Museum), Cathy Klimaszewski (Cornell Johnson Museum), Meg Elliott (Cornell Johnson Museum), and J.P. Pollack (head of Visual Biosystems, specialists in visualizing population data movement and patterns). Through these interactions, we created a number of ideas for how we could represent the range of visitor experiences happening in the museum at any given time without necessarily requiring new or unfamiliar behaviors from the visitor (such as the commenting feature in MUSE that resulted in poor uptake). For example, some representations could simply depict the number of people in different parts of a gallery as dots on a floor plan. This information could be detected through sensors or use of tracking technology on handheld guides and the information could be presented on the handheld screen or projected in some central location. Alternatively, we could try to represent not simply presence of bodies, but the different moods people were feeling. This might be visualized as a kind of climate map or something like abstract art with swaths of color representing intensity of different emotions. We also suggested depicting preference information – such as path displays indicating popular routes through the museum or highlighting popular and unpopular pieces in the exhibit.

After generating and mocking up these design ideas, we tested them with two focus groups: one group of museum staff (six participants) and one group of museum visitors (eleven participants). During each focus group meeting, I projected each display on a large screen and gave a brief description while participants individually rated the picture on a seven point scale for three different dimensions: Attention (on a scale from Boring to Engaging), Information (on a scale from un-Informative to Informative), and Behavior Change (on a scale from Irrelevant to Influential). I asked participants to rate the displays from their own perspective and from what they imagined the perspective of the alternate stakeholder would be (e.g. visitors rating what they imagined museum staff to think and vice versa). In addition to filling out these surveys, participants were encouraged to discuss the displays. Because of the small sample size and the prototype nature of this stage, findings will be presented only as general trends that informed the developments of stage two and three of this larger case study.

From a qualitative analysis of the discussions held around the displays, additional comments left on their surveys, and our previous design experiences with technology in the art museum, I identified the following four design findings for informing the next stages of development:

1. Digital Scaffolding for Staff and Visitors.

Based on the initial experiences from the HCI Group with the MUSE platform and the difficulty in simply adding a new form of engagement into the museum environment, we had anticipated that visitors would need some kind of ‘digital scaffolding’ for the new information to be presented. This was partly why we chose to augment existing visitor behavior, such as where they went and what they looked at, and not require new behaviors. The feedback from

the tested displays suggested that representing their behaviors in the museum would have some degree of value to them. However, we were reminded through the focus groups that this scaffolding applies not only to visitors but to the staff as well. Just as visitors are familiar with the prescribed routines of the art museum, staff are equally if not more so. The difficulty the staff had with imagining how visitors might use visitor information reinforced our awareness that in our eventual designs we would need to build trust with the museum staff as well as start with designs that were less threatening and more familiar.

2. Ambiguity for Engagement.

The second finding is somewhat in contrast to the first idea of digital scaffolding which suggests grounding our designs in what people already know or are familiar with and not leading too far with an extreme or unfamiliar experience. We had originally anticipated that some of the more literal displays, such as the population density displays and the path displays showing common paths, would fare well with people because they would be easy to read and immediately informative. However, we found that the displays about emotion generated more interest and enthusiasm. The more abstract or ambiguous displays lent themselves to user-constructed narratives as opposed to the literal displays that left little room for interpretation. For example, for an animated display that showed objects in the museum growing or decreasing in size based on number of visits, one participant explained it looked like a collective memory map of the museum, like a view into the museum's brain. For one of the more abstract displays, one participant felt it was an example of visitors creating art through simply participating in the regular museum experience.

3. Finding Self in the Collective.

Some of the displays depicted only aggregation and for these displays participants asked to be able to identify their own place. There was an expressed desire not necessarily to isolate oneself, and therefore give up privacy, but to be able to see how one's own participation influenced the overall display. Visitors especially expressed an interest in the idea of being able to leave a trace that may influence the experience of others.

4. Site Specific Displays.

As our focus groups consisted of staff from the Johnson Museum and students from Cornell, when we used a floorplan for the displays, it was from the Cornell Johnson Museum of Art. The map provided one level of grounding for constructing what was happening in the displays and what they meant. One of the reasons the popularity display was so favorable may have been because it created montages based on the museum's collection of objects. However, the form of the both of these displays was very generic – i.e. if we moved to another museum, we could swap in a different floor plan and make it specific for that museum. Our displays did not test the level of site specificity required but it was an issue we highlighted to explore in future studies.

The main take away from the focus groups was the general level of interest expressed in highlighting visitor information to visitors themselves as opposed to a tool for a context-aware system or an evaluation metric for curators. It was important to have a range of displays for discussion, however, as this allowed not only for conversations about an individual display but about the differences between the different displays. The tactic of having the different stakeholders try to anticipate the perspective of an alternate stakeholder (e.g. museum staff projecting visitor's reactions and visitors

projecting staff reactions) also proved a useful technique for fostering more discussion about what aspects of the display were valuable and why. The fact that museum staff consistently underestimated visitor interest in the displays was an interesting finding but perhaps would have been a more useful prompt if the discrepancies were revealed to both staff and visitors.

This leads to a few suggestions for how to improve the pilot methods. The rating system ended up being less interesting in terms of the actual scores returned, but more interesting in terms of the disparity between what visitors anticipated would be interesting to curators and vice versa. Furthermore, the rating system acted as a prompt for discussion about the more or less popular displays. In future iterations of such studies, it would be useful to push on the role of the ratings as stimuli as opposed to output. For instance, if participants entered their scores into a networked device, the immediate results of their tabulated scores could be projected next to the display thereby generating reflection on the aggregate scores in addition to their own individual input. In addition, we chose to run the focus groups as separate discussions, one with staff and one with visitors. It would be useful to have a third group with staff and visitors to encourage more deliberation and discussion across different viewpoints.

At this point, we could now move into building actual systems. In the following section, I will present two installations: Imprints and Birdscape. These installations draw from the pilot above but they also involved a period of intial brainstorming in order to customize the design for the particular exhibit. I will describe each project in detail from drawing board through evaluation.

Stage Two: Imprints in the Museum

The Imprints program began with an opportunity to create a handheld guided tour for the Cornell Johnson Museum of Art's temporary exhibition of contemporary arts and craft from the 1900s Byrdcliffe colony in upstate New York. The Johnson museum's objectives for this exhibit were markedly similar to the objectives of the Renwick Gallery discussed earlier. The difference between the two exhibits however is that the Renwick features contemporary craft and created rich multimedia materials such as interviews with the living artists and clips of the artists in their studios. The Byrdcliffe exhibit featured the work of artisans from the turn of the century and therefore had to rely on existing source material found primarily in books. Another contrast between the Renwick and the Johnson exhibits is that the handheld guides provided the only source of multimedia in the Renwick gallery whereas in the Byrdcliffe exhibit at the Johnson, there were several stations throughout the gallery for listening to actors portraying the artists or watching animations of pictures taken from this time period.

Despite these differences, the objectives were very similar. The Johnson museum's curator for the special exhibit and the education staff wanted to explore the use of handheld guides as an interpretive aide for the works on display. The HCI group at Cornell agreed to facilitate the design of the handhelds, working with a tour development company called Spotlight Mobile, with the understanding that we could also add an element on new visitor experiences such as the displays we had explored with the museum staff in the earlier focus groups. We wanted to reflect visitor information as a stimulus for constructing meaning about their role and the museum itself.

Design Objectives

Returning to the historical review that began this chapter, I wanted to explore the space between using visitor information to drive technology as art versus driving technology as tool. As an example of the former category, Simon Penny's Traces is a 3-D cave environment where the visitor enters the cave and through his or her movements is able to bring into being semi-autonomous forms that dance around the cave (Penny, Smith, and Bernhardt, 1999). The visitor is thus immersed in a creative and reflective process examining the shape of his or her movements as projected in the emergent forms. This approach stands in contrast to the use of visitor movement information for the Museum Wearable (Sparacino, 2002) where the visitor is unaware that their movement is having any influence on the system at all and the information that is returned is the information about the art on display. The challenge for augmenting the Byrdcliffe handheld system that we would build was to reflect visitor presence and activity but not in a didactic way that would reduce visitor information to another bit of information about an object, such as '5 people visited this object' or 'this object is the most popular.'

Therefore, the design and research questions motivating this stage of the case study were as follows:

- How can we augment the visitor's experience in the museum through the presentation of visitor information? How can we present this information not didactically but evocatively, serving both to inform the visit and as a source of reflection?
- What sense will visitor's make of this information – will they consider the information valuable? Will they use the information to inform their behavior, such as for navigation? Will they use the information to reflect on aspects of the museum experience beyond the art objects?

Design Methods

The Imprints project was designed and implemented in collaboration with the curator Nancy Green, members of the educational department Cathy Klimaszewski and Meg Elliott, software designer Kiyo Kubo from Spotlight Mobile and a team of designers and students from the HCI group including: Geri Gay, Helene Hembrooke, Jennifer Thom-Santelli, Angela Zoss, Tucker Barrett, and Justin Hall. The team from the HCI Group was involved in both the design and the analysis (Boehner, et al., 2005) the results of which will be presented here. My particular role was to lead and coordinate the design, implementation and evaluation efforts.

Our initial design discussions were informed by the pilot study results, particularly the need to support digital scaffolding to grant license for participation, to use ambiguity to draw in more engagement in the meaning making process, to allow visitors to leave a trace of their individual mark in the collective, and to make the eventual design site specific. I will describe how each of these in turn influenced our design decisions. For the last objective of site specificity, we oriented this toward the Byrdcliffe collection as it was a temporary exhibit and not rooted to the space of the Johnson museum itself. As we read about and discussed the exhibit with Green, the curator, we focused on one of the defining debates of the Byrdcliffe colony. Founded partly in response to the mass market and commodification impulses of the Industrial Revolution, the Byrdcliffe artisans were split about the use of technology in their work (Green, 2004). Some felt it took away from the skill and personal touch of the artisan whereas others felt it automated the routine aspects of the craft and freed the artisan to focus on the creative aspects of the art. Through this debate there was an emphasis on seeing the imprint of the individual

artisan – whether through a signature motif or an actual signature – as something that presented the piece as individual and not mass-produced. We therefore sought to translate this idea of the artist imprint to the visitor experience.

One of the first ideas for the visitor's imprint was to play off of the faceless museum surveys described in an earlier section regarding visitor studies. Since part of the evaluation of the handheld devices would consist of a survey asking standard demographic questions (e.g. age; experience with museums, arts and crafts and technology; or motivation for visit) in order to assess the universality of the device, we first contemplated using this same information and turning it into an iconic stamp for the visitor. The idea here would be to make the survey actually part of the creation and design process as opposed to an analysis tool alone. Although we felt this would provide high degrees of information about visitor presence, we also reflected that this kind of demographic information had scored poorly in our pilot study. A second idea suggested approaching the individuality of visitors through the literal imprints of their fingers. As most people would not recognize their own fingerprint however, and as the idea of capturing the fingerprint steered too close to privacy concerns, we pulled back to the idea of a handprint or a picture of one's hand. We imagined visitors could come to the gallery and in order to check out a handheld guide, they would place their hand in front of a camera and this image would become their print. The visitor could make a gesture or simply snap a picture of their hand, similar to the clay handprints children make for their parents. This print would then be associated with the visitor's tour. However, when we discussed this idea with Green and the education staff, the concern was that this design would not fit with the more simplistic

collection – that it would be introducing something too high-tech into an experience about the more low-tech means of production.

Ultimately, the inspiration for the final form of the Imprint came from a page in the Byrdcliffe catalogue portraying an image of ceramic tile samples from Jane Whitehead. The tile samples were lined up in a grid creating a mosaic of colors. The tiles immediately suggested the idea of a print to us and the mosaic suggested the idea of tiling each individual's imprint with the imprints of other visitors. This then would address our objective of letting visitors create their own mark, or imprint, in the shape of a tile which would then be shown within an array of other imprints as the collective presence of the museums' visitors. We anticipated that the imprint would be used in two ways. First, the imprint would be associated with each piece that a visitor looked at using the handheld tour. This would be like leaving one's calling card upon visiting a place – the imprint would then become part of the information accessible about each object on the tour. Secondly, the imprints from all visitors would be collected and displayed in a wall mosaic. In this way, we imagined that the information about visitors accessible on the handheld would perhaps act as a source of information or a tool informing the visitor's movement through the museum and the projected wall display would serve as more of a reflective piece for visitors to contemplate the array of presence that had passed through the exhibit before them.

Regarding the principle of designing for ambiguity, we wanted the visitor to create tiles that would allow for personalization and therefore provide a range of open-ended expression. The fact that each visitor would make one mark would mean a literal mapping of one mark per visitor, but we felt the design of the marks themselves could be left up to the visitor's discretion.

Originally, we talked about using ‘alien presence’ in the system, something that would suggest that the creator of the imprint did not have complete control over their final form – just as firing a tile in a kiln adds an element of surprise and the kiln becomes an active player in determining the final shape and color of a ceramic work. We described this as providing for ‘happy accidents’, something we thought would be an interesting part of the creation process. Ultimately, however, this was not implemented in any concerted way (due to time constraints) other than having no erase feature in the Imprint application. This meant if a visitor made a mistake, he had to make the best of this or start all over again. The eventual palette for the Imprint program would consist of background patterns from the Byrdcliffe exhibit and a simple drawing tool for embellishing this pattern (described more below).

Finally, we addressed the principle of digital scaffolding in three ways. First, the Imprint and the Imprint making process was layered on top of the handheld tour and associated with the generally familiar process of using an audio or handheld guide. The Imprint program was positioned as an additional and optional feature. Secondly, once a visitor made an imprint, no other actions would be required for leaving their mark behind through the exhibit. Making an Imprint was part of the handheld check out process and then faded into the background of the tour. Finally, the Imprint making process needed to be simple. During the MUSE example, people felt they lacked the license to participate as a commentator of art and it was important therefore that we did not create a new barrier to participation of artistic license. Instead, we wanted the Imprint application to be quick and simple, but potentially expressive in the ways described above.

Implementation

As with any design project, our design choices also became our design constraints. One of the biggest challenges in implementing the Imprint program was the decision to tie it to the handheld guided tour. In doing so, we would only reach visitors who chose to use the tour[20] and we were also dependent on the success of the traditional tour itself. This was a concern as the tour developed and we realized only 6 of the objects in the exhibit would be developed with additional information. Furthermore, the audio-visual guides would not only compete for attention with the additional multimedia kiosks and audio stations in the exhibit, but the handheld would present largely the same information that could be experienced elsewhere, either from label copy or from the other multimedia aides. We anticipated that if visitors did not enjoy or find valuable the handheld tour, then this sentiment would likely be transferred to the Imprints as well since the two were tied together. However, we wondered if the Imprint program could work the other way, in that it would provide information that was not available through any other means in the exhibit and perhaps the Imprint program could improve the reaction to the tour.

One way of teasing out the role of the Imprints as a source of valuable information was to create a new category of objects on the tour called 'non-featured' objects. When a visitor selected a 'featured object' on the handheld tour, the visitor would then have the option of asking the following six questions about that object:

- Why does the object look like this?
- How was it used?
- Who made the object?

[20] Reports of use of interpretive aides by visitors for temporary exhibits is low, some estimate only 30% of visitors take audio-visual guides (Anderson, 1999; McClellan, 2003)

- How was it made?
- How does it fit the Byrdcliffe story?
- Who else has visited this object?

Clicking on one of the questions on the handheld would then return the relevant information such as pictures of the artist or examples of the tools used to make the object, all narrated by the voice of the curator Nancy Green. Whereas when a visitor selected a 'non-featured object', the only information returned would be additional label information as text (i.e. no audio) and the question: "Who else has visited this object?" We originally planned to test two conditions of the handhelds: one with the social information and one without. We anticipated that people would mainly go to the featured objects and taper off visiting the non-featured objects when they realized the information was simply a repetition of the label text. However, if we noticed a different pattern when the social information was present, we could infer that this information has a degree of attraction to it. Unfortunately, again due to time constraints, we were only able to test the system with the social information included.

Although as designers of the system our intention was to make the social information on the same level as the information about the art, for the curators and educators, the social information represented a nice additional feature but not critical. One example of this difference in priorities manifested in the placement of the collective mosaic of visitor imprints – although we had originally intended for the mosaic to be situated near the handheld check out station or on a wall in the gallery, the only available wall space left for the display was tucked away in a back alcove. The difference in agendas between the HCI design team and the museum staff is mentioned not as a criticism of our museum partners nor as an excuse for the eventual limited delivery on the

Imprint program, but as a logistical feature of research through building. Although we defined design and research questions at the start of our project, these would eventually become modified in order to fit the actual implementation given the real world, i.e. non-laboratory, setting of the art museum.

The eventual Imprint program was implemented through a combination of a Java-application on a Tablet PC, a network server and wireless access point, and the Dell Axim handheld devices with wireless modem cards. The handheld guides were made available at the opening of the exhibit space. When visitors checked out a handheld guide, they were asked if they would also like to make an Imprint to mark their tour. The Imprint program was explained as being similar to the process of the artisans in the Byrdcliffe colony who would mark their creations with a personalized symbol. The imprint, we explained to visitors, would be associated with their tour and would be left behind with each object they visited. Consequently, they could also look at the imprints of other visitors who had seen the same object before them.

If the visitor agreed to make an Imprint, they moved to the Tablet PC and started the Imprint program which had two steps: 1) selecting a background that represented the Byrdcliffe Arts and Crafts aesthetic, and 2) using the calligraphy style pen to enhance the pattern with their personal addition (Figure 1). If a user chose not to create an imprint, a default image was randomly assigned.

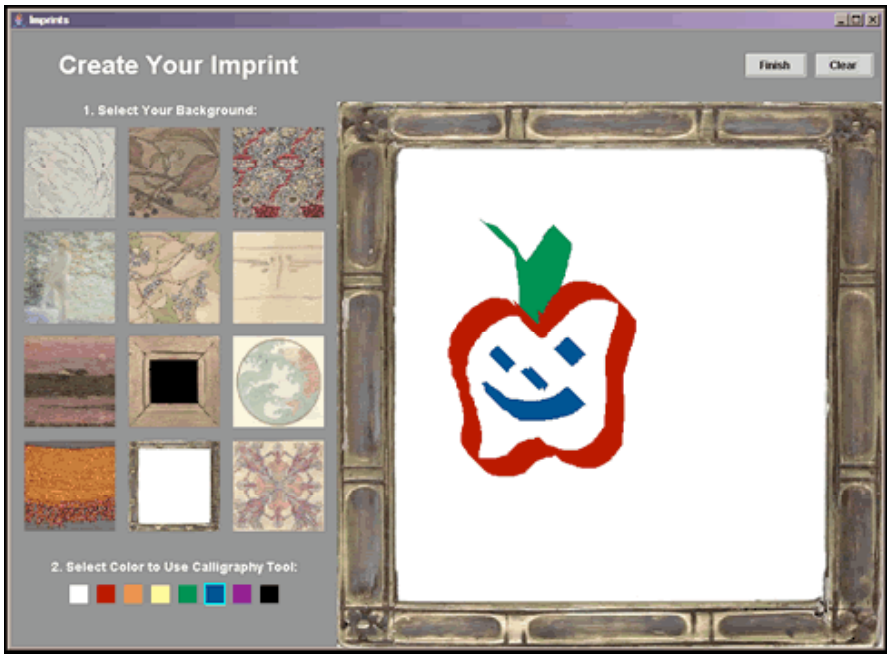


Figure 1. Imprints interface with created imprint

When the visitor began the tour, she would play an introduction about the guide and the Byrdcliffe exhibit in general and would then move to a visual menu of all the objects on the tour. The objects were ordered roughly according to how the visitor would encounter them if moving in a clockwise direction through the exhibit hall, however visitors tended to wander somewhat more randomly. Each object in the physical space had an icon of a dragonfly with a number on it (featured objects also had a star) and this corresponded with the numbered position of the objects on the visual menu page. When the visitor stood in front of an object in the gallery that he or she wished to learn more about, the visitor would scroll through the visual menu of objects on the tour's index or home page and then tap the image/number that corresponded with the desired object. This action returned a page with subsequent questions that could be asked about the featured object (see Figure 2).

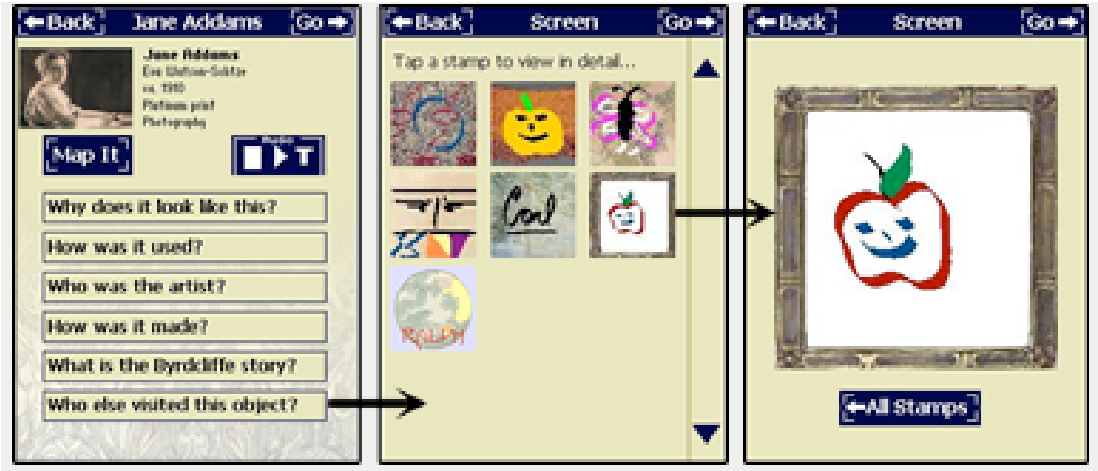


Figure 2. Screen shots of an object's exhibit page and response to the question "Who else visited this object?"

Once the visitor selected an object to learn more about his or her imprint was immediately associated with that object. When asking the question "Who else visited this object?", the visitor would then see a page of Imprints of all previous visitors including his or herself. Selecting an imprint would show an enlarged version of this mark. In future iterations we hope to include the ability to follow a particular Imprint to other objects (e.g. 'where else did this Imprint go?'). In addition to leaving one's imprint behind on the handheld, all of the imprints were combined into the photomosaic (see Figure 3).

As a photomosaic, the imprints were not only collected but constructed into a particular image. The goal was to use the visitor imprints to create the shape of the most popular object (i.e. most frequently visited object) in the gallery. Ultimately, however, for this first iteration, the mosaic only formed a predetermined source image, in this case a White Pines vase. Both the photomosaic and the imprints to the handheld were to be displayed in real-time, meaning once a visitor selected on object to view, this selection would be communicated to the server. Then, when the visitor asked the question "Who

else has visited this object?", the device would ping the server to get all of the imprints including those from visitors as recent as one second ago. Likewise, the photomosaic would refresh every five minutes to present all of the imprints collected thus far. In practice, only the photomosaic worked dynamically although the computer projecting the mosaic kept falling off the wireless network and needed constant rebooting. The handhelds had to be active synched through the USB port when they were turned in therefore showing only the imprints of visitors who had already left the exhibit.

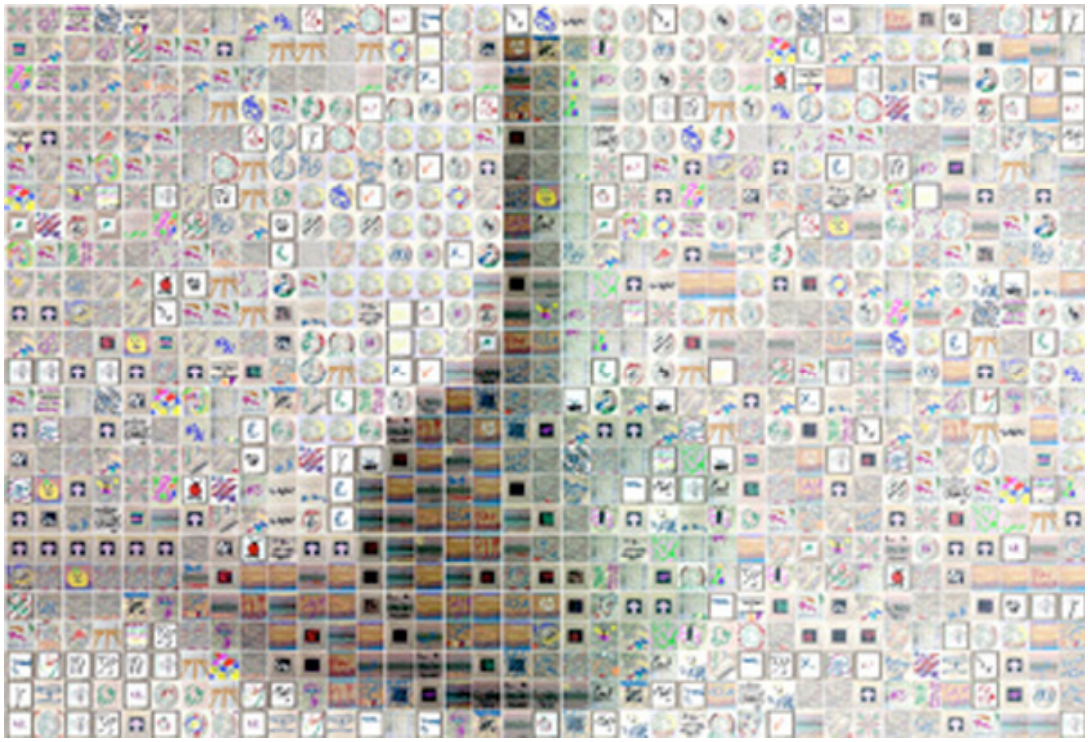


Figure 3. Projected photomosaic

Once visitors completed their visit, they would turn in the handheld device and the device would be synched with the server and readied for the next visitor. Synching the device collected all of the clickstream data for what objects a visitor visited and what information was accessed in what order. In

addition, if the visitor filled out the visitor survey, one of the options on the handheld tour Go menu, this data was also collected at this time.

Evaluation Methods

The evaluation of the Imprint program used many different methods but primarily focused on developing a phenomenological account of whether and how people used the imprints. We used a combination of qualitative and quantitative methods to provide evidence that would allow us to infer whether we were successful in designing a technology device that pushed beyond the traditional role of serving information about the art object on display. To this end, we used clickstream data collected from the handhelds, surveys administered on the handheld, observations and video footage, and interviews. As the first implementation of the handheld tour and the Imprint program, we position this evaluation as an exploratory study. In future iterations when the technology is more stable, we can conduct more controlled studies regarding comparisons of different conditions.

Our interview guide was informed by the Falk and Dierking (2000) critique of studies that overlook visitor expectations and motivation. This critique is leveled against studies that present visitors as simple categories and turn their survey results into statistics proving that information was transferred or not. Therefore we did not ask simple rating questions such as: Did you like the imprint display? (scale of 1 to 5). Instead we were interested in probing why people were at the museum, how they defined the museum as a place, and what their expectations were for their visit. During our previous work with the Renwick Gallery, we had used a survey question that asked the reason for the museum visit with options such as: to study, to learn, to explore, to meditate, and other. “Other” received the highest mark, suggesting not just

that the categories were wrong but that attempting to categorize a visit's motivation in such a way was not very useful. Therefore, our interview questions were designed to be open-ended and thought provoking.

Just as the design of the program and its implementation were exploratory, so too were the evaluation methods. A number of the methods did not work due to technical failure or oversight. For instance, we wished to discover if people navigated by using the feature on the handheld that let visitors sort the objects by most popular or most undiscovered. However, the tagging in the system code only allowed us to discern if people used the sort filter but not which filter. Furthermore, the imprints often failed to appear with the right handheld – where we had hoped to build up for each object a number of imprints and a variety of imprints, we often only had 4 or 5 despite many more visitors using the devices. However, although we knew the system was malfunctioning, the visitors did not unless their particular imprint was lost. We had a video camera stationed near the photomosaic, but since the display was often off-line, we collected very little footage. We do have some observations from around the display however that I will describe later. In addition to technical difficulties hampering some of our evaluation methods, we also discovered that several of our interview questions did not provide the kind of stimulus we were looking for. In particular, we experimented with using a semantic differential methodology (e.g. Osgood, Suci, and Tannebaum, 1975) as one approach in our interview guides, as an attempt to compare people's perceptions of a general museum experience with their specific experience using the Imprint enhanced handheld guides. The differentials proved to be a confusing exercise for visitors however and we ultimately abandoned them.

Therefore, the results presented here will revolve around the content analysis of the imprints that were made which we are able to match with demographics from the online surveys, results from interviews and observations, and some basic survey information and the clearly coded clicksteam results. This study presents the results from a period of thirteen days spread out over approximately four weeks (generally conducted on weekends) when handhelds were distributed to interested individuals. Logging the usage of the handhelds created a database of recorded navigation events from 152 visitors. Of these 152 records, 62 visitors filled out an online survey providing further demographic information associated with their path and their imprint creation. In the semi-structured interviews, we elicited the visitors' reactions to the museum, the handheld, and the collective display. Visitors were asked if they would participate in a 15-20 minute interview after their visit. Forty-six visitors agreed, including twenty-two females between the ages of 19 and 60, as well as twenty-four males between the ages of 8 and 60. Over half of the visitors of each gender were between the ages of 19 and 29.

Results

The results can be categorized into evidence of three types: evidence for the potential of the design space we were targeting, evidence about how people used the Imprint program in terms of personalization and evidence for how people responded to the resulting imprints for reflection. These will be discussed in turn.

1. Evidence for an expanded design space.

This whole project was motivated as a form of reflective design which examines the dominant practices in technology design and use and questions

the motivating assumptions. Reflective design does not wait for a technical impasse before intervening, as does critical technical practice, nor does it wait to be led by users needs and requirements, as is dictated by participatory and user led design. Reflective design draws from these practices but does not begin with technical or social breakdown – instead, the intervention inserts new practices into an existing functioning space and observes what happens.

Therefore, part of our validation for the design space hinged upon a level of uptake. From the tour log of 152 visitors, 73% chose to make their own imprint rather than use a default, suggesting that indeed visitors engaged in the creation of a personal mark. We did not use the metric of time as a measure of engagement, although in future studies this may be of interest, but anecdotally, many visitors spent a large amount of time playing with their imprint – testing out different backgrounds and working with the calligraphy pen until satisfied with their results. It was not uncommon for a line to build up behind the imprint making Tablet PC. In addition, and also anecdotally, on several occasions when an imprint was lost due to a malfunction, visitors made the repeated effort to redraw their mark. One visitor even returned to the handheld desk after handing in his device when he discovered that his mark was missing from the collective display.

As mentioned, networking difficulties prevented the imprints from appearing consistently on the handheld but initial evidence suggests that visitors not only made their own mark but observed the marks of others. Log data from survey respondents showed that 95% of these visitors asked the question "*Who else visited this object?*" at least once, indicating that the opportunity to see traces of others provoked curiosity.

In addition to statistics of uptake, we also discovered evidence for continuing to explore the design space through our interviews. As described in the methods section, rather than simply asking visitors how they would define the museum as a place, we asked this question more obliquely in order to surface the salient features, feelings, or activities that people associate with museums. The first question was, "*If there were no museums, what would be missing?*" The second question was, "*If you compared the museum to another public space, what would that be*?" A content analysis of the first question identified three categories of responses. Out of 31 responses[21], 27.3% said that without museums we would miss the art itself, for example the visual interaction with an object to scale. 24.2% would miss the information about art, such as the historical context and the curatorial point of view. In the final category, 48.5% cited the shared space, the experience of being involved, and expressions of community and inter-connectivity as critical aspects of museums.

When asked to create a metaphor for the museum, visitors offered a range of responses from commercial art galleries to civic agoras. The top two responses, accounting for nearly half the metaphors offered, were a library or bookstore (30% of responses) and a public park or garden (15% of responses). Although the library metaphor reveals a perception of the museum as an information source, comments regarding both the library and the public park identified a special type of sociality that did not require explicit social interaction. Visitors can have a private, individualized experience yet still be a part of a social, shared place.

[21] Our coding was performed by two independent coders with resulting Cohen's kappa of .95 ($p<.01$).

Taken together, these responses confirm that information transfer is a critical component of the museum experience, but they also reveal the importance of social awareness. Personalization is less directly accounted for, although visitors talked about having individualized experience within the context of a public place. This suggests an interesting tension between being public and private at the same time. These responses are especially interesting in light of the typical museum application of technology, which tends to be for information about the art, and promotes the private at the expense of the public. Critical dimensions of the museum experience have been overlooked.

2. Evidence of personalization.

In addition to the evidence suggesting that the Imprint program was used, we wanted to look for evidence indicating how it was used. A content analysis of the 112 imprints we collected offers some further insights into the imprint making process as an exercise of personalization. Imprints were coded in terms of pattern selected, type of marking added by the visitor, and the coverage of the visitors' mark.[22] The most common, out of 12 possible patterns, were the two open frames (31.2%) possibly indicating the desire for a high degree of freedom in creating one's mark. In terms of the mark added, signatures and initials, a readily apparent form of personalization, constituted the bulk of the markings at 32.1%. The least popular mark was simply tracing the existing pattern (5.5%), indicating that people were not simply mimicking the pattern but attempting to add something unique or personal on top. Finally, the majority of marks used the entire background canvas (42%) whereas a

[22] Cohen's kappa of 1.0 ($p<.01$), .88 ($p<.01$), and .89 ($p<.01$) respectively

much smaller percentage of marks (11.9%) were minimized and pushed to one of the corners. In sum, these data suggest that visitors appropriated the patterns provided for personal expression.

The interview data corroborate, and further describe, the content analysis findings regarding the importance of personalization in the imprint creation process. When interviewees discussed why they chose certain patterns, there were two predominant reasons. Popular patterns, such as the Japanese fish set in a circular border, provided a good canvas, felt stamp-like, or left space for their personal mark. Unpopular patterns, like the Morris tapestry (Figure 1, top right), were too complicated and felt fragmented. The second predominant reason for pattern choice was that it appealed to their personal aesthetic preferences. Only three out of 44 interviewees indicated that their choice of pattern was actually a non-choice (e.g. “it was the first thing I saw” or “I didn’t like any of the others”).

Regarding the type of marks made, several interviewees used marks reflective of a personal preference (e.g. “I like butterflies”) or a personal symbol (e.g. “I’m a teacher, so I drew an apple”, “I’m a caver, so I drew a bat”). The use of signatures or initials was primarily explained as being either a simple or a safe form of personalization. Two of our respondents used their name because they did not feel artistic and the signature was a non-threatening expression. However, the signature was also used as a call-out. One respondent noted that his friends would be able to read his signature, whereas strangers would not.

In addition to the interview data, our observations also confirmed people were spending time on creating their marks and felt personally invested in the process – as discussed earlier, reactions when a mark were lost were

not to give up but to make sure the imprint was logged by the system. One final anecdote came from working with an eight year old boy as he made his imprint. He chose the dragonfly print, because he “just liked it”, and began to draw various abstract shapes at the bottom of the mark. At one point, he started to color over what he had done with new shapes. I asked what he was making and he said he didn’t know but that he had made a mistake and since there was no eraser he was marking over it until it looked like what he wanted. I asked if he knew this is probably how the painters in the exhibit corrected their mistakes by painting over them. He said no. I asked if he thought the painters knew exactly what they wanted to make or if it changed while they were making it and he said it probably changed. Although I don’t believe this exchange is representative of others who made their imprints in that I don’t think others were drawn to compare their mark with the work of the artisans, it was encouraging that for an eight year old boy the mark making could take on an artistic process and for others the mark could simply be a quick mark of individuality.

3. Evidence of social awareness

The above results demonstrate that personalization was an important part of the imprint making process, but our next set of questions explore whether the imprints were consequently used for social awareness. As indicated in the first section of evidence regarding uptake, 95% of visitors at least explored the question of who else visited an object. Networking difficulties and tagging issues in the code prevent assessing whether this interest was sheer novelty or if people continued to return to the question about social presence for each object. The log files suggest that people often

asked the question, but because of our tagging error[23] we can only make the conservative estimate that they looked at the question at least once.

However, from the interview process and the observations of people's reactions in front of the mosaic, we have further evidence that the imprints were used for reflection on the presence of others. For instance, the following quotes are from three separate visitors in response to the question of whether or not they looked at the imprints:

> "I went to a particular piece of artwork that I really liked and thought, 'I wonder who else has been here to look at this'? Maybe I could see a pattern…or recognize a kindred spirit." (female, 48 yrs old)

> "A museum is usually a very solitary experience, so the notion that someone was here before you, I really like that." (female, 30 yrs old)

> "I went to one object with four other imprints, and I thought 'mine is better than theirs.'" (male, 60 yrs old)

As the last quote above demonstrates, visitors displayed a range of social awareness. Whereas some visitors looked for commonality and connection in the traces left behind, others looked for differences. Regardless, the data suggest that visitors were able to construct social narratives regarding the use of the imprints on the handheld.

The display of the imprints in the mosaic (Figure 3), however, was more difficult for people to understand in the context of social awareness. Several interviewees commented that although the mosaic was interesting, they weren't sure what to read into it: was there some greater meaning to the

[23] The question "who else looked at this object" was tagged as 'stamp' therefore we could look for this tag in the clickstream path. However, due to an oversight, we did not tag this question for each object differently therefore could not tell with complete certainty whether someone had hit the back button or if they had moved to the question for a different object.

collection and placement of imprints? In this vein, several people tried to figure out how they might design their imprint differently in order to make their imprint bolder or position it in the center of the mosaic. They wondered if there were rules they could have played with or if the mosaic was simply random. Overall however, the display did not seem to generate much discussion or pause for reflection. People would stand in front of the display, squint their eyes to find their imprint, and then walk away. The display suffered not only from being tucked back in a corner and having networking difficulties (when the display was down an Error File Not Found web browser page was displayed), but the screen resolution also made viewing the imprints difficult. Several people during the interviews suggested ways to improve the display however – for instance making the screen interactive so that if you touch an imprint, you can see where this imprint was left behind in the gallery. Or as another suggestion, grouping imprints not in order to make a photomosaic of a popular object but because the imprints themselves were similar based on similar content in the imprint or based on similar paths through the museum. The fact that people had opinions about how to improve the display indicated again the potential for turning it into a valuable addition to this type of experience.

Overall, viewing the imprints on the handheld was more successful in terms of social presence awareness than viewing the mosaic of imprints displayed on the museum wall. Visitors could easily read an imprint's significance when associated with an object, but the wall display was too ambiguous without inviting interpretation. This suggests that perhaps using social information in the museum for utility or tool-like functions (as in a recommender system for finding other objects) made more sense to visitors than portraying the social information as art itself. The mosaic display in its

current form served as neither art nor tool. To be art, it needed to be more evocative to allow for playful or poetic interpretations; to be a tool, it needed more context cues for people to be able to read it.

Discussion

The purpose of this stage of investigation was to explore aspects of the museum experience that have been overlooked by technology. Previous attempts to use technology for more active visitor participation, such as MUSE, have met with limited success partly due to the institutionalized definitions of the museum and the visitor's traditional role. This study therefore supported new forms of expression through reflection of existing behaviors and built upon findings from the initial pilot study with visitors and museums staff. The simplicity of the Imprints process acted as a scaffold for the realization of alternative visitor roles and the impact of presence in the co-construction of the museum experience. The evidence collected through interviews and log files suggests a degree of reception to technology and use for personalization and social awareness. Future work with technology in the museum should incorporate these opportunities, adjusting the balance between individual expression and the larger temporal social context.

Although this stage of work provided evidence of uptake and value, it also identified a number of areas for improvement in both the design and the evaluation methods. On the design side many of the improvements will be realized through a more robust implementation of the technology. We are in the process of building a new handheld tour system for the Johnson museum's permanent Asia Gallery collection focusing on art of the Buddha and Bodhissatvas. The results discussed here have provided a valuable starting point for this process. One final mark of success is that the museum educators

requested that we work with them again to build in the social component for the device. Furthermore, they indicated that in their grant writing for funding, they discuss the importance of this component in addition to providing information about the objects. Although our evaluation focused on the visitor's experience with the Imprint program, this acceptance from the museum educators indicates that the program was valued by the museum staff as well.

For design improvements, we are exploring how to make the imprints more evocative of the 'kindred spirit' connection expressed by one of our Byrdcliffe visitors. In the Byrdcliffe marks, connections were deduced generally through the symbolic content or, similar to the Amazon.com model, familiar patterns of consumption in terms of objects visited. For the Buddha tour, we are planning to ask people to write a word that symbolizes something they wish to meditate on. These words will be stylized into a chop or stamp in cinnabar (the traditional color for Japanese seals). Instead of demographics or consumption patterns, we felt asking visitors to disclose something they were thinking about might afford kindred spirit connections. In addition to improvements on the design side, we will also address the evaluation issues. As discussed some of these were linked to the technical issues of coding and the network difficulties. Improving these will allow for greater control over meaningful comparisons. For instance, we can compare if objects that only have stamp information still receive visits on the handheld tour. We can also compare the tour with and without the imprint program to assess what the imprint program adds to the tour process.

The issues above will be taken up at a later time (outside this case study), but the lessons learned in stage two of our case study also informed the development of stage three where we explore the question of bridging art

and tool in more depth. Whereas the imprint program combined art and tool by having two different interfaces – the handheld application serving as tool and the collective display intended to serve as art – in stage three we wanted to collapse these categories even more and create one installation that would serve as both art and tool simultaneously.

Stage Three: Birdscape

Stage three of our overall case study on designing new technology for the museum environment involves another project designed for the Johnson Museum, but specifically for their permanent collection in the Asia Gallery. While the stage two Imprints program took a fairly literal approach to reflection on visitor presence and tackled the art and tool divide by having two separate interfaces to the system, Birdscape is more abstract in presentation and aims to combine tool and art functionality into one experience. Furthermore, the Imprints program only reached visitors who self selected an experience of the art museum mediated by technology as tool. Visitors experienced the Imprint program only after they decided to take a guided tour of the museum and therefore we reached a smaller subset of visitors, and potentially a subset more familiar with using technology in museums in a standard way. For this next stage, we sought to reach a wider subset of the visitor population and therefore did not want to tie the experience to the handheld guides. Instead we wanted to use sensor technology that could be embedded in the environment and available to all visitors simply through their presence.

In order to develop a system that better hybridizes art and tool, I initiated a collaboration with Xiaowen Chen, an artist and professor at Cornell University. Our collaboration began at an open house held by the Information Science program, an event designed to bring together researchers from a

range of disciplines. During this event, Chen and I discovered a shared interest in new technology and art in the museum. I wanted to draw from the arts and humanities as a means for pushing beyond the usability and task focus of tool design dominant in HCI. Chen was interested in exploring new artistic practices enabled by science and technology research. We therefore felt that the combination of our different background, and mutual interest in each other's work, would facilitate this attempt to bridge art and tool. Part of this case study then will be about examining this strategy of addressing an interdisciplinary space through the simple combination of different disciplines. In this effort, Geri Gay of the HCI Group and Phoebe Sengers of the Culturally Embedded Computing Group joined us in refining the conceptual ideas. Throughout the following sections, I will outline how this collaboration developed further, the resulting design, and an evaluation of the design in the museum.

Design Objectives

The initial starting point for the project was to identify the marginalized aspects of the museum experience we wanted to target. To generate ideas for this end, Chen and I began by sharing points of inspiration. We both identified The Weather Project by Olafur Eliasson as a motivating piece (see Figure 4). The Weather Project was installed in the foyer of the Tate Modern in London, England in 2003. It consisted of more than 200 low-sodium lights behind a translucent shield generating not only light, but also warmth. The sodium lights generated only the bottom half of the sun; mirrors on the ceiling completed the top. Eliasson cited the British obsession with the weather as his point of departure, and indeed sun-starved Londoners flocked to bask and picnic by the simulated glow. People soaked up the atmosphere, but they also became

part of it as they quickly found and played with their reflections in the mirrored ceiling. Visitors could be seen simply waving at themselves or more ambitiously spelling words with the help of their friends' bodies.

A couple of important points emerged from our discussion of the Weather Project. First, it was a very site-specific piece. It fit both the outside (London and its characteristically horrible weather) and the inside (the dramatic open foyer of what used to be an industrial power plant). Secondly, the technology for reflection behind the Weather Project was the humble mirror. People intuitively interacted with the installation as it elegantly reflected presence in the museum.

Figure 4. "The Weather Project" by Olafur Eliasson, view from the Tate Modern's entrance foyer. Photo by Bob Binda.

The simplicity of the technology in the Weather Project led to discussions of other media installation pieces such as The Wooden Mirror by Daniel Rozin and Text Rain by Camille Utterback and Romy Achituv. In both of these works, the technology is simple but the conceptual experience rich. In the Wooden Mirror, a 6-foot tall display is created out of 830 wood chips, akin to 830 pixels, each driven by a motor and tilting dynamically for the required

light intensity to reflect the image captured by a video camera behind the display. The artist suggests this piece plays with the divide between the analogue and the digital, but, whether or not the visitor grasps this distinction, the mirror is intuitively playful and a simple interaction causing wonderment about how it works. In the case of Text Rain, the shadow of visitors' bodies or props provides a ground for catching the text of a poem falling from the top of the screen. Visitors catch words and phrases with various parts of their body, causing reflection on their movement and the interaction with words. These examples contrast with systems designed with very complex technology and more shallow conceptual ideas, such as the systems presented at the 2005 Boston Cyberarts Festival and reviewed by New York Times art critic Sarah Boxer (2005). In her review, Boxer suggests that the technical interactivity employed by several of the systems at the Cyberarts Festival were about creating novel interfaces for interaction, a showcase for the technology, as opposed to a richer evocative experience.

One caveat must be mentioned in reference to the installations just described. As described in the introduction, we wanted to bridge art and tool functionality. All of the pieces mentioned here as inspiration fall neatly into the category of art. They cause new reflections and new forms of participation but they do not necessarily engender new experiences of the museum visit, in other words, visitors would not likely use these pieces to inform the rest of their museum visit. These pieces comfortably occupy the pedestal of art as installations that the visitor interacts with before moving on to the next interaction. The installations do not permeate the museum experience except by the lingering effect they have in the visitor's memory. Jennifer Crowe and Scott Paterson created an example for the Whitney Art Gallery in New York

City[24] of something closer to the experience of something permeating the museum visit. With the installation Follow Through, Crowe and Paterson targeted visitors with handheld guides to draw attention to the disparity between the vibrant art on the walls and the relatively passive form of the visitor. This was accomplished by having posture notes displayed on the handheld for each piece (see Figure 5). In this way, the guide acted as a playful commentary on traditional postures but also alerted the visitor to different ways of responding.

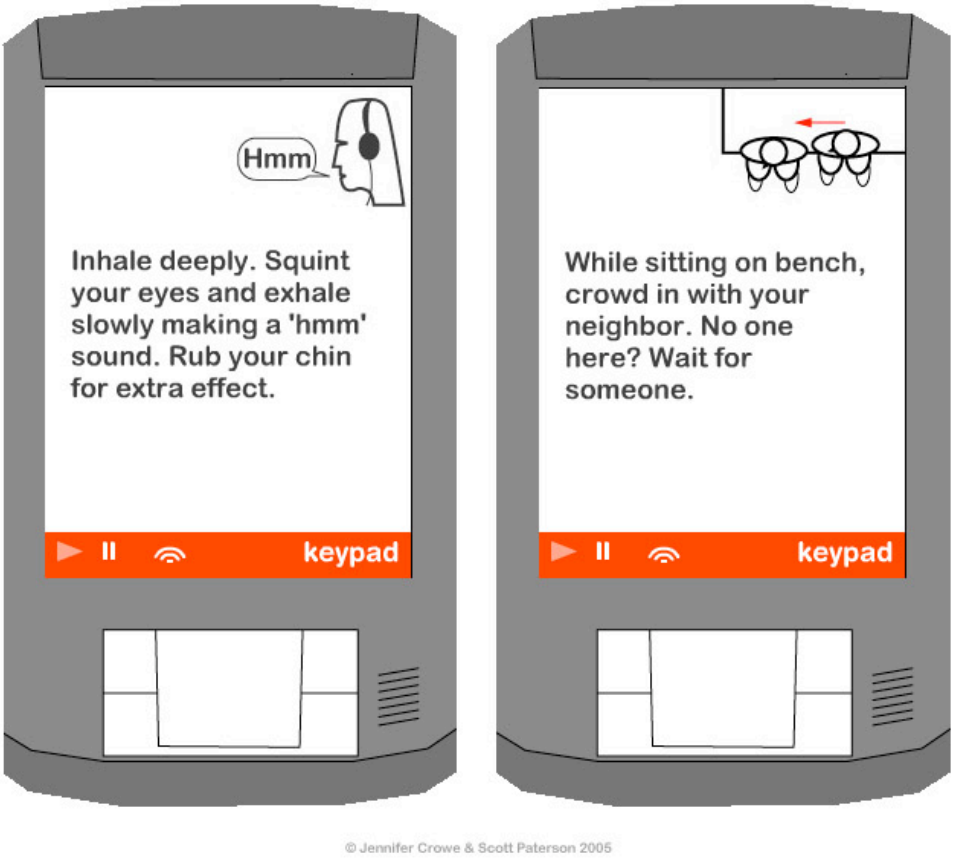


Figure 5. A mock-up of the Follow Through installation. Copyright Jennifer Crowe and Scott Paterson, 2005.

[24] This project did not launch until after the Birdscape project had completed, therefore we could not use this as a point of initial inspiration, only as a point of subsequent reflection. http://artport.whitney.org/commissions/followthrough/

In addition to identifying art works that provide inspiration, Chen shared a personal anecdote that became a touch point for the resulting design. As a small boy growing up in China, Chen remembered visits to a modern shopping mall in his hometown. During each of these visits, he would gaze up at the ceiling to watch the fish swimming in the aquarium visible overhead. He never explicitly questioned where these fish came from but enjoyed watching their darting movements. As he got older, he realized the black silhouettes he saw were not fish at all but the soles of people's feet as they walked on the translucent glass walkways above him (see Figure 6). The shadows were a literal trace of presence – like the bodies reflected in the Weather Project – but these shadows only revealed themselves for what they were after the passage of time.

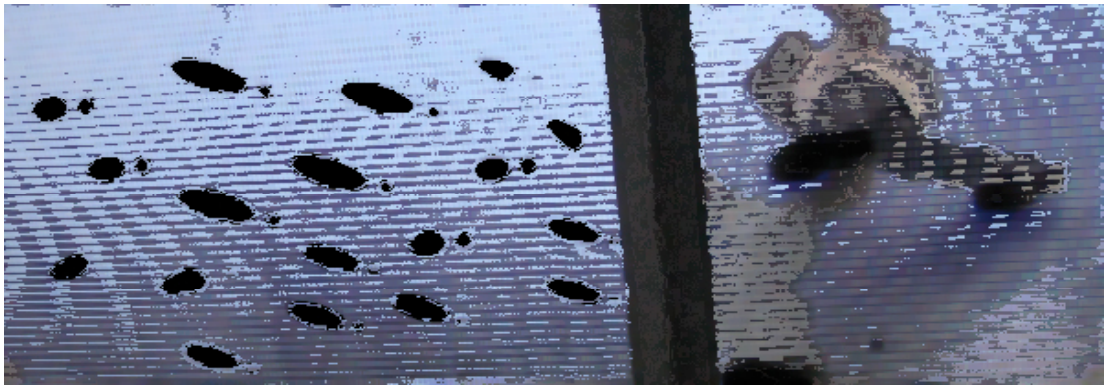


Figure 6. A sketch of Chen's memory of fish/footsteps

Design Objectives

From these stories and examples, I can now summarize the objectives guiding our new design. Specifically, we wanted to:

- Encourage reflection on other aspects of museum experience beyond just the individual art objects. This reflection may occur during the initial visit or perhaps only after repeat visits.
- Design for openness to interpretation. Whereas the Imprints program or something like the Weather Project created simple one to one mappings between individual and impact, we wanted to leave more room for interpretation and adaptation.
- Be technically simple yet evocative. We did not want to simply create a technically novel interaction interface.
- Avoid creating a separate art installation but instead something that permeates the museum experience.
- Integrate with the specific space.

Design Methods and Implementation

As we worked toward the design objectives described above, a simple metaphor of migrating birds, hence the name Birdscape, began to materialize. Chen suggested the sound of birds as a proxy for presence, or rather lack of presence, in undiscovered areas of the museum. The connection of birds with visitor presence would be achieved by implementing a sensor network attached to speakers across the gallery space. Based on measurements of activity levels, bird sounds would trigger from the speakers in areas lacking visitor activity. If visitors are drawn to this space, or if they navigate there independently, the bird sounds stop as the birds metaphorically fly elsewhere. We felt this design embraced both the functionality of art and tool. As art, it had the potential to cause reflection and be open to interpretation. As tool, it could be used to navigate to new areas of the gallery.

Once this initial idea materialized, the team could align and assess the implementation around the guiding objectives. In terms of a site-specific design, for example, the bird metaphor was a perfect fit. The gallery space holds Asian art with many pieces honoring or representing nature. The space itself is a quiet haven for contemplation. Most dramatically, however, 360 degrees of window views surround the perimeter and look out from the perch of the fifth floor toward Cayuga lake and the hills of Ithaca. Many visitors come to the Johnson Museum simply to take in this view. Finally, Cornell University has a special relationship with birds as the home of one of the premier ornithology research labs.

The decision to use sound helped achieve the objectives of permeating the museum space and designing for open interpretation. Prior to deciding upon the bird metaphor we had engaged in discussions about whether the installation should be a visual display of people's presence or something like the emotional climate of the gallery. These ideas all took shape around some form of abstract animations or images projected onto a screen. In one design idea, we proposed immersing visitors in a room and projecting images of reflected emotion along the walls. In these examples, however, we ran the risk of creating an art installation separated from the rest of the museum. Furthermore, the visual displays tended to be better for conveying information, depicting presence for example, as opposed to encouraging an alternate experience of the museum space. We were striving for a design that would indicate presence while experiencing the space as opposed to depicting presence at a single point in space.

The technical apparatus for the Birdscape system is purposefully simple. Engineered by Eric Lee and Arun Israel, the system consists of four

small devices, each comprised of a PIR motion detector, a small speaker connected to a sound-chip, and a small PC board containing an EEPROM chip and a serial port. These four devices are placed into floor recesses in the gallery (see Figure 7), as far as possible from each other. The motion detector is then positioned to measure motion within a wide angle of view. Every time the motion detector is triggered the event is logged on the device's internal memory. The motion detector thus tracks an approximation of the activity level, but not exact head counts or direction of traffic. If the detector is not triggered for two minutes, a short sound loop of wild birdcalls starts playing from an attached speaker. When an object crosses the detector's range, the birds "fly away" and the singing stops.

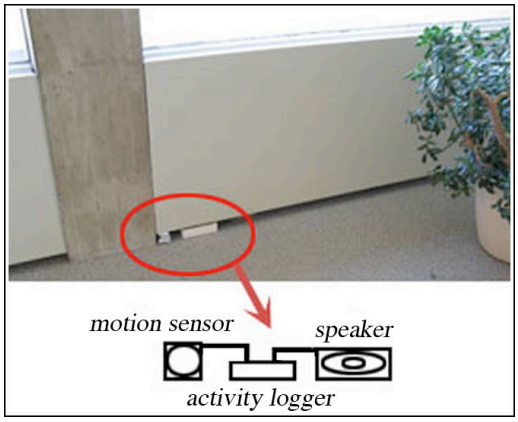


Figure 7. A bird sensor in one corner of the Asia Gallery, and a simple schematic of components.

Finally, we can consider the first objective, the overarching objective of the entire project, to design technology for alternate activities in the museum by augmenting that experiences are taking place instead of dictating what those experiences should be. Rather than occupying the role of art itself or the role of providing information about the art on display, we wanted the Birdscape

to occupy a new design space by augmenting marginalized aspects of the museum experience. For the HCI group, the marginalized aspect we wanted to design for was the fact that the museum houses not only objects but also people. Any experience in the museum, whether sublime or mundane, is textured by this dynamic presence. Whether or not visitors attend to this presence explicitly, a crowded gallery influences our experiences in ways that an empty gallery does not. This is why the bird sounds keyed off the presence and absence of visitors.

Because we were concerned about the motion sensors simply becoming a novel interface turning the system on and off, we provided an explicit 'frame' to the experience in the form of a small placard or sign near the front entrance of the gallery. Underneath the title Birdscape and the creators' names, the placard read:

> "The bird sounds you hear in the Asia gallery today are generated by the absence and presence of visitors, including yourself. Motion detectors are monitoring the level of activity in various parts of the gallery. Areas with minimal activity will produce bird sounds. Once activity resumes in the these parts of the gallery, the birds 'fly away.' This movement of sound creates a dynamic soundscape of presence in the gallery."

Therefore, we directly linked the birds to presence in the gallery. Although the explicitness of this signage may seem to close off room for interpretation, we felt it was open enough to allow different interpretations of what to do with this information. In other words, if the birds are keyed off of presence, what does this experience mean? How might people respond to or make sense of this information? Originally, we had planned to remove this

framing device to try and gauge how much of an effect it had on people's interpretations. However, the results presented here focus only on the study when the frame was present.

However, Chen also brought a slightly different focus to the project. For Chen, the marginal experience to augment was the outdoor view. He wanted to play with the fact that visitors came to the gallery not just for the artifacts inside, but for the view to the outside. He sought to permeate the boundary between outdoors and indoors, bringing sounds of nature inside as art and directing the eye outside to the aesthetic of the natural world. Although Chen and I may have outlined different perspectives in terms of the marginal experience we wished to augment, these were not incompatible. On the contrary, I felt a design that could encompass both would push us toward designing for the openness to interpretation we hoped to achieve.

Evaluation Methods

Before introducing the specific evaluation methods used for this installation, I will outline what we were hoping to assess in addition to meeting our design objectives. In a standard HCI evaluation, the first step in designing an evaluation is identifying the criteria of a successful design in order to determine the appropriate metrics to measure. One of my questions in working with an artist outside the traditional HCI practices was whether the idea of evaluation would be foreign or irrelevant to him and if our evaluation practices would need to be transformed to have relevance for evaluating the space between art and tool. Höök, Sengers, and Andersson (2003), for example, have explored the tension between applying evaluation methods from HCI to the digital arts world and the reverse application of the art world's perspective on evaluation for HCI. An artist may deny that evaluation even matters,

whereas, an art critic may use the term ‘evaluation’ differently from the way an HCI practitioner uses the term. An art critic will judge how a piece fits within or against an established canon or history of art, while an HCI practitioner will begin with a set list of objectives and criteria of success that the final design is then judged against. Evaluating art in terms of meeting its ‘objectives’ seems tantamount to treating art as something that can be reduced to a ‘tool’ as opposed to honoring its nature as an open ended experience.

In our experience, however, Chen did not find the question of defining criteria of success a difficult one to answer. In fact, he had a very clear view of what would constitute a failure and what would constitute a success. Chen identified two main types of failure for interactive installations in general: 1) if people never recognize that it is there, or they choose to ignore it, and 2) if people interact with it only at the level of the technical interface. They may approach it as a novel game and once they’ve found the underlying apparatus (such as the motion sensor), they lose interest rapidly. We felt if these two types of experiences were the only ones to materialize, then we would consider the installation a failure. Therefore, in some ways, we defined success in terms of not being a failure, a condition more easily identified.

Yet, we could also speak in positive terms about the kinds of experiences we hoped to engender. For example, Chen described what he would like if he were a visitor to the space:

> *“I would imagine myself getting up [to the gallery], walking into the space, being immersed into the space, and seeing the works -- the art work, seeing the beautiful landscape. But then gradually, I might notice there are some bird sounds. And this might make me start to feel like I am not in the museum. I see that moment as very powerful…it’s not the*

museum, but it is the museum. It's nature, but it's not nature. So you blur that boundary."

Similarly, when asked to articulate my own criteria, I would describe a successful experience as:

"I would imagine walking through the space, looking at the art, looking outdoors, looking for something interesting. And then I would hear something unexpected: the sound of birds. Perhaps the sound would draw me toward it to see if I could find its source. But the closer I get, the further it goes. Maybe I would play with this a little bit, chasing it perhaps. Ideally, I might stop and watch how other people interact with this same event."

Both of these stories describe an ideal type of interaction, although we had also hoped the design was ambiguous enough that experiences we did not anticipate might also occur. It is interesting to note how despite the close affinity in terms of inspirations and objectives, at this point, the differences in perspectives between myself and Chen are starting to emerge. Although both are described narratively, Chen's description focuses on one evocative moment whereas my description reads as a much more goal oriented activity despite my desire to move beyond the task focus of HCI.

From defining the criteria for success, I can now move to describing the evaluation methods we used to assess whether or not we met these criteria. Birdscape was installed in the Johnson Museum for a period of three months. Over this time period, we had originally planned to modify various attributes of the system to assess how people make sense of different configurations, for example altering how the experience is framed in terms of the signage available or altering whether there is visual feedback in addition to the auditory

feedback of bird sounds. This first installation, however, evaluates the basic Birdscape design through an assessment of visitor and staff reactions.

We used a combination of sensor data, observations, interviews, and feedback cards (see Figure 8). The motion sensors collected information about activity levels and time of day. In the original evaluation plan, I intended to collect activity information with the bird sounds turned on and off in order to compare visitor patterns that could be attributed to the absence or presence of the bird sounds. Unfortunately, however, the sensor implementation was not robust enough to present these results – the sensors would often not be triggered when someone was present and at times throughout the installation various sensors were not logging data at all[25]. Instead, I will discuss evaluation results from the observations, interviews and feedback cards.

In designing the evaluation cards for visitors, I specifically drew from our objective of openness to interpretation and from art practices in general. As opposed to a rigid experimental survey, we wanted to leave visitors room for expressing themselves in a variety of ways. As a result, we received comments, scribbles, pictures, and indications of emphasis such as underlining certain words or exclamation points. This type of feedback card is a departure from a traditional HCI evaluation method (although similar to ethnographic approaches as employed in HCI). Instead of setting up the exploration to allow for statistical analysis of majority opinions along predefined categories (e.g. 'on a scale of 1 to 7, how much did you like the bird

[25] The sensor kits were homemade devices with lenses literally taped to foam core and place precariously on the floor. If the devices shifted at all, the angle required for the sensors to pick up movement was disrupted. We therefore continuously had to check the devices to make sure they were still functioning properly.

sounds?'), we were primarily interested in different shades of the visitor experience that might emerge.

The feedback cards were available at the entrance of the gallery near the sign describing the installation. The first round of feedback cards were postcards with two prompts: "Today I heard soft bird sounds in the gallery, these made me…" and "I'm visiting the gallery today because…". For the first prompt, I deliberately did not include a second verb such as 'think' or 'feel' because I wanted to see what kind of behavior seemed to be elicited more. The main problem encountered with the feedback cards was that visitors took the cards as keepsakes instead of leaving them behind. In our first pass, only 10 out of 20 cards taken were returned. Therefore, as a next pass, we created a comment book with the same prompts on each page. Each page was marked with a bird bookmark that visitors could take away as a thank you.

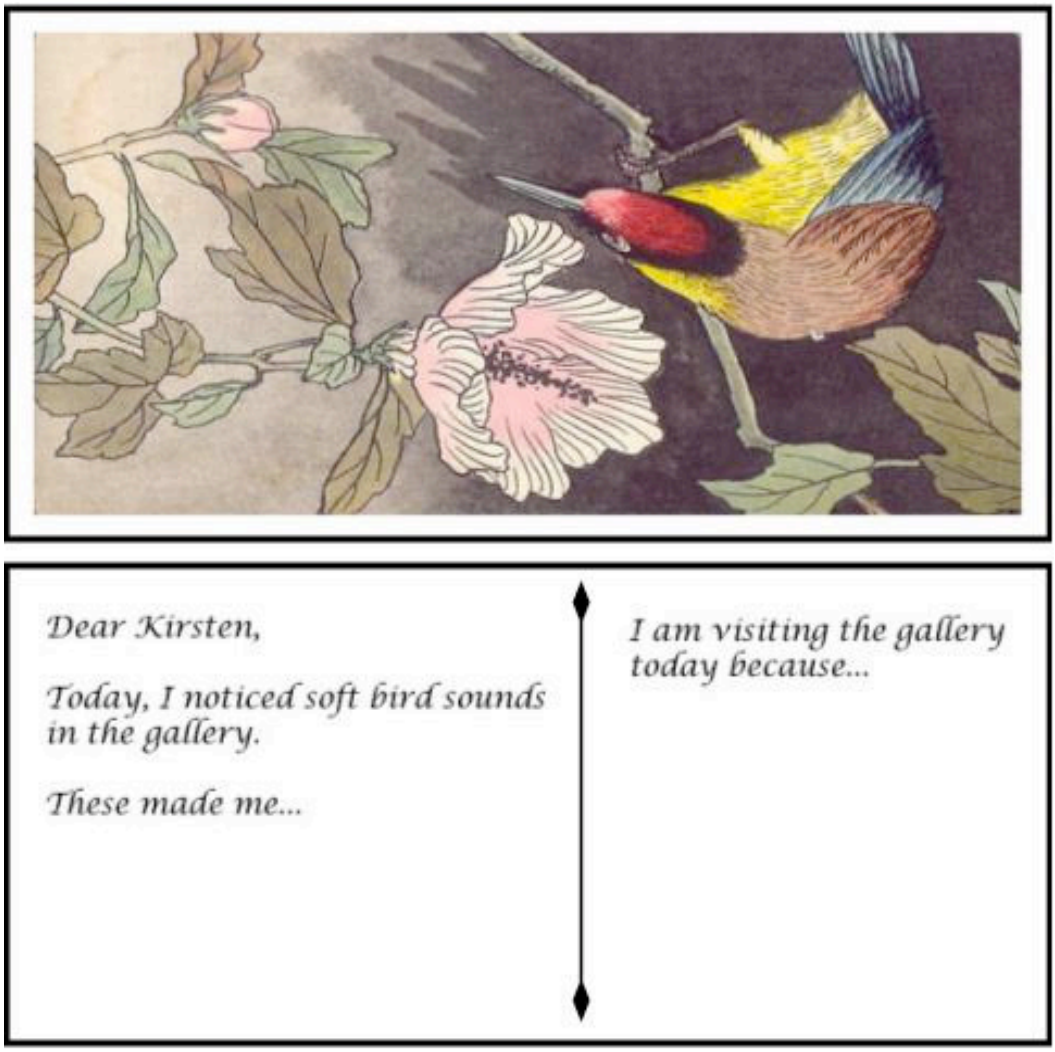


Figure 8. The front and back view of the evaluation postcards

For the interviews, I interviewed the additional members of our design team, the curator of the gallery, visitors to the gallery, and security guards who witnessed visitors' reactions to Birdscape over the length of the installation. The interview with the curator, Ellen Avril, lasted approximately 30 minutes and included questions about the design objectives as well as her impressions about the visitors' experiences. Interviews with the security guards focused on the guards' own impressions of the installation as well as their impressions and anecdotes regarding visitor reactions. These interviews were shorter,

generally 15 to 20 minutes, as they transpired during the guards' breaks; six guards were interviewed in total. Finally, I both observed and interviewed museum visitors. Interviews with museum visitors were very short, from 5 to 15 minutes long, as visitors were often on their way to another part of the museum or leaving the museum (one interview for example lasted the length of the elevator ride from the 5th to the ground floor). In total, I conducted six interviews with single or groups of visitors, interviewing a total of 12 people. The interview consisted of asking if the visitor(s) had heard the bird sounds, what their impressions were, and the purpose of their visit to the museum.

Results

I will present the results from the installation in two groups: first the collected responses from the feedback cards and comment book, and then a summary of reactions from the interviews with the visitors, guards, and curator. Because of the format of the feedback cards, i.e. specifically asking visitors about their impressions of the birds, this data source only reflects the attitudes of visitors who had noticed, or were directed to notice, the installation. As a quick description of the 37 responses gathered, almost half (51%) indicated the sounds made them 'feel' something, such as happiness, calm, surprised or natural. Of these responses, two people indicated feeling 'annoyed' and although we hoped the experience would be open for interpretation, for this particular piece we would classify 'annoyance' as another type of failure. However, within this small sample, the annoyance factor appears small. A quarter of the 37 responses (24%) commented that the sounds made them 'think' of birds or nature. The rest of the responses were

either general comments about liking the Birdscape (5%) or about the museum gallery (19%)[26].

Several responses indicated that the sounds caused visitors to blur the indoor/outdoor boundary:

> [The sounds made me…] *"feel invited. I loved the bird chatter. It added to the serenity and felt like wonderful company".*
>
> [The sounds made me…] *"feel surprised at first because I thought I was outside. But it was actually pretty peaceful. Props."*
>
> [The sounds made me…] *"feel as if I could picture myself outdoors in one of the lovely scenes depicted in the hanging scrolls."*
>
> [The sounds made me…] *"on a beautiful day like today, they made the indoors like the outdoors."*

Two people indicated changing how they moved in response to the bird sounds:

> [The sounds made me…] *"At first I didn't hear the sounds [but because of the comment book]…I walked back toward the main quad until I was about to give up…then finally I heard them. Feel very high up. Go towards the sounds, feel more connected to the environment."*
>
> [The sounds made me…] *"The bird sounds were great. They created a sense of playfulness and calm. They also drew my attention from room to room. Like walking in a forest. It was lovely."*

[26] Because used for descriptive purposes only, percentages were rounded to the nearest whole number, therefore don't add up to 100%.

As a self-selection method, the comment cards and book only provide insight from people who actively chose to comment on the birds. Therefore, to provide additional views onto the visitor experience, I will turn to the interviews and observations with the visitors, security guards, and curator.

The security guards provided a broad summary view of visitor reactions in addition to specific anecdotes. The guards in a sense became a critical interface to the project as visitors would often stop and ask them where (or what) the bird noises were. All six of the security guards interviewed indicated that when asked by visitors about the Birdscape they would explain it as a 'project' (as opposed to an installation or art) about visitor movement in the gallery or about measuring the most popular or least popular objects on display. One guard said he explained it to visitors as a zen-like version of hide and seek: you look for something only to discover it's not there.

When asked to summarize visitor reactions, the guards felt many people simply did not seem to notice the birds. This is the same impression the curator had of the visitor experience and was corroborated by our own observations and interviews. When visitors did notice the birds, however, the guards recounted watching people look around, first outside and then inside, for the source. When people explicitly asked about the sound and the guards explained it, the guards and our own interviews with visitors indicated that visitor reaction was positive. People commented that the sounds were soothing or made them feel like they were outdoors. The curator of the gallery also felt that response to the birds, when noticed, was positive. However, from the guards, the curators and our own interviews, it was evident that people did not connect the bird sounds to the absence or presence of visitors. When

reflection was triggered, it was about the connection between indoors and outdoors.

Several people interpreted Birdscape as an ambient part of the Asia gallery. Some thought it was for atmosphere across the gallery. One woman I interviewed for instance had just recently visited a nature museum in California where soundscapes of nature featured prominently. She assumed the bird sounds in the Asia Galley were something similar. A couple of people thought the birds were connected with a particular piece in the gallery as opposed to a backdrop for the whole floor. In the results we collected, this impression happened only in the room with no windows. Three of the four sensors were placed on the perimeter of the gallery, but one sensor and speaker were placed in an alcove without a direct line of sight to windows. When people were asked about the birds while in this room, they tended to assume the sound was connected with either one of the Japanese nature prints, or interestingly enough, with the samuari warrior's battle gear, the most prominent piece in the room. This suggests that perceptual salience played a large role in people's interpretations – when they were on the perimeter, the windows were an obvious point of reference but in the internal room they either related the sounds to something associated with birds or to the largest piece in the room. Similar to the priming of the woman's experience with the nature museum in California, one visitor indicated that he had connected the bird sounds to the nature prints because he had just seen a multi-media piece on the gallery floor below and assumed this was of a similar nature.

We had little evidence of people simply interacting with sensors as a novel interface – i.e. tripping the sensors with no reflection on the overall experience. Although the sensors were placed in recesses on the floor, they

were still visible if a visitor directed his or her eyes toward them. In the three months of installation, however, we only witnessed or learned of two incidents of 'gaming' the system. I observed only one person literally laying on the floor and looking at the apparatus, and a security guard informed us that one person actually turned the play button of one of the speakers off and left a note: "Ha ha Bird Man. The gig is up."

In addition to asking for and observing visitor impressions, we were also interested in interviewing the guards and the curator for their own impressions of Birdscape. Five of the six guards we interviewed felt the Birdscape added to the museum experience because it was something different, it made people stop and think, or it added an element of life to an otherwise quiet space. Some of the guards even played with and extended the Birdscape functionality. One guard, for example, would augment the sounds with his own bird calls. Another guard revealed that he could use the sound of the birds to track people as they moved through the gallery – a kind of remote monitoring tool. A third guard described extending the reach of the Birdscape by using his push to talk radio to broadcast the birds throughout the museum. His fellow guards thus became mobile speakers, something that they quickly stopped out of annoyance. When asked if they felt the Birdscape was more art than tool, all of the guards described it as art for themselves, even though they described it to visitors as a project about visitor movement and monitoring popular areas in the gallery.

Our discussion with the curator was enlightening about the art and tool distinction as well. She worked with us during the earliest discussions of this project, prior to the bird metaphor even developing. Her original interest was in the data that could be collected about visitors' patterns and preferences. In

other words, she saw the project as a potentially useful source of information for curators and museum staff. At first, she was not sure how this same information might be valuable or interesting to visitors. In other words, she only saw the tool potential of the project, but not as a tool for visitors. As the project progressed, however, she also felt visitors approached the sounds as a type of art experience or perhaps as subtle background music for their regular museum visit.

Discussion

Based on the results from the visitors' written comments and the interviews with various museum stakeholders, I can now return to our original design objectives and our criteria for success or failure. In terms of the criteria for failure, we listed gaming the system or never noticing the system. We only had two recorded instances of people simply playing with the system at a technical level, i.e. trying to start and stop the sounds purely at the level of interacting with the sensors. However, we had more evidence of people not noticing the system. On the one hand, this would register as a failure for these visitors. On the other hand, some people did notice the sounds either at an ambient level or consciously trying to find the source. I can not conclude as a whole then that the project failed. Furthermore, we had also agreed that if the system required multiple encounters in order to understand (like Chen's fish/footprints), then this would be a successful design. During the time of our installation though, we did not record repeat visitors so could not assess how people responded to the installation over time.

One of the limitations of this evaluation is in the lack of information regarding visitors who did not notice the system. We did not collect enough information from such visitors to conclusively say what encouraged or

prevented people noticing the bird sounds. One speculation we have is that the low number of sensor/speaker points, basically the four corners of the gallery, meant that if people made a single loop through the gallery, they only had four points of contact with the bird movement. This low exposure combined with the relatively low sensitivity of the motion sensors (the PIR detectors often missed people who were close to the sensor but not within its range of sight) could effectively prevent people from hearing and registering the sounds. Therefore, in practice, the sense of visitor control or influence over the sensors may not have been high enough for encouraging greater levels of visitor awareness. For a future implementation we have planned to section the gallery into eight zones, as opposed to four corners, and we will be using more powerful sensors. These are speculations based on the technical limitations of the system. I will turn now to examining each of our design objectives in turn in order to discuss if the limited awareness of the Birdscape was due solely to poor implementation or to poor design.

Site specific

We set out to design specifically for the Johnson museum's Asia gallery. Based on the positive reaction from the curator, the guards and visitors who noticed the system, we felt the Birdscape fit well within the space. The birdscape metaphor worked because of both the content of the art in the gallery and the architecture of the windowed space. In fact, one possible interpretation of why the Birdscape was not noticed was because it fit too well within the space and therefore became too ambient.

Avoid creating a separate art installation.

For this objective, the intention was that we would not just create an art piece that was simply dispersed throughout the gallery. We wanted the installation to serve both as a point of reflection, either on presence or on the indoor/outdoor boundary, but also that the sounds would draw people to different parts of the museum, i.e. that the installation would have a functional component to it as well. In this regard we were less successful. Although the guards and the curator recognized that the system could have information potential, the visitors did not experience the system in this way. Only two visitors indicated that the system influenced their movement into other parts of the gallery.

Be technically simple yet evocative.

For this objective, we believe we were successful. The PIR system was a very simple set-up and even the planned enhancements to the system will not make the technology the focus of the system. Furthermore, the fact that visitors did not show an interest in gaming the system suggests the focus was on the experience of the sounds and not on the mechanics that triggered the sounds.

Design for openness to interpretation.

There was a small range of interpretation amongst the visitors who did notice the sounds. Some thought they were background music for the gallery or individual pieces and some, most likely with the help of the guards, the comment book and/or the placard, used the sounds for reflecting on nature. We did not have any unexpected interpretations from the visitors but we did have unexpected adoption of the system by the security guards. The one security guard who realized he could use the system for remote monitoring

varied our objective slightly – we had thought if visitors connected the sounds with their own movement it would draw them into different places of the gallery. The guard figured out since the sounds were connected to visitor movements, he could stand in one place. The guard who used his push to talk radio provided the most extreme adaptation in our sample by reflecting the presence and movement of one floor to other floors.

Two design principles we have played with in other projects for supporting an openness to interpretation are ambiguity and the avoidance of one to one mappings between a representation and a set meaning. We felt that the use of a metaphor, such as birds flying away at the approach of people, was an example of ambiguity in the design. We did not want, for example, a visual display over a floor map that showed the most popular and least popular areas of the gallery. However, the metaphor we used may have been too well situated in the context. Several visitors took the sound of birds as actual birds and therefore were not open to any kind of interpretation or reflection other than wondering where they were roosting and looking for their source on the ledge or in the trees outside. This suggests that in the spectrum of the familiar to the strange, we had erred perhaps too far toward the familiar and needed to push more toward the strange end of the spectrum in order to encourage both the moment of reflection and the range of meaning that could be constructed.

In terms of the one to one mapping, we also fell short on this design principle. This is not just because the birds were mapped to actual birds, but because of our technical limitations we only had two states for the birds: on and off. Therefore, the bird sounds would be on, but the moment they were triggered, they turned off. The one to one mapping then was: presence, off;

absence, on. Although a simple one to one mapping should help people recognize their influence on the system, we believe it may have had an opposite effect. For the future installation, we plan to play with the complexity of the sound adding variables such as tempo of the call or increasing the volume based on triggers such as time since last trigger or number of people in the gallery. This would not be done in order for people to read and decode the sounds but to give them a greater degree of richness and variety that could have one meaning but could also generate alternate interpretations.

Encourage reflection on other aspects of museum experience.

This last objective was the original starting point of the project – to design technology so that it did not just stand as art but also did not just function as a guide for information transfer about the art on display. Toward this end, Chen and I had slightly different but compatible ideas of the kinds of experiences we wanted to support. Chen wanted to support reflection on the indoor/outdoor boundary and draw people through the gallery as they followed the birds. I wanted the bird sounds to stand as a reflection of presence but to also draw people throughout the gallery. From our results, the majority of people who did use the system for reflection reflected on the art/nature divide. A very small subset (2 out of the 49 comments from the book and interviews) indicated that the sounds made them move differently through the gallery. No one except for the one security guard indicated using the system for reflection on presence.

By creating a design that in theory could support at least two different reflection points, we felt we were supporting the previous design objective of being open to interpretation. However, in the implementation, the design

favored one interpretation over the other. In our subsequent design sessions, the ideas we have for improving the chances of people reflecting on presence would likely demote the reflection on nature. For instance, one suggestion was to replace the bird sounds with the sounds of whispers or murmurs from past visitors, i.e. to block the interpretation that the sound is disconnected from people. Another idea was to use different lighting in the gallery based on presence and absence, lots of light in popular areas for example, or even bars of light projected on the floor as a type of luminary footprint. A third idea involved creating a visual display projected somewhere in the gallery that would depict the popular and less popular areas. All of these suggestions however start to turn against the other objectives – for instance, the visual display would not permeate the museum experience, i.e. it would become another stop or object on a visitor's tour. In addition, a visual display could potentially encourage a rational processing of the information, and an attempt to read the right message, as opposed to appealing to a gut feeling or peripheral sensation that would encourage reflection.

In processing these alternate design ideas with Chen, we decided to do one of two things, either the muffled voices (which would block the reflection on indoors/outdoors) or make the bird sounds more complex, for instance playing the sound of wings flapping as the birds fly away and adding this particular bird song to a new area in the gallery. This could potentially allow a visitor to chase a specific bird around the gallery. These redesign sessions with Chen were illuminating to me because they highlighted some of the divides in our practices. I will turn now to discussing an examination of designing and evaluating a system across disciplinary backgrounds.

Designing and Evaluating across Art and HCI.

At the beginning of the project, I had anticipated that we would have a number of cross-discipline challenges. I anticipated that the idea of evaluation would go against 'art' and I had thought that the HCI practice bound by project deadlines would contrast with the artist practice bound by inspiration. I was also curious as to whether Chen would find the collaboration useful or distracting, assuming that most artists operate as the solitary creator able to make choices due to personal tastes and intuition. I was worried that our approaching Chen would be viewed as an 'art goes here' approach to making our project more aesthetically appealing. At the same time, I was wary that the HCI lab could become a 'engineers code this' shop for implementing an existing artistic vision.

To some degree, however, I was disabused of these notions throughout our experience. First, Chen was quite amenable to project deadlines and indicated that these are often the source of inspiration even for artists. Second, he had a number of experiences working collaboratively. This was partly due to his work in China where collaboration was expected and the individual artist not encouraged. Yet this was also due, more recently, to his work with new technology and the need for collaborators with different skill sets. Finally, Chen was also amenable to the idea of evaluation as mentioned in the section on disclosing what a successful and unsuccessful design would be. I had thought an artist typically puts a piece of work out to the world because it is what he or she wishes to express and whether people 'get it' or not is less of a concern. The larger concern is that the curator or commissioner of the piece 'gets it'.

Despite the fact that my impressions of an artist's practices turned out to be somewhat naïve and stereotypical, there were nuances to our

approaches that roughly followed these initial impressions. Regarding the design process for instance, we had brainstormed for a long time about the possible forms the design would take but Chen eventually came up with the idea of the bird metaphor. And it was evident immediately that this just worked – it was 'better' than the visual representations I had proposed such as climate maps. It was also 'better' suited for the kind of reflection Chen wanted and less so for mine. I could justify that people might reflect on visitor presence, but I also recognized that his proposed design and even the objective of the space between indoors and outdoors was more elegant. This is troubling for an HCI practice, though, as I cannot point to how the idea came about or why exactly it was more elegant than a climate map.

Secondly, in terms of the collaboration, I do believe that this worked well but I often felt it was more of a coordination than a collaboration. Much of Chen's involvement happened during the initial brainstorming phase and then the task of implementing toward this design specification became an issue for the HCI team. As one of the engineer's on the HCI team commented:

> *"The challenges came from bridging the definition of the project between the designers, the engineers, and the artist. The engineers worked with a technical definition of "working" -- something that produced an output in a specified range when given a fixed input (e.g. the people counters, or motion sensor), that didn't necessarily mesh with the designers' definition of working in the "real life" context. The artist, on the other hand, seemed to find that coming up with and thinking about the idea was the most important part, and everything else was just "filling in details" -- not really worth worrying too much about."*

These differences in focus became apparent throughout the project phases, from the design to the implementation to the final evaluation and redesign discussion.

For the evaluation, I had been surprised that this was not an anathema to the artist but in practice, the evaluation was still not a priority. For an HCI practice, evaluation is a critical component but for the artist, evaluation is a 'nice to have.' Chen was definitely interested in the visitor's reactions to Birdscape but by the time the piece was installed in the museum, it was time to move on; whereas for us, the work was only half completed. This is not in any way a criticism of Chen as a collaborator but just an indication of the difficulty in interdisciplinary work. Although we both value each other's practices, the fact that the practices value different aspects of work means that it will be difficult to move beyond coordination to true collaboration. This insight was corroborated during a presentation of these findings to an interdisciplinary audience at the 2005 Digital Arts and Culture conference. The audience consisted of game designers, digital artists, interactive fiction writers, dancers, cultural theorists, and a small representation of HCI practitioners. On the one hand, we had a writer respond to the Birdscape presentation by asking why evaluation should matter for the artist, how the artist in the end will just choose what he or she wants to say and use their artistic judgment to decide what way is best. On the other hand, we had artists indicate that the movement toward more and more interactive art that blurs the boundary between artist and 'user' means that the issue of evaluation is becoming more critical for artists as well.

In our redesign sessions with Chen, I could see both sentiments at work. On the one hand, he was very amenable to starting a completely new design. He had said what he wanted to say about the indoor/outdoor boundary

so he was willing to start a new design that would reflect on visitor presence – suggesting that the evaluation was irrelevant for the initial design. On the other hand, he was also willing to operate within the practice of iterative design: taking the initial Birdscape and continuing to tweak it in order to meet different design objectives. From my work with Chen, I also started to question what exactly I wanted to get out of an evaluation. Were we trying to create designs where the 'majority' of people would 'get it'? Because only 2 people used Birdscape to influence their movements, I suggested that to some degree we had failed to meet this design objective since it was a minority experience. This impression is a legacy of HCI evaluation practices that tend to focus on majority experiences and significant difference, smoothing out the uniqueness of individual experiences and marginal outliers. In contrast, in the art community, evaluation is a less uniform discipline and often relegated to the realm of subjective opinion and personal experience.

As tool designers become more interested in designing for unique experiences and as artists become more interested in the medium of technology as a tool for their own and for audience expression, the interplay between forms of evaluation seems a fruitful tension to explore further. In other words, interactive artists appear to be moving from the belief that no one needs to 'get it' for the art to be successful while HCI practice may be moving toward a belief that not everyone has to get it for success to be declared. These different approaches to evaluation suggest that part of what interdisciplinary work requires is time – time to not only put different practices side by side but time for these practices to mutually inform each other.

One final issue we are struggling with in our redesign sessions that illuminates the divide between HCI and the arts is the issue of privacy. As

mentioned, for our redesigns, we are experimenting with more sophisticated sensor technology being developed and tested in Stephen Wicker's Wireless Intelligent Systems Laboratory at Cornell University. An area of great concern for this group as they work with embedded sensor networks is the issue of privacy. As tool designers, we are also sensitive to the need for full disclosure and safeguards for how personal information is collected and ultimately used. However, privacy concerns may be a relatively new topic in the art community. When something is an art work, do the same privacy regulations apply? Do visitors who become part of a participatory art installation require the same informed consent and control over their image? Or, does visiting the art museum and participating with a piece give implied consent? For participatory art installations rooted in one location, visitors can choose to interact or not, but in a soundscape installation such as ours, visitors participate in the piece by virtue of visiting the fifth floor gallery. We attempted to address this concern with signage that indicated how the Birdscape worked and indicating that the sensors could be turned off should anyone desire. However, as we develop more projects to bridge the space of art and tool, we anticipate privacy issues becoming something requiring further consideration.

Overall, the design and evaluation methods we used for this project proved to be useful for iteratively exploring a conceptual space we identified – namely the space between art and tool for visitor experiences. Through our evaluation, we generated a number of ideas for redesign: such as the complexity of the sound and the increase in encounters with the trigger points. Therefore, in terms of the iterative design cycle, our evaluation was very helpful in providing suggestions of where to move forward. However, the evaluation was less helpful in providing direction in terms of re-examining our

initial objectives. To this end, the design and evaluation methods produced as many questions as answers.

Furthermore, our experience is causing us to question the conceptualization of art versus tool. The more we leaned on this dichotomy, the more instable it appeared in practice. Although it makes intuitive sense to talk about bridging art and tool, in reality the space we are designing for is blurry. I believe though that the ideas discussed here have underscored this tension and although the dichotomy may not exist cleanly, this does not negate the need for a greater understanding of how arts practices and HCI practices may inform and influence each other. What would an arts based HCI practice, or an HCI based art practice, look like? What would its problem space or objective encompass? What methods would it employ?[27] Our experience has outlined how the form of art and tool in and of themselves is not as interesting but the cultural practices that develop around these constructs. In other words, Birdscape may be seen as a project on visitor traffic or it may be seen as an installation on the boundaries of the museum space. How Birdscape is framed influences who becomes involved, the language for discussing it, the goals and methods for advancing its development. By trying to hybridize art and tool, we hope to pull critically-informed design, art practice, and user-centered design together in a way that affords new roles to visitors, museum staff, designers and artists in the co-construction of new museum experiences.

[27] These questions follow from the experience presented here yet they also echo the questions being asked by other researchers attempting to bridge the arts and sciences in HCI (e.g. Gaver and Dunne, 1999; Mitchell, W., Inouye, A., and Blumenthal, M., 2001; Wilson, 2002).

Conclusion

The case study above presents an example of a reflective design for exploring the experience of the ineffable in the art museum context. I began with a description of how the ineffable is associated with the experience of art: as something transcendent or sublime that defies explanation. I reviewed how this idea of the ineffable experience of art has been contested and debated through different changes in the art museum and through the practice of art itself. The introduction of technology as a tool for mediating or understanding an experience of art, however, tends to take a dominant form of explaining rather than experiencing the ineffable. As a reflective design practice, I then looked at what existing practices the dominant experience marginalizes in the art museum. In particular, I chose to use an approach directed toward augmenting these existing experiences in a way that people could draw their own conclusions and make their own meaning about the value and use of this information. In this way, I designed for an interpretation approach as opposed to an explanatory or reduction approach described in the first chapter. The case study proceeded with a prototype brainstorming session to explore designing for these marginal experiences, such as the fact that the museum is a social place where people can be both private and public at the same time.

The pilot study identified initial objectives for guiding the development of designs for this alternate design space and these objectives were further refined for the specific nature of both the Imprints and the Birdscape projects. From these implementations, I noted a relationship or tension between providing familiar footholds or clues in the digital scaffolding objective and using ambiguity for increasing engagement. In the Imprints example, I suggested that by using visitor's existing movement, we had provided an

effective scaffold to draw them into a new experience of reflection on other visitors. However, in the collective mosaic of all of the imprints, we found the ambiguity of meaning left the visitors with no way or guide into interpreting the mosaic's significance or their role in it. With the Birdscape example, we also used visitor's existing movement as a kind of digital scaffolding with the metaphor of birds that fly away at the approach of humans. Yet we discovered that this design was not open or ambiguous enough – people tended to literally interpret the sounds and the movement as that from actual birds. Therefore, we need to explore further designs and conditions that support this sweet spot of ambiguity while maintaining the digital scaffolding. In fact, this holds true to the original idea of scaffolding inspired by Lev Vygotsky's philosophy that learning happens when something is just out of one's reach. Too big of a gap to negotiate between the known and unknown means the learner will not, and perhaps cannot, engage.

The projects also revealed different insights regarding the objective of supporting the self in the collective. In the Birdscape implementation, the binary condition of the sounds being on or off partly played a role in preventing visitors from connecting the sounds not only with themselves but with the movement of other people. When the connection between self and sound did occur, it happened at the level of the individual. The Imprints implementation was more successful in displaying the individual in the space of a collective and we had evidence from people using their signatures or their unique emblems as a way to call out to friends in a publicly private way. The interviews from this stage further highlighted the uniqueness of the museum in this regard. People often go to this public place as a way to disappear amongst the masses, as a way to be with people while at the same time be

alone. This suggests an interesting twist to the type of visitor reflection we have been attempting to highlight.

All three stages of the case study suggested not only ways forward and issues for design but ways forward in the evaluation. The use of dynamic feedback suggested from the initial pilot studies, i.e. taking feedback on surveys and presenting it immediately as a stimulus for discussion, was not picked up in the later stages of the museum project but was picked up in the case study in the next chapter. However, the pilot study did inspire us to design our evaluation methods in a way that provoked discussion. This was a challenging endeavor however with the museum visitors. It was important to us to reach visitors who came to the museum for their own reasons, rather than depending on soliciting focus groups, and therefore we approached visitors during their visit with the invitation to join us for a discussion. Although we were eager to have a provoking dialogue, visitors may not wish to have this kind of dialogue with us or during that particular time. This is of course an issue all researchers face but our objectives for designing the evaluation as a form of engagement conflicted with our desire to get people as they were going about the course of their predetermined day. One area for further exploration is designing exchanges with individual visitors that support thought provoking exchanges but don't require a fifteen to twenty minute dialogue.

We also experienced a number of technical difficulties in our evaluation that can be addressed in future iterations. Just as the designs themselves ultimately became a compromise between serving different stakeholders' needs, time, logistics of the space, and budget, so too the evaluation methods had to be modified to fit the environment and the resulting design. Many of our design features however reflected our desire to build evaluation opportunities

into the system itself – for instance measuring whether people follow the Imprint of another person on the handheld tour or whether people continue to ask the question of who visited the objects before them. The evaluation issues we are tacking with the sensor side of the Birdscape implementation raise a new level of concerns about privacy. As a project that is at once art, design, tool, and research study, the requirements for how data is used and what is disclosed across all these different categories are different. We obviously must start with protecting visitors' information to the degree required by human subjects but we want to do so in a way that doesn't unduly scare visitors (e.g. signs that say: 'warning: you are being tracked!!') or take away from the experience of discovery (e.g. signs that say: "There are sensors around the gallery and you are triggering them. This is meant to cause reflection on visitor presence in the gallery").

All stages of this study presented designs that augmented visitor movement in the gallery and attempted to present this information in a way that would be considered at once art and tool. In Stage one, the different designs generated different opinions in terms of who they would be useful for and if they would simply be fun to look at or if they would be informative. Stage two with the handheld guide and the Imprints was ultimately perceived as more tool-like whereas the results from stage three suggested that the Birdscape was experienced more as art than tool. These different experiences suggest that more implementations will continue to find nuances in this space between art and tool. The collaboration with Xiaowen Chen has further troubled this dichotomy that has guided our thinking. The distinction between technology that enters the art museum as art and technology that enters the art museum for learning about art is an easy enough distinction to make. But

the distinction between the categories and functions of art and tool on their own becomes more difficult to sustain. For instance, with the Imprints program, we felt people used this more as a form of social navigation, as a way of telling the more popular pieces from the less popular pieces. Yet, why isn't reflection on social navigation given art status? My criteria seems to be if the information can be 'read' to mean one thing and it can be used to inform some part of the visit, then it is tool. But, in the Birdscape example, which I considered more art-like, people were 'reading' the birds as a point of contact with the outdoors. When does reflection become a tool? As mentioned in the Birdscape discussion, this distinction between art and tool is perhaps more interesting when we consider the different discourses and surrounding practices.

I believe there is also another way to frame this dichotomy that will be more useful for our future work. Instead of presenting a spectrum between art and tool, I believe what is underlying this is a spectrum of being open or closed to interpretation. On this spectrum, we are aiming to push from the closed to the open, not aiming for the middle although designs all along the spectrum will be interesting to explore in particular how they could be moved from one spot to another. This is what we were ultimately addressing when reacting against the one-way information transfer of technology as tool in the museum. We were reacting against how this predominant design tended to shut down the possibility for alternate types of engagement with the art on display, or indeed reflection and awareness of alternate experiences in the gallery.

Throughout the history of art and art museums, the ineffable communion that is to take place has alternatively focused on the relation

between the artist and the visitor, between the artist and his or her art to which the visitor is simply a bystander, or between the visitor and the art to which the artist is the mediator or facilitator. Furthermore, there exists an ongoing debate about how to support this type of ineffable communion, whether experiences should be unmediated or if induction is required. The rise of dialogical art suggests a greater need for understanding how this type of communion can occur without shutting down the possibility of multiplicity of meaning. This history of art and the ineffable has shown how art troubles the boundaries, the purpose, and the role of the art museum. It has also shown how technology as art troubles the nature and process of what art is. However, when technology enters the art museum as a tool, it does not trouble the dominant practices and instead reinforces them. This study and its conclusions argues for an alternate way to approaching technology design for art museums, one where different levels of openness in the designs are explored and the potential for transforming the standard practices of the museum is supported.

Chapter 3. Affect and the Ineffable

Emotions are qualities of a complex experience
that moves and changes.
– John Dewey

Affect, like art in the previous chapter, is a term that is both imminently knowable but difficult to capture in descriptive terms. As with art, one could argue that one knows it when one sees it, or perhaps more to the point, one knows affect through experience. The ability to recognize, express, and respond to affect seems to be an unlearned and often unconscious process, but one that is essential for meaningful experience. As a phenomenon of study, however, affect morphs and changes mainly in response to the discipline or perspective from which it is approached and the objective of the study. From a sociological point of view for example, affect may be approached in order to increase understanding about group norms, social trends, or social stratification. From a cognitive science perspective, studies of affect offer insights into mental processes such as decision-making, language choice, attitude formation and creativity. From a computer science perspective, studies in affect seek to build applications that respond to or recognize affect in their users or can improve processing through the addition of something akin to affective judgment. In other words, affect becomes a component for exploring the predominant questions of the discipline from which it is studied.

In this case study, I return to the paradox of interfaces with the ineffable but this time through designing technology for affect. I begin with an overview of how affect has historically been conceptualized for study and how this has influenced the dominant approach of designing technological interfaces with

affect in a way that tries to control or pin down the ineffable. In response to the challenges of this approach, I use reflective design to explore how interfaces with affect may be created to support affect as a phenomenon that is open to interpretation and changing.

Contextualizing Affect

As affect has been explored and debated from a range of disciplines and therefore developed into a range of competing and complementary perspectives, I must first contextualize what is meant by affect and in particular how affect relates to the idea of the ineffable. I will use 'affect' in a broad sense and synonymously with 'emotions' as a phenomenon encompassing a range of constructs including feelings and moods. By starting with a broad view of affect, I will move into more precise definitions of the term when addressing specific theories and specific designs. Detailing how affect is re-conceptualized through definitions, experiments, or the design of technological interfaces is one of the main thrusts of inquiry for this chapter.

Affect has been explored and debated since the time of ancient Greek philosophers who first began questioning the nature of affect and its role on the essence of mind, the soul, and figuring one's place in the world. Even during the early beginnings of its contemplation, affect was approached diametrically, for instance in Plato's rhetoric as something to be controlled or in Aristotle's view something to be celebrated in the sense that our imperfect (uncertain) world requires emotion as a guide (de Sousa, 2003; Oatley, 2004). As the nature of affect became a focus of study in the sciences, approaches became not just dichotomous but multifarious.

The connotations and denotations of affect have since exploded to the point where Klaus Scherer refers to over one hundred different scientific

constructions for the phenomenon (Scherer, 2005). Many of these definitions focus on what emotions are for, a teleological or functional approach to understanding affect, but the majority of these definitions construct a point of view regarding what emotions are. In particular, many of these perspectives attempt to identify the unique signature of affect or emotion in general – i.e. what differentiates affect from any other cognitive or behavioral construct – and what differentiates individual emotions from one another – e.g. how is angry different from happy. For instance, in the late 1800s, William James presented one of the earliest attempts to classify emotions by identifying people's physiological states of arousal as the defining moment[28]. According to James, we don't see a bear, feel afraid and then run but we see a bear, run, and this movement or heightened state of arousal is what we recognize as fear. This perspective was later refuted by Walter Cannon who argued that physiology by itself was not enough to distinguish arousal states into different emotions as fear and anger would have similar physical profiles[29]. These two counter points illustrate what continues as an ongoing search for defining emotions.

Some of the current perspectives for uniquely identifying affect focus on the output or results of emotions, such as the expressions, the subsequent behaviors, or the significance attributed to the emotion by an individual or a larger group. Other perspectives focus on the input that causes an emotion

[28] Georg Lang, a Danish researcher, published a similar perspective to James a year later in 1885 therefore this perspective is often referred to as James-Lange theory of emotion. An Italian researcher, Guiseppe Sergie, came to a similar conclusion in 1894 but is less referenced (Griffiths, 2001)

[29] This perspective was famously illustrated by Stanly Schacter and Jerome Singer (1962). Schacter and Singer injected subjects with adrenaline in two different conditions, one set in a room designed to make people feel happy and the other to make people feel anxious. Although arguably induced to have similar physiological states, people reported different feelings based on the room condition they were in (de Sousa, 2003).

such as the inciting events, and still other perspectives attempt to identify the psychological and physiological processes between input and output. As an example of this last approach, Scherer's component process definition of emotion identifies five components to emotion including cognitive appraisal, bodily arousal, motivation or action preparation, expression, and subjective feeling (Scherer, 2005). He argues that much of the debate in emotion research is due to researchers not clearly articulating what aspect of the broad phenomenon they are studying and he calls for further consensus building on what is meant by emotions. Scherer notes that due to the complexity of emotion, a variety of approaches will most likely be required for measuring emotions, although he would argue against a variety of conceptions for modeling emotion. Other researchers however suggest that a pluralistic view is required to both model and measure the phenomenon of affect (Rorty, 2003). Although the research presented here agrees with the pluralistic stance, the subsequent question is how these pluralistic views inform each other, if at all.

The Contours of Affect

Comparing and synthesizing research into affect is an overwhelming task as each broad discipline, such as psychology or anthropology, takes a different stance and within each discipline a further division of approaches exists. One goal of synthesis would be to try and identify the essential aspects of affect that are agreed upon, but this results in a rather vague description of affect as an evaluation that can influence current or future behaviors. More useful for the purpose of this chapter is to examine briefly some of the important contours of affect in terms of its borders and proponents of different

sides before taking a more historical look at the link between affect and the ineffable.

Boundaries

Much of the social science literature[30] around contextualizing affect begins by attempting to delimit boundaries around emotion (as a construct) and between emotions (as individual constructs). In terms of delimiting emotions, this is best characterized by debates regarding whether emotions are discrete or dimensional. Discrete emotions are identified as a core set of 'basic' emotions, including emotions such as anger, joy, surprise, sadness, fear, and disgust. Discrete emotions are seen as the building blocks of more complicated emotions such as love, grief, or schadenfreude. Some researchers suggest that this is due to a distinction between primary and secondary emotions (Damasio, 1995), also referred to as lower or higher level emotions (Le Doux, 1996; Oatley, 2004), or utilitarian and aesthetic emotions (Scherer, 2005) where the first term in these pairs is posited as more universal across cultures, more automatic or 'subconscious', and processed by the lower parts of the limbic system. This point of view on how to contain emotions differs from the dimensional approach that focuses not on discrete states or labels but on movement across a set of defining dimensions. In most cases, the dimensions pertinent to defining affect have been boiled down to a valence, from positive to negative, and level of arousal, from low to high (Russell, 1980). In this two-dimensional space then, happiness would be located at high arousal, positive valence and sadness would be at low arousal,

[30] Although there is a rich history and current literature on emotions from the humanities as well, for the most part this review will focus on the range of approaches in the social sciences and in particular in psychology as this is the field most traditionally drawn on for design of affective technology. Later in the chapter I will discuss how the humanities are becoming a more popular source of inspiration and guidance.

negative valence[31]. The reported advantage of the dimensional approach to classifying affect is its ability to account for a wider range of emotions and although a location on the grid still exists as a single point, the form of the dimensions suggests loose rather than defined borders between emotions.

Approaching emotions as having more or less defined boundaries has methodological implications and this can be readily seen in how or for what end these different approaches tend to measure emotions. The discrete approach, for example, seeks to pattern feedback such as physiological or gestural responses into a set number of emotions (e.g. Ekman, Friesen, and Ellsworth, 1972; Ekman, 1992). The dimensional approach attempts to match different physiological signals to valence and arousal, or if using self-report measures, the subject is asked to place his or her feelings within the dimensional model, in other words the model in this case literally becomes the method. Scherer (2005) argues however that the methods should not only match the conception or models of affect but must take into account what kind of comparisons one is after. He advocates using dimensional methods for comparing different emotions held by a single individual as opposed to across individuals since the dimensions are more meaningful in terms of points in relation to each other on the grid. For comparing emotions across individuals, Scherer favors the label approach, whether using discrete emotions or a more nuanced set. Even though Person A and Person B may mean slightly different things by the word 'fear', Scherer argues it likely shares more qualities than if Person A and Person B marked themselves on the exact same coordinates in a dimensional grid where one might mean fear and the other might mean

[31] Some researchers suggest a third dimension of power or tension is required in order to differentiate between experiences of anger and terror (Scherer, 2005; Lively, 2004).

anger. Overall, however, the different models of affect, whether basic or dimensional, tend to employ different methods with the shortcomings of one addressed by the strengths of the other. Whereas discrete methods narrow the focus of study, dimensional methods allow for more variety and interpretation.

How hard and identifiable the boundaries are between emotions is also at issue regarding the boundaries between emotion and other processes such as cognition. Affect has historically, in terms of philosophical and psychological accounts, been held as a separate process to thinking with the latter playing a more desirable leading role. In other words, the optimal state has been portrayed as one where cognition leads or tames affect. New research by neuropsychologists, however, has called into question the line between, and the causal roles of, cognition and affect. At a material or biological level, it was once believed that perceptual processes, such as awareness and attention, occurred in the neocortex, the part of the brain assumed to differentiate humans most from mammals and reptiles. However, recent research suggests that the limbic system, the seat of emotional responses, plays a much larger role than realized in directing or preparing the neocortex (Oatley, 2004; Picard, 1997). This is reminiscent of the early debate between James and Cannon whether cognitive processes prime feelings or vice versa; current research suggests that it goes both ways. Research by neurologist Antonio Damasio (1994) further blurs the line between thinking and feeling. In his studies of patients with severed or damaged connections between the cortex and limbic systems, Damasio demonstrated how rational behavior and rational decision-making requires emotion. In other words, whereas emotion had often been portrayed as operating separately from, and

at times at cross purposes with, rational thought, Damasio's research shows how emotions and value judgments are intertwined with decision making and other thought processes.

Control

Implicated in the above discussion regarding the relationship and borders between affect and cognition is the issue of control. From a physio-cognitive perspective, the issue is how different parts of the brain and the senses of the body coordinate the phenomenon of affect, i.e. what is the cause and what is the effect. The range of different emotion theories could be categorized according to whether led by cognitive appraisal or by bodily perception and movement. Computer scientist Rosalind Picard (1997) nicely contrasts these views along the lines of the acting methods of Stanislavksy versus Chekhov. Stanislavsky taught students to think about and imagine their character's motivation and the appropriate bodily responses would follow; whereas, Checkov taught students to adopt the posture and gestures of their characters which would lead to the appropriate mind set.

Another issue of control, beyond what process leads or controls what, is the question of what parts of our body and our minds are controllable and what parts respond automatically or subconsciously to stimuli. For example, in Darwin's original account of emotions, many expressions of emotions, such as the hairs standing up on the back of one's neck, were seen as unconscious and automatic signs that have ceased to perform their same adaptive and communicative potential (Oatley, 2004). In this sense, emotional expression need not require intention. A slightly different point of view suggests that we have more control over some emotional expressions than we do over 'the emotion' itself. For example, we may layer a false sense or expression of how

we are feeling over a true one. A Freudian view for instance suggests that our unconscious dictates our desires and emotions and it is the therapist's job to excavate through the explanations and reasoning that obstructs this true self from emerging (Oatley, 2004). Ekman (1973) explores both control and non-control over our emotions and expressions. He suggests that true emotions may linger hidden beneath a false expression of emotion or, in other instances, that our facial expressions may betray an emotion we are not even aware of having. In these examples, a boundary is drawn between having an emotion and expressing an emotion, with control being variably allocated to the person experiencing these different aspects. This is a discussion of controlling emotion internally or individually, but a different boundary for emotion is also debated between individuals and the social or cultural environment.

Locus

The final contour I will discuss is whether affect is constructed as an internal or a relational phenomenon. The discussion thus far has focused on defining affect's borders with regards to an individual and has drawn primarily from literature of cognitive psychology and physiology. I began with this emphasis as it has arguably had the most influence on the design of affective technologies to which I will turn in the subsequent section. However, a substantial amount of work also exists that challenges the boundary of emotion as being neatly contained within an individual. Keith Oatley (2004) for instance points to Aristotle's view of emotions as an interface between inner concerns and the outer world, a view that Oatley translates into today's terms to suggest that an emotion derives jointly from "genes, individual experience, and society" (p. 43). The field of anthropology has also stressed the

importance of external forces, such as culture, on the experience and expression of emotion (e.g. Lutz, 1988). One could argue that cognitive accounts, such as appraisal theories, address the role of the environment on affect yet in doing so the locus of the emotion still remains individual. The environment becomes a stimulus to which the individual responds. A more radical point of view is one where the locus of the emotion is in the relation between self and world, self and other, self and society as opposed to contained within the self.

Larissa Tiedens and Colin Leach (2004) express this relational view in their discussion of the social life of emotion. They identify three links between emotion and the social: emotional responses to social situations, social norms influencing the expression of emotions, and emotions as socially constituted. For this last link, they draw on Sartre's perspective that we don't just respond affectively to the world, but that our affective projections shape the world in which we live. "According to Sartre, ours is a world of emotion because our emotion makes us and the world a unified whole. In this way, emotion is what is *between* us and the world. This suggests that emotion is always, at the same time, inside us and outside us." (Tiedens and Leach, 2004, p.6). Empirical evidence for a relational view of affect has been presented through studies of emotional contagion (e.g. Hatfield and Rapson, 2004) and emotional convergence (e.g. Anderson and Keltner, 2004) where the line blurs between individual and social responses to stimuli as they become sympathetic with each other. This relational view is also behind symbolic interactionists' (e.g. Staske, 1996) and paralinguists' (e.g. Fridlund, 1994) approaches to emotion where a discrete emotion is not matched with the right label but an emotion is experienced or called into being through emotion talk and expression. This

idea of the locus of emotions, whether internal or at some interface between the internal and external will be addressed again in the following section tracing a historical account of affect and the ineffable.

All of the above shadings are important contours in the current discussions of affect. Whether emotions are modeled as discrete or dimensional, how integrated emotional processes are with other processes, and the locus of emotions from internal to relational all sketch out the nature of affect and in particular whether it is a phenomenon that is found versus created. It is interesting to note how a found versus created perspective could be applied to the same study and end with alternate conclusions in terms of the contours of affect. For example, in an Ekman study of facial expressions, Japanese and American subjects were shown to display the same facial expressions to a film when the subjects were alone in the room, yet the subjects differed in their expressions along cultural lines when a researcher was present (Ekman, 1973). From the 'found' perspective of affect, the interpretation of these results is that in the case with the researcher present, social display rules were invoked that therefore caused the subjects to mask the emotions elicited by the film. From a 'created' perspective, subjects in the condition with the researcher were in an entirely different condition than when alone and therefore experiencing an entirely different emotion.

As an example from another school of thought, in a symbolic interactionist study of language, if partner A says "I'm angry" and then through the course of conversation with partner B downgrades this to "I'm kind of upset", a 'found' perspective of affect would suggest that A first felt angry and then over time upset. The 'created' perspective of affect would look at this same conversation and suggest that partner A wasn't sure how he was feeling

until working it out collaboratively with partner B. The point of these different examples is to demonstrate how the contours of affect appear differently and how this difference is apparent in the models and methods of studying affect. For the purpose of this research, I lean toward defining affect along the dimensional, relational, and creative contours and this will be described in more detail in the discussion of two contrasting approaching to designing technology interfaces for the experience of affect. Before turning to the interfaces however, I want to first take a step back from the current contours of affect and trace in a little more detail how we came to this point. In particular, I will focus on how affect and the idea of the ineffable relate to each other.

From Mystery to Mathematics

As described above, from some of the earliest periods of writing we know that affect was originally conceived of as something separate from reason and even separate from the will. Emotions early on tended to be identified more with the "magic and mysteries of human life" and into the Middle Ages emotions were viewed as expressions of animal spirits (Mandler, 2001). As part of the spiritual realm, affect was a force outside the self that could descend upon the self, or that the self could aspire to join as a type of transcendent experience of the sublime. Affect was an ineffable force that people could recognize but not explain as it defied reason and prediction. In popular beliefs, people thought affect could spread like a disease or a virus, such as the view during the 16th and 17th century that an old man could feast on a young man's energy simply by being in the same room together or that a woman could become depleted of energy or mad through coming in contact with the 'vapors' (Brennan, 2004). Although part of the spirit world, there was also a belief that humans' ability to express and feel emotions was a mark of

humanity, something that separated them from beasts. For instance, in 1884, in one of the first anatomical studies of facial expressions, Sir Charles Bell remarked that God made the muscles in the human face so that we could express emotions (Griffiths, 2001). Thus the concept of affect was shaped by Victorian values of human uniqueness and Romantic values of intuition and mystery.

In the late 1800s, the connection between affect and the ineffable begins to change. Darwin's 1872 study of emotion in animals is marked as one of the first attempts by science to understand emotions. Up until this time, affect was largely viewed as the province of philosophers[32], rhetoricians and artists (Oatley, 2004). Darwin's study of emotional expression in animals began the process of removing affect from the realm of spirit and grounding it, or as Otniel Dror (2001) states 'embodying' it in nature. Darwin demonstrated emotions in animals as functional and mechanical and the implication was that the phenomenon could be the same in humans. Some emotions and expressions continue to have adaptive value and some take on the biological equivalence of our appendix, expressions we retain but no longer need (Oatley, 2004). Therefore, this unknown quality of affect began to erode and the romantic notion of emotion as a force larger than or outside oneself began to give way.

However, emotion was still considered something messy, a disturbance. Although the connection with our animal ancestors emphasizes

[32] As a brief recounting of an expansive period of history, these broad brush strokes risk leaving some of the important details unaccounted for – specifically in this case, the work of Rene Descartes on emotion. Descartes defied categorization as a scientist or a philospher since he was both. His work on emotion predates Darwin's as his work *Les Passions de L'âme* (The Passions of the Soul) was written in 1649. In this work, he prefigures the debate on discrete versus dimensional emotions identifying 6 building blocks of wonder, love, hate, desire, joy and sadness (Mandler, 2001).

the naturalness of emotions, at the same time the predominant biological analogy beginning in the late 19th and early 20th century was with machines. A well-run machine was predictable and emotions disturbed this precise functioning (Dror, 2001). In the popular culture, therefore, the free expression of emotions in Western society began to be looked down upon (Oatley, 2004; Dror, 2001). But perhaps the more decisive move away from the ineffable came through the rise of the scientific method, classification, and practices during the 19th century.

During the late 19th century, the science of emotions began to re-conceptualize emotion from something uncertain, unexplainable and unpredictable into something accountable. One mark of this move can be found in the growing interest in taxonomies and classifications that continues today as described above in the discussion of affect's contours. Dror (2001) notes that during this time, laboratories were considered 'emotion free spaces' (p. 364); just as emotion would disrupt the body's running as a machine so too would emotion disturb the accurate production of knowledge. However, with the growing interest in emotion work and the rise of classifications of emotion came the need for and the development of tools to measure emotions in the form of technologies to measure blood circulation or temperature, measures that could then be mapped to different emotional states.

The transcription of these measurements into numbers and graphs began what Dror calls the "numerization of emotions" (p. 360), thereby legitimizing or releasing emotions into the laboratory. In this same work, Dror argues that "emotion-as-number provided an alternative medium for the circulation and expression of emotions. It sanctioned an economy of emotional exchange and authorized affective communicability in a culture that, at least

overtly, emphasized restraint and management of the affective self." (p. 359). In the laboratory then, affect ceased to be ineffable, or indescribable and uncontrollable. The more subjective expressions or discourses of affect, those still considered ineffable, were relegated to the arts. This contributed to the growing divide between the sciences and the arts, as well as to the gender attributions of non-numerical expressions of emotion as feminine. Raw, savage, or feminine emotion was intractable, but emotion as number was accountable. Therefore although emotion could still be acknowledged as messy and uncontrollable in one context, emotion as a science could be tentatively embraced when represented and authenticated through the abstraction of numbers.

The first technological interfaces to affect, according to Dror (2001), occurred through these measuring devices and through the numerical representations they produced. He identifies a number of devices designed for the laboratory prior the second World War including the Stomach Balloon, the Tremograph, and Electroencephalography (EEG) machines. From the laboratory, this type of technology and the numerization of numbers began to seep out into the popular environment as well. Dror gives representative examples of such devices as the Emotograph from the late 1920s which provided a "complete emotional diagnosis" or the 1930 Darrow Reflexohmeter for carrying in one's pocket when in an automobile to "measure galvanic reactions as a study of perturbations of daily life" (p. 367). Also in the 1930s, Dror reports stories of people measuring their emotional reactions during their wedding vows as a sign of compatability and filing their blood pressure charts with their marriage certificates as "a record of affective authentication" (p. 368). In the 1940s, Paramount used a device called the Emotion Meter to

record spectators' affective responses to movies by monitoring their heartbeats and breathing and General Electric produced a Mechanical Freud (date unknown) that counted heartbeats as an index of repressed emotions. All of these examples prefigure the 'origin' of affective computing several decades later.

Although emotion could be transcribed into numbers, it did not figure into early computer design during the 1950s and 1960s. Instead computer science drew largely from the current focus of the cognitive sciences, the production of rational and procedural intelligence. As this new computer technology developed, we can also start to trace a shift from designing computers to mimic the mind toward understanding the mind in terms of computer processes. In 1967, Herbert Simon published a seminal paper, linking affect to information processing models of cognition. He argued that although computers run without interruptions, people rarely operate in such a fashion and more often than not we are faced with a number of tasks at once and need to switch between urgent processes. He argued that the search space of possibilities is too large for a human to canvas with simple mental models and that something else must be at play in order to direct our thinking. Simon hypothesized that emotions acted as a heuristic for prioritizing multiple, competing, and uncertain processes (Simon, 1967; Oatley, 2001), a point of view that was later corroborated in the studies of Damasio and Le Doux described in the previous section. For Simon and other researchers at the time, affect presented a point of difference between humans and computers. Computers may be optimized for sequential or parallel processing, but judgments of value between matters of priority or making 'gut' decisions was

still the domain of people. How this affective decision-making happened in humans still eluded the code of computers.

As discussed in the first chapter, however, the line between what humans can do and what computers can't do, i.e. the essential qualities that make us human, often sets the agenda for computing design. With artificial intelligence's failure to deliver on its promised potential during the 1970s and 80s, and with the growing popularity of personal computers and graphical interfaces, an interest in affect and computers began to develop again in the early 1990s. New research into creating performance-like expressions with software and interactive environments explored how people became emotionally invested in computer applications and how different designs could appeal to or portray emotion through the computer (e.g. Bates, 1994; Laurel, 1991; Nass, Steuer, and Tauber, 1994; Turkle, 1984).

These early researchers exploring computers and affect argued that the dominant focus in computer science on problem solving and reasoning was missing an essential aspect of how we actually make sense of the world as emotional beings. If people were already responding to new technology emotionally and attributing emotion to new technology, in the form of the hardware or the software such as the agents on the screen (e.g. Reeves and Nass, 1996), then shouldn't designers be facilitating this emotional communication? Therefore a new breed of researcher, coming from the field of computer science and human computer interaction, began looking for guidance in designing interfaces for affective experiences. As described above, inspiration could be found in roughly two broad camps: the sciences on the one hand where a view toward emotion-as-number had gained the most ground, and the arts and cultural studies on the other hand where affect

retained more of its ineffable qualities not easily reduced to abstract representation. In the following section, I will explore the predominant path taken by computer scientists and human computer interaction designers, explore the implications of this dominant view, and propose an alterative approach.

Designing Interfaces with Affect

The movement to build affective interfaces is part a growing discourse around broadening computer design to move beyond usability toward user experience (Dourish, 2001; McCarthy and Wright, 2004). A usability approach focused on tasks and valued certainty, standardization, and efficiency in the interface. The critique of such applications is that they designed only for a very narrow slice of human life ignoring non-task based activities such as the pursuit of fun or emotional communion. Furthermore, the task focus tends to design from a portrayal of a generic user, removed from particular circumstances and interactions. Several strategies have been proposed to redress this narrow focus, including a turn toward the social, toward situated actions and bodies, and finally a turn toward emotion (Dourish, 2001; Suchman, 2004). As discussed above, this last turn has much earlier roots but it became popularized in human computer interaction a bit later than the social and embodied turns. During the late 1990s, Rosalind Picard at the MIT research laboratory coined the term Affective Computing (Picard, 1997). Affective Computing was positioned as a new research agenda for exploring how computers could recognize, respond to, and express emotions. In the following sections, I will explore how the affective computing approach addresses the ineffable experience of emotion as something to be conquered,

whereas an alternative approach to affect as interaction tries to support the ineffability of lived experiences of affect.

Affective Computing: Affect as Information

Although the field of affective computing is expanding, in introducing it I will draw primarily from Picard's research because her work is regarded as one of the preeminent examples of technology. In her book *Affective Computing*, Picard begins by outlining the motivation for addressing affect in computers. Technology based on models of rational intelligence divorced from emotion, she argues, neglects the evidence of the pivotal and integral role of emotion in cognitive processes. If computers are to be intelligent, they must include a form of affective intelligence as well. Citing fellow MIT researcher and futurist Nicholas Negroponte (1995), Picard posits a Darwinian-type claim that even dogs understand the emotional valence of a message, such as 'Get off the couch'. If animals can understand emotion, and computers are to mimic life not just machines, then they must also understand emotion. Including an emotional model in computer design, according to Picard's examples, should result in more efficient, more pleasurable, and more effective interactions with technology. Furthermore, although people readily anthropomorphize and ascribe emotions to their computers, and although people use computer mediated communication such as email to communicate emotion, Picard suggests that the 'affective bandwidth' of computers could be improved. In discussing email, for example, she remarks on the limited palette of emotional expression available through emoticons and the difficulty in communicating emotion through text without the richness of voice. The majority of Picard's examples, however, focus not on computers as a medium through which people express emotions but on computers as another actor in emotional

communication. The goal of affective computing is to build computer systems that recognize, respond to, express, and ultimately 'have' emotions.

Picard's book draws on a wide number of sources, from philosophers to scientists to artists, for grounding affective computing in an initial discussion of affect. She paints a rich picture of the pivotal, yet difficult to capture, role emotions play in people's everyday meaning making activities. Emotions are not laws, Picard states, but "songs of the heart" (Picard, 1997, p. 4). She uses 'affect' and 'emotion' as synonyms, as I have also done, preferring the term affect for three reasons. First, she believes that affective could usefully be mistaken for the meaning of effective, a link she wishes to make. Secondly, she believes that the term 'emotional computing' might conjure up connotations of machines acting irrationally or out of control as portrayed by HAL in Stanley Kubrick's *2001: A Space Odyssey*. Finally, apart from popular misconceptions of emotion as separate from reason, she wants to use a perhaps less familiar term due to the overabundance of competing definitions in science as well. Despite this broad beginning, however, the space for affect narrows when Picard moves to describing the designs of affective computing.

Picard does not claim to create a new theory of emotion but draws from existing theories where relevant for the design of affective computers. In discussing technology that can recognize emotion, for example, she draws on new advances in the measurement of emotion particularly in physiology and neurophysiology. The technologies are similar to those described earlier by Dror and use indices such as heart rate, body temperature, sweat, pupil dilation, and other bodily reactions to infer different emotional states. In order for computers to respond to emotions, they must first work through this measurement and identification stage. Most of the work here is on refining the

ability of technology to sense different bodily signals and on the mappings of these stimuli to emotional categories. In both the recognition and the response stages of affective computing design, Picard draws heavily from the emotion-as-number approach favored in the sciences. For the goal of computers that express emotion, Picard draws on communication theories of Claude Shannon and Warren Weaver and an information theory framework. She uses the analogy of sending bits of information through a channel and how typically computers would throw away the affective bits of the signal, for example by converting the spoken word to text. The objective for affective computing is to increase the ability to carry affective signals. Based on the theories of support that Picard references, the implicit theory of affect she is building is a theory of affect as information.

A theory of affect as information presents affect in a very specific way from within the many possible contours of affect described earlier in this chapter. Affect is discrete and because it is bounded can be transferred from one person to another or from one person to a computer and vice versa. The transfer of affect does not change, or should not change, the initial state of affect to be decoded by the receiver. This transfer idea draws from the conduit metaphors of information processing (Reddy, 1993; Boehner, DePaula, Dourish, and Sengers, 2005) which has become a guiding force in HCI. Affect as information tends to present affect as something internal, something that occurs within the individual (DePaula and Dourish, 2005; Boehner, DePaula, Dourish, and Sengers, 2005). In this sense, affect is modeled in the same way that cognition in HCI had been modeled prior to the field's turn to the social and the situated. As discussed in the previous section about the links between emotion, cognition, and context, a substantial amount

of research and design has shown the pitfalls in modeling cognition as something isolated from its particular context. Yet in attempting to add emotion to the computing equation the effect has been less of an enrichment of information processing and more of a reduction of affect.

Design

Although Picard does not explicitly articulate a theory of affect as information, the work of this implied theory is apparent in the types of designs that have resulted in the affective computing agenda. Although there are several examples in affective computing of people using computers to express emotion in new ways, the main emphasis in the designs is on augmenting the computer system's understanding or modeling of affect. In other words, whether the goal is to support human-computer interaction or human-human interaction through computers, the computer mediates this experience as a kind of emotional agent with its own understanding and model of emotion. To illustrate this, I will briefly describe four prototypical systems within the field of affective computing before turning to a description of how these systems are evaluated and the implications of a theory of affect as information.

- Facial Affect in Instant Messaging, FAIM (see Figure 9): The FAIM system is designed by researchers at the University of Cambridge for improving the 'affective bandwidth' of text-based instant messaging (El Kaliouby and Robinson, 2004). In this system, a video camera captures a person's facial expression as she is composing an instant message. This image is then analyzed according to indices such as the shape of one's mouth and head gestures and one of seven affective states is determined (happy, surprised, agreeing, disagreeing, confused,

indecisive, and neutral). This state is subsequently displayed by modifying a cartoon animation of a person that now accompanies the instant text message. Therefore, on the receiving end of the instant message, the receiver sees not only a text box but a character box where a cartoon figure's facial expression changes to match the sender's analyzed facial expressions. In presenting this work, the researchers identify the challenges as being determining when to deduce an emotional expression as it may change throughout the course of writing a message, but they argue that the video capture allows for more natural and richer communication of emotion than using emoticons.

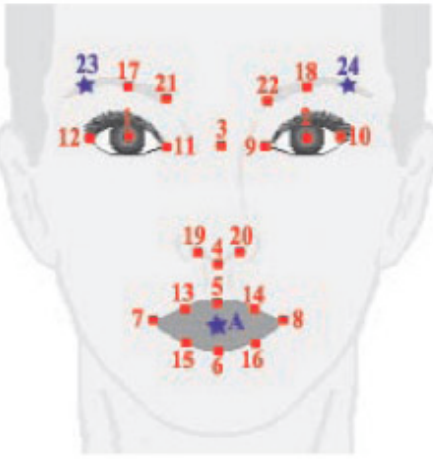
- EMFi Chair: Developed through a collaboration between the University of Tampere and the Tampere University Hospital in Finland, the Electromechanical Film (EMFi) Chair measures the sitter's heart rate as an indicator of pleasant or unpleasant emotions (Anttonen and Surakka, 2005). Heart rate was selected because people have less control over this signal than, for example, their facial expressions, and heart rate has been correlated with positive and negative emotions. The researchers propose to embed the electromechanical film in an office chair and then communicate this information wirelessly to other computer applications that could adapt and respond to the user's inferred emotions. Although the researchers recognize the ethical issues of hidden sensors, they suggest that by putting a logo on the chair the user would be aware that his or her emotions were being tracked and recorded. This type of measurement is considered

desirable because it allows for continuous and non-instrusive measurement of an office worker's emotion.

- Automatic Call-In Systems: This example draws on the work of emotion detection in vocal patterns discussed by Batliner, Fischer, Huber, Spilker, and Nöth (2003) from the University of Erlangen-Nuremberg and the University of Bremen. The researchers examine methods for detecting the point of frustration in callers to automatic directory systems. The goal is to detect frustration at an early enough stage that callers may be patched through to a human operator before the caller hangs up. A majority of systems on the market at the time of this research depended upon prosodic signals of frustration in the intonation, stress, and rhythm of the caller's voice. Furthermore, these systems tended to be tested in the laboratory with actors portraying emotions. Batliner and colleagues have suggested expanding the models of frustration to include linguistic cues as well such as cursing or repetition to improve the ability of a system to detect frustration before it reaches the point of no return.

- Kismet: Kismet is a socially expressive robot designed by Cynthia Breazeal (2000) at the MIT Media Lab as part of the Sociable Machines Project. Breazeal began Kismet with the objective of creating a semi-autonomous agent, in other words, an agent that did not operate independently but worked in interaction with others: including communicating and responding to emotion in human interlocutors. Kismet is designed to have facial expressions including eye gaze,

eyebrow movement, ear placement (e.g. like an animal), and lip movement. In addition Kismet can alter the emotional qualities of it's synthesized voice. The robot is programmed to respond to emotional cues from others and engage in social activities such as drawing people into conversations, taking turns in conversation, establishing personal space, and withdrawing from an interaction. Through her work with Kismet, Breazeal demonstrates the value in focusing on semi-autonomous as opposed to autonomous displays of emotion.



1. Head yaw $\frac{\overline{P_9P_{10}}}{\overline{P_{11}P_{12}}}$
2. Head pitch $P_4[t] - P_4[t-1]$
3. Head roll $\angle P_9P_{11}$
4. Eyebrow raise $\frac{(\overline{P_{11}P_{21}}+\overline{P_1P_{17}}+\overline{P_{12}P_{23}})_t}{(\overline{P_{11}P_{21}}+\overline{P_1P_{17}}+\overline{P_{12}P_{23}})_0}$
5. Lip pull $\frac{(\overline{AP_7}+\overline{AP_8})_t-(\overline{AP_7}+\overline{AP_8})_0}{(\overline{AP_7}+\overline{AP_8})_0} > k$
6. Lip pucker $\frac{(\overline{AP_7}+\overline{AP_8})_t-(\overline{AP_7}+\overline{AP_8})_0}{(\overline{AP_7}+\overline{AP_8})_0} < k$
7. Lips part $\sum Aperture + \sum Teeth \approx 0$
8. Jaw drop $\sum Aperture \geq \sum Teeth \geq a$
9. Teeth $\sum Teeth \geq t$

Figure 9. Facial analyzer for the FAIM system. Copyright Rana El Kaliouby and Peter Robinson

The example designs described above were selected because of the diversity in their approach and application but also because they are emblematic of the affect as information approach. In all of these examples, affect is positioned as something discrete, something that can be captured (largely without the explicit awareness or control of the user), labeled, and then transferred. These systems seek to improve the affective bandwidth and the emotional expression of computers without requiring much additional work

on the part of the user. In order to meet this goal, the systems base their design on the natural expression, recognition and communication of emotion in their human counterparts.

Evaluation

In evaluating the above systems, the objectives and the methods are also informed by the view of affect as information. In this case, the evaluation of the systems is about getting the emotion 'right' whether this is accurately recognizing the right emotion, responding appropriately to the detected emotion, or expressing emotion in a convincing fashion. As Picard states, computers need not be right 100% of the time in order to be considered successful since humans are not 100% accurate in detecting, responding to or communicating affect – that emotional states can not be observed but only inferred (Picard 1997, p.24). Since the objective is for computers to perform as humans emotionally, Picard proposes variations on the Turing test as appropriate ways of evaluating the success of affective computing systems. For example, if a human actor portrays an emotion, a computer should be able to detect the emotions portrayed at the same rate of success as a person. The use of actors and controlled sets of emotions is a popular approach, as discussed in the automatic call-in system, and most of the evaluation studies of affective computing systems begin in the laboratory as part of the iterative design of the system. The success of FAIM depends upon two stages: first modeling an expression that the sender of the message believes accurately represents how he or she feels at that moment, and second on the success of the animation to portray this emotion to the receiver. For the automatic call-in centers, success is measured in the laboratory in terms of whether or not the system picks up the point in the script where the actor is becoming frustrated.

Outside the lab, the measure of success for such an automated system is a low volume of callers hanging up. The success of Kismet would be rated against whether Kismet responded appropriately and believably, i.e. as another human might, to Breazeal.

Although many of the measurements of emotion in the system design are based on physiological measures due to their relatively unobtrusive and involuntary nature, the evaluation of these systems depends upon correlating the results of these measurements with self-reports. For instance, the algorithms for the EMFi chair correlated the detection of negative mood with the subjects' report of negative or positive mood. Furthermore, many of these studies begin with a standardized tool that has been developed from self-report methods. In the EMFi study, subjects responded to a selection of images and sounds from the International Affective Picture System (Lang, Bradley, and Cuthbert, 2005) and the International Affective Digital Sounds (Bradley and Lang, 1999) – two databases of images and sounds given statistically significant scores of valence and arousal based on responses of hundreds of subjects. The example designs described here use physiological measurement as part of the system design, but physiological measurement is also proposed in affective computing as a method of evaluation as well. For instance, researchers at Simon Fraser and at Dalhousie Universities have proposed using heart rate, similar to the EMFi chair, to evaluate players' engagement with video games (Mandryk, Atkins, and Inkpen, 2006).

The researchers propose using physiological measures as an evaluation method for the same reason the examples above proposed to use them as design input: because the measures could be continuous and unobtrusive. However Mandryk, Atkins and Inkpen explicitly remark on the

objective nature of such methods as another added benefit. Yet although physiological data is presented as a very different metric than self-report data, the validation of this method is marked against players' self report. In this particular study, the authors felt the physiological data not only performed as well as self-report but it also provided more statistically significant differences for further exploration. Although this is an example of using physiological methods to evaluate systems not explicitly designed for affect, one could imagine for instance the EMFi chair or a similar detection device could become a part of the game as the system begins to respond to the users detected emotional state.

All of these evaluation studies of the designs described above suggest that the gold standard by which affective computing systems are judged is the performance of humans. A right response or a right emotion to detect is modeled a priori to the experiment and success is determined by performance which matches these models. The evaluation methods follow from the design methods and the overriding model of information as affect. If affect is discrete, then a particular emotion can be detected. If affect is transferable intact, then the emotion one sets out to communicate should be able to be decoded by the receiver. Finally, and perhaps most importantly, is the preference for physiological data as an objective measure – one that must be validated by self report but then eventually comes to replace self report as a more objective method.

Implications

The designs and evaluation methods of affective computing neatly follow from a conceptualization of affect as information. However, there are a number of design and evaluation issues that result from this perspective. First

of all, regarding the designs, although one of the motivations for affective computing is to improve on things such as the short list of emoticons for emotional expression, the designs still end up supporting a very limited palette of expression. With the FAIM system for instance, the palette is limited not only in how emotion is expressed but in terms of what emotions can be expressed with a short list of seven states. This reductionism is not only apparent in the palette of expressions but in the indices used to detect emotion. Although the development of new technology with ever more refined capabilities for visualizing the invisible and sensing new modalities offer exciting ways for measuring emotion, what often happens is the measurement comes to stand for the emotion itself. Just as a label of 'happy' is a weak signification of what it feels or means to be happy and leaves much about the individual experience undescribed and unaccounted for, a number on a heart rate chart also only represents one aspect of emotion. The danger in affective computing is that the dependency on discrete labels and on emotion-as-number reduces rich experience to abstract, but easily tractable and tradable, representations. In other words, the ineffable is erased from the experience of affect.

Secondly, as the designs focus on creating and refining an emotional model for the computer system, the priority established is one of improving the system's knowledge of the user's emotional states. This begs the question of who has control over this information once it has been collected. Although the EMFi chair acknowledges this issue and plans to address this with a logo on the chair, the stated goal of most of these systems is to fade into the background so that users are unaware of the system working. This leads to serious implications for accuracy. Systems that have this much control without

our awareness require a high degree of accuracy, yet the systems have been shown to only operate at a level on par with or below human ability. This human fallibility would be acceptable only if users are aware of the potential for error and if there are built in feedback mechanisms for users to detect and correct the errors. With the emphasis on invisibility, this information and its use is often hidden from the user.

There are also several limitations embedded in the evaluation of affective computing systems. In reviewing the phone call-in centers for example, Batliner et al. note a marked decline in performance from systems in the laboratory and systems in the actual world. The reason for this is that people are rarely ever expressing one emotion and rarely do they express it in the exaggerated kinds of caricatures an actor might employ. Batliner cites Scherer's (2000) study of people arguing with baggage claim attendants after losing their luggage. If ever there is a time when people might be experiencing a 'pure' emotion of frustration, it would be in the process of trying to retrieve a lost bag. Yet both from observers of these interactions and from the people themselves, the emotions identified were much more nuanced. The legacy of affective computing evaluations that depend on experimental exaggeration comes from earlier studies on measuring emotion such as those explored by Dror (1999) in his accounts of the numerization of emotion. In these early studies, Dror notes that subjects who could not produce unambiguous emotions were dropped from the protocol.

Lucy Suchman (2004) also provides an interesting critique of evaluating affect as information through her comments on the Kismet studies. Although Kismet successfully demonstrated human like emotional expressions and reactions, Suchman notes that this only happens when Kismet is responding

to Breazeal – when responding to other people, the experience is much more unconvincing. In commenting on this result, Suchman suggests that Breazeal has been trained in the same way that Kismet has been trained – that she knows which of her behaviors will command a suitable response from Kismet. This is not to suggest that the Kismet design is a failure instead of a success but to claim it is a success because of its choreographed evaluation. The evaluation actually speaks to a different type of affect, one that emerges through the interaction of Breazeal with Kismet rather than one that is found by Kismet or found by Breazeal.

Finally, many of the designs and evaluation methods discussed above either implicitly or explicitly rely on the objective account of physiological measures of affect. Even though these methods are either induced or validated through comparisons with self-report methods, self-report is positioned as subjective and therefore difficult to depend on for accuracy. Picard, for instance, discussed the limitations of self report at a recent workshop on Innovating Evaluation Methods for Affective Systems at CHI 2005. She noted that self-report was difficult to rely upon for three reasons: people often forget what they are feeling or can't articulate it, people may misrepresent what they are feeling to either please the researcher or in the interest of self-presentation, or people often express their feelings along the middle of a spectrum as opposed to pushing it toward extremes (which makes for less variance). For all of these reasons, self-report is considered a less desirable evaluation method or at least one that must be supplemented with more 'objective' measures. However, these limitations all follow from a model of affect that is found, internal, and discrete. It assumes for instance that nuanced emotions are less valid (or valuable for the researcher) than extreme

emotions. Due to all of these implications, I will now turn to a different model of affect and the subsequent designs, evaluations, and implications.

Affective Presence: Affect as Interaction

The implications of affective computing discussed in the previous section can be summarized into the following three issues: emotions are reduced to abstract representations that miss the lived experience of emotion, there is an illicit shift of control from people interpreting emotion to computers interpreting the emotions, and the emphasis is on the accuracy of detecting 'found' emotions as opposed to the authenticity of emerging emotions. These issues arise from a perspective on affect as information and are based on a fundamental disjunction between the subjective, situated, cultural, and social ways in which people think about and experience emotions and the objective, formalized ways in which computers model them. This disjunction presents a gap between the experience of emotion and how it is defined (and by whom/what); a gap between what is experienced and what can be measured; and a gap between the richness of experience and the relative simplicity of its formalization (Sengers and Mateas, 2005). A growing number of researchers are beginning to look at ways of addressing this gap including a collective of researchers focusing on what we have termed affective presence as an alternative approach to affective computing. The founding members[33] of this

[33] For the purposes of space only I have not listed the many graduate students at all of these institutions who have also been active in advancing the Affective Presence ideas including (but not limited to): Joseph 'Jofish' Kaye, Petra Sundström, Jarmo Laaksolahti, Anna Ståhl, Michael Golembowski, Mario Romero, and Zach Pousman. The Affective Presence consortium began with the original schools/institutes in January of 2004 with a presentation for the Intel People and Practices Group on alternate models to affective computing. Since this time, we have begun working with several other researchers pursuing similar ideas including (but not limited to): Paul Dourish at University of Irvine, Peter Wright and Mark Blythe at the University of York, John McCarthy at University of Limerick, Katherine Isbister at RPI, and Rogerio DePaula at Intel.

group include: from Cornell University, Geri Gay and Phoebe Sengers; from the Swedish Institute of Computer Science, Kristina Höök; from Goldsmiths College University of London, Bill Gaver; from Georgia Technology Institute, Michael Mateas; and from Intel's People and Practices Group, Ken Anderson. The issues defining the affective presence agenda boil down to one central question: how is it possible, despite the relative inability of computational systems to understand the full meaning and context of human experience, to build systems that address people's experiences at a humanly meaningful and appropriate level? To rephrase this question in terms of this work: how can we design interfaces for affect without losing the ineffable qualities that make affect meaningful?

The answer being proposed by current affective computing research is to close the gap between lived experience and its representations by improving computers' understanding of human emotions, in the hopes that formalized models will eventually capture the full complexity of human emotional experience. We propose, instead, to close the gap by rebalancing the roles of humans and machines in affective computing. In our model, affect is co-constructed through a process of collaboration rather than focusing on the computer's ability to acquire and reason about a user's emotion states. Instead, in this model, computing provides new opportunities for users to experience, interpret, and reflect on their emotions. By designing for this collaboration between computers and users, we solve the three central problems introduced earlier: we address emotions that computational systems alone cannot truly understand, keep users in charge of emotional meaning-making, and focus our design efforts not on formalizations but on complex, idiosyncratic, and enigmatic emotional experiences. In the next section, I will

illustrate the difference in this approach to the affective computing approach through specific design examples.

Therefore, we propose a theory of affect not as information but affect as interaction. In returning to the contours of affect described earlier in this chapter, a position of affect as interaction views affect as non-discrete, integrally related and intertwined with a number of other processes, and relational. In developing the theory of affect as interaction, we were inspired by previous moves to expanding cognitive models in HCI for understanding any information as socially and culturally produced. In my collaboration with Phoebe Sengers, Paul Dourish and Rogerio DePaula, we explained the entwining of emotion and culture as follows: "To experience a feeling as, say, anger, love, happiness, lust, or frustration, one must be grounded in a cultural context that makes anger, love, happiness, lust, or frustration meaningful (and in turn determines a response to that emotion – whether it is something to be proud of, ashamed of, etc.)" (Boehner, DePaula, Dourish, and Sengers, 2005, p. 63). Emotions are culturally situated and culturally defined. This is not to suggest that different cultures just have different names for different emotions and it is not enough to just say that emotions play a role in defining our cultures (e.g. Western societies tend to express emotions in this way versus Eastern societies). The strong point of view here is that "the experience of emotion is mediated by cultural and social situations, but it is also used to enact and sustain those settings" (Boehner, DePaula, Dourish, and Sengers, 2005, p. 64). In other words, through culture, emotion is experienced, and through emotion, culture is produced. More broadly, a view of affect as interaction maintains that emotion cannot be seen as bounded and complete within the individual.

By positioning individual emotion and the social/cultural field in which this is experienced as a mutually constitutive relationship, the interactional approach reframes the dichotomous divide discussed in the section on the contours of affect. The divides between the individual and the social, the cognitive and the physical, the objective and the subjective are seen in relation to each other, in interaction and informing each other. For instance, "the binding of the social and the cultural to emotion does not negate the agency and subjective feelings of the individual. As productive phenomena, culture and social contexts are also realized, reconstituted, experienced, and over time re-imagined, through the interaction of individuals. In this relationship, emotions are constructed and experienced as individuals act in and through their culture and social interactions. From the interactional perspective, affect is not a representational state to be transferred from one place to another, but rather is an aspect of collectively enacted social settings. Emotion is a witnessable property of social action, and a way in which actions are rendered interpretable and meaningful" (Boehner, DePaola, Dourish, and Sengers, 2005 p. 64). In summary, affect is created through interactions and not found as a static or reductive bit of information. This divergence between these approaches to affect is perhaps best illustrated through a discussion of designs, evaluations and their implications.

Design

Rebalancing the affective gap through an affective presence approach does not attempt to make computers the mirror image of humans but instead draws on what computers do best as computers and what humans do best as humans. Computers are used for alternate forms of representation and for visualizing and processing information in new ways whereas humans make

sense of and attribute meaning to this information. We position computers as actors in this meaning making process but actors who are decidedly 'other.' In this way, we position the design as one of supporting 'co-interpretation' of affect as opposed to the detection, response, and possession of affect.

- Influencing Machine (see Figure 10): Created at the MARS Exploratory Research Lab, Fraunhofer Institute für Medienkommunkation, the Influencing Machine (IM) is designed to encourage reflection on the intersection between emotion and technology (Sengers et al., 2002). To use the IM, participants enter a room, and see projected on the wall a display of childlike scribbling: jagged lines, circles, spirals in simple colors, each building up and fading away. A large wooden mailbox sits on a table surrounded by a variety of postcards of emotionally evocative art. Feeding postcards into the mailbox triggers unusual sounds and changes the speed, color, and form of the drawings on the wall. These sounds and drawings are tied to the cards chosen by the participants which were read electronically when entered into the mailbox. Importantly, the changes are not designed to directly communicate the computer's emotions, but are deliberately multi-valenced and enigmatic, and intended to encourage reflection about emotion and the role computing may play in it. The Influencing Machine is not transparently readable; it demands reflective interpretation.

- Home Health Horoscope: Created in collaboration between Goldsmiths College, Cornell University, and Intel, the Home Health Horoscope is a reaction in part to the development of "Smart Homes" and "Proactive

Homes." These smart homes are laced with sensors for tracking inhabitants' activities and establishing patterns that allow for emergency notifications should something be amiss, such as grandma falling in the shower, an intruder in the home, or perhaps something less disastrous like the milk going sour in the refrigerator. In response to this type of surveillance technology and the overdependence on models that accurately reproduce one's world, the Home Health Horoscope proposes to use deliberately "shy" and idiosyncratic sensors such as force sensors in one's slippers as a measure of how often comfort is needed and reports the health of the home not as a call for help to emergency services but as a fortune-like horoscope printed out for the inhabitants of the home to read. The sensors are designed specifically according to what the target family believes is important information for their specific patterns. By having a role in designing the sensors and by presenting the information in the playful manner of a horoscope that people are used to finding meaning in and discounting, the Home Health Horoscope supports discussion and reflection on emotional well-being.

- eMoto (see Figure 10): Developed at the Swedish Institute of Computer Science, eMoto is a system designed for Multimedia Messaging System (MMS) capabilities of mobile phones (Sundström, Ståhl, and Höök, 2005). A user can compose a text message as per normal but then can add an emotionally valenced background which changes based on the user's gestures with a sensor embedded and Bluetooth enabled stylus. Different movements, such as abrupt jabbing movements or slow

circular movements, are given different positions along a spectrum of colors and shapes. The matching between movements and outputs is based on movement, color, and shape theory although the user can simply continue to move the stylus around until he or she creates a suitable background pattern for expressing their message. Receivers of the message learn over time how to interpret the combination of the content of the text, with the color and shapes of the background pattern all judged in relation to the particular sender and his or her patterns of communication.

- Office Plant #1 (see Figure 10): Created at the Georgia Institute of Technology, the Office Plant is a desktop robot that responds to light and sound levels in the environment as well as the social and emotional tone of email received by its user (Böhlen and Mateas, 1998). Based on this information, the plant acts as a living sculpture responding with its own sounds and physical movements occurring over long periods of time. The user might not notice the movement as it is happening but over time, the plant is recognizably in different states from a closed frond to an open bloom and various other states in between. The Office Plant is made of metallic materials but is reminiscent of an actual plant that one might find seeking life in a rather artificial climate of an office cubicle. The timing of the plant's movements do not draw immediate attention but present snapshots of changes in emotional climate over time. In addition, the plant itself possesses what Mateas refers to as alien presence (Mateas, 2001), based on artificial intelligence, the plant develops its own ability to infer alternate, or alien, interpretations of

what is happening in the email and light/sound levels of the office. In terming this ‘alien presence’, Mateas signals that the role of the plant is as an ‘other’ not as an authority on the exact or right emotional state of the office inhabitants.

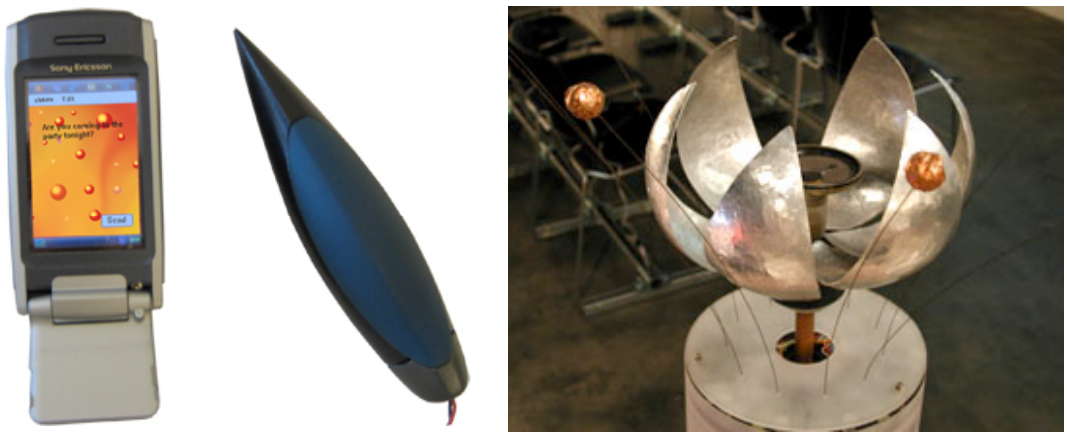


Figure 10. eMoto, and the Office Plant (left to right)

These designs may not differ drastically in form from the ones described in the affective computing section, but in principle and spirit they differ markedly. The Office Plant for example has a series of state diagrams that could look very similar to the Kismet diagram above of different emotional states represented by different positions. However, the difference is that the states in the Office Plant are positioned as an approximation – the strangeness of an office plant reflecting the emotional climate or the playfulness of a Home Health Horoscope for predicting the fortune of a home all indicate that this information is part of the interaction not the conclusion of it. Furthermore, the designs all suggest very different contours of affect than the designs from affective computing. In an affective presence approach, the designs work with affect that is conceived of as dimensional, difficult to isolate

from other practices, and relational. eMoto, for example, specifically plays with the dynamic nature of emotion with what the researchers call the Affective Loop. The Affective Loop pertains to the phenomenon that through expressing one's emotion, one's emotion changes. As with the emergent expression of affect in the other designs, this is based on a conception of affect as something created through interaction and not found or transferred intact as information.

Evaluation

As the affective presence designs above demonstrate, they all start from a very different point of view regarding affect, specifically a point of view where affect is a form of interaction. Therefore, what constitutes a 'successful' design also changes dramatically from the affect as information approach. Instead, in an approach to affect as interaction, the focus in evaluation is on whether or not the designs encourage reflection and whether or not the designs provide evidence and cues for engaging in the collaborative interpretation of affect. Shifting to a constructed, interpretive notion of emotion leads to new research questions around emotions and moods in *social* relationships, rather than focusing on individuals communicating with machines. A system designed for affect as information leads to questions about transfer of information: Did the system recognize the 'right' emotion and respond appropriately? Did the system transfer user A's emotion to user B so that user B could decode it accurately? A system designed for affect as interaction, in contrast, will be evaluated through questions about co-interpretation, such as: How do users experience and shape one another's moods or a collective mood? What role can interactive systems play in helping multiple users in coordinating senses of each other's emotions? What

system attributes encourage or impair how users make meaning? How do users appropriate a system to evoke novel and personally meaningful practices of affect? How does the system stimulate reflection on or awareness of affect?

Answering such questions requires open-ended but systematic evaluation methods accounting for the richness of co-interpretation. Since our design methods are inspired by theoretical approaches to meaning-making, our evaluation goals and methods also draw from forms of interpretive inquiry (Denzin and Lincoln, 2000). For instance, the Home Health Horoscope project plans to use documentary methods to provide alternate accounts of how the household adopts and adapts the horoscope system. In eMoto, participants used the system during the course of their daily lives while they also documented their own use and their partner's use through video footage and participant observation. For the Influencing Machine, participants were observed as they used the machine in groups (in order to promote discussion) and interviewed afterwards about their experience. The evaluation of the Influencing Machine attempted to combine practices for evaluating system design and evaluating interactive art in order to draw out not only what users did with the system but their interpretations of what the system was for (Höök, Sengers, and Andersson, 2003), for example by looking for the metaphors users employed to guide their interactions.

In contrast to the affective computing approach, all of these studies favor evaluation in the intended setting (although pre-testing in the laboratory does occur) such as the home or the office. Another critical difference is the level of involvement of participants in the analysis of the evaluation results as they are collected. Participants play an active role in responding to and

interpreting their patterns of use. Whereas self-report is looked upon in affective computing as something that requires more objective methods to round out its use, in the affective presence approach methods are developed to encourage self-report as a way to round out the use of seemingly objective measures of behaviors or sensor data. This does not mean that physiological data and other usage type reports are not used as evaluation metrics, but it means that the information is positioned as a stimulus for reflection and interpretation by the participants as opposed to having a predetermined meaning.

Implications

The shift in designs within the affective presence approach suggests that we are not simply creating different designs focused more on the social and cultural experience of affect, but we are designing for a very different understanding of what affect is and the role of technology in supporting this. Whereas in the affect as information approach, the ineffable is explained away, in the affect as interaction, the ineffable complexity of affect is left open for interpretation. Affect as information and affect as interaction are like two adjacent points on a circle yet facing in opposite directions. It would not take much to shift Kismet or the EMFi for example to the affect as interaction approach. For instance, the EMFi chair could become part of the Office Plant experience where lack of sitting in one's chair or different heartbeat rhythms cause changes in the plant's morphology. The difference however is in a perspective on what authority is placed on the information collected and how transparent this is. In the affect as information perspective, the information is the affect, in other words, the affect is complete if the tools are considered sophisticated enough to get the right information and the information is

considered accountable. In the affect as interaction perspective, the information is considered a starting point, a part of a much larger whole.

Designing for affect as interaction shifts the design from one of attempting to design affect 'into' the system to design 'for' affect where affect is experienced through the design and is not simply a component of the design. This requires rethinking many of the traditional design and evaluation strategies of HCI as the standard approaches do not fit well with an attempt to design for this kind of emergent, unfolding, open experience. Whereas a traditional HCI evaluation for example starts with established criteria for success and judges the design based on meeting these criteria, the designs described above and the evaluation methods for exploring their use are more open ended. What exactly this means – to design for open-ended experience – is currently an issue of debate within HCI. If experiences are open-ended, then does it really matter what we design? Couldn't a screen saver or a lava lamp serve as an emotionally evocative display if the user chooses to make it so?

Furthermore, if our objective is for causing reflection and new experiences of affect, what allows us to have a point of view on whether one design causes 'better' reflection than another or one design is a 'better' experience than another? We must answer critiques of phenomenological evaluations being relative accounts with little to offer for more general practices and understandings. As we search for criteria to guide and judge our designs we need new criteria for guiding and judging our evaluation methods. Standard HCI practices and the work of affective computing largely draw from the evaluation criteria established through the sciences, criteria for evaluation

methods with high degrees of accuracy, validity, and generalizability. These criteria may or may not be the right ones for systems designed for openness.

Reflective Design: An Interpretation Approach for Affect

In introducing this case study on affect, I have again followed a practice of reflective design. The first step of this process consists of examining the historical developments and the socio-cultural influences and implications of a particular area of design. In this case, my starting point was the development of affective computing. The motivating observation for initiating a reflective design practice was in how affective computing approached the ineffable experience of affect as something to be found, codified and transferred. In order to unpack this development, I had to take a step back and look at how affect as a concept is conceptualized in a number of different fields but primarily from cognitive psychology as this exerts the most influence on affective computing research and design. Although proponents of affective computing do not claim to propose a theory of affect, I could trace the theory or the perspective influencing their designs and evaluations as a perspective of affect as information.

The second step then in reflective design is to imagine alternate possibilities and in turn to uncover the grounding available for an alternate approach, the assumptions that would support such an approach, and the resulting implications. For this step, I described the emerging perspective from the Affective Presence consortium. This group is developing a contrasting perspective or theory of affect as interaction where affect is created and the ineffable or lived experience of affect is not explained away. Contrasting the affect as information and the affect as interaction perspectives produces the following comparisons (see Table 1).

Table 1: Affect as information vs. affect as interaction

	Affect as Information	**Affect as Interaction**
Nature of Affect	Inside the Individual Reified or Static Abstract	Individual + Social Dynamic Felt
Design Objectives	Transference of Meaning	Co-Interpretation of Meaning
System Evaluation	Accuracy of Representation	Evocativeness of Reflection

The table summarizes how each perspective will result not only in different designs but also in different methods and metrics for evaluating these designs. The third step in a reflective design practice is to engage in the design process itself with a continual orientation toward critically examining design choices. In the next section, I will discuss in detail the design and evaluation of one Affective Presence system. This case study will serve as an in depth exploration of the affect as interaction perspective and its implications.

Affector: A Case Study of Affective Presence

The case study for this chapter revolves around the design and initial evaluation of a system called Affector, a video window for communicating the affective climate of neighboring offices. Comments such as “a chill came over the room” or “you could cut the tension with a knife” suggest that people believe in their ability to read the climate of a space based on cues such as the number of people, their apparent moods, levels activity, and amount of clutter or crowding. We wanted to play with this perceived ability by creating displays of mood in an office space. I will begin this case study by first

examining background work on mood in the office space and lessons learned from this experience. I will then move to describing the Affector design and evaluation before ending with a discussion of implications for the affect as interaction perspective and the practice of reflective design.

Background Work

I will first describe an initial design for displaying collective mood called Miro, a system that ultimately played a large role in the ultimate shape of Affector. Miro was a collaboration between myself, Mo Chen and Zheng Liu created in the fall of 2002 (Boehner, K., Chen, M., & Z. Liu, 2003). We were designing for a public space in the Information Science Building of Cornell University, where approximately 20-30 people work at any given time. As we were designing to augment people's perceived abilities of sensing the emotional climate, we first set out to understand how they currently deduced information about affect in the office. We then brainstormed how sensors and ambient displays that foreground peripheral information could enhance and supplement the senses for detecting collective mood.

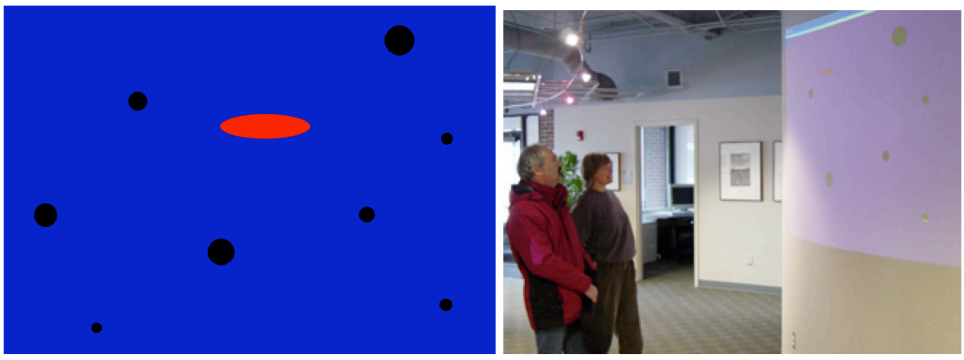


Figure 11. The Miro display (left) and users' attempting to interpret it (right)

Our criteria of success were whether our system would 1) correctly model the affective climate (assuming that 'a climate' actually exists), and 2)

clearly communicate this climate in an informative display. In this way, our starting point was very similar to affective computing projects.

However, we felt most affective computing and ambient systems communicated their underlying model of emotion too literally, e.g. using a bar chart to indicate the amount of 'happiness' or 'sadness' in a room. We felt this literal and didactic representation would quickly lose the interest of people in the office. Therefore, we chose to portray the emotional climate more abstractly as an animation of the painting Blue by Joan Miro. The display, henceforth dubbed Miro, was projected onto the walls of the shared office space (see Figure 11). The composition of Miro, such as its color, number of dots, and movement, changed according to indices of emotion gathered through sound monitors and surveys of how people in the office were feeling. It is important to note that, although we chose not to make the external display an easily decoded mapping of input to output, there was a direct internal mapping driving the display. For example, a number of online responses of happy versus sad changed the background color of the display toward the yellow end of the color spectrum.

During our evaluation of the installation, we began to confront the challenges described earlier in the affective computing approach. For one thing, people interpreted the display 'incorrectly', i.e. they rarely deduced the correct internal mapping between the display effect and their input. However, people did develop an interpretation of the display by standing in front of it in groups, talking about what it might mean, and sharing their impressions of why it changed. The "whys" that people discussed were not the system indices (e.g. the survey input or the amount of noise), but the surrounding context (e.g. the absence of people, the weather conditions, or the presence of impending

grant deadlines). In other words, rather than the display representing a pre-existing climate, the collective interpretation people generated around the display worked to create an emotional climate. Because of how Miro was actually used, we realized our metrics for success, as well as our design approach, were misleading. The affective climate was less a state to measure and more an emergent expression. The readability of our display, therefore, was less important than its ability to provoke converation. The engagement we needed to focus on was how people collaboratively interacted *around* the display, in addition to how they interacted *with* the display.

Our experience with Miro developed as we were collaborating with the Affective Presence coalition to articulate the principles and strategies for affect as interaction. In this context, we highlighted two important insights from Miro. First, the internal emotional model of the system trapped us into presenting affect as information rather than interaction. Even though we had tried to reduce the visibility of this emotional model in the display by using ambiguous graphics, we were still using an information model for the collection of input. We wondered what would happen if we removed, or at least drastically reduced, this internal mapping. Second, in thinking about affect as a process of co-interpretation, we realized that with Miro the interpretation occurred in distinct phases. In the first phase, the designers anticipated how the users might interpret the different display effects (e.g. choosing color changes to indicate happiness). The second phase of interpretation occurred in use, as the users collaborated with each other to create meaning around the display. As a result, the coordination of interpretation was asynchronous between designers and users. We decided it would be interesting to collapse these phases by tightly coupling design and use. Finally, the Affector system also

differs from Miro in that it would originally be designed for use by two people as opposed to a larger group. We chose to start with a dyad for a more focused study that may then be tested against differences of use for larger groups. In the following section, I will present an overview of the Affector design process as enacted by its main designers Phoebe Sengers and Simeon Warner beginning in the autumn of 2004. The purpose of this case study is to both demonstrate the viability of designing for the ineffable experience of affect that is open to interpretation, rather than scripting and flattening affect, and to explore the design and evaluation implications of taking such a fundamentally different approach to affect and technology design.

Designing Affector

Although Miro provides a backdrop for Affector, and many of the Affector design decisions were made in response to the Miro experience, Affector has an origin story of its own. The story as told by its developers begins late one evening at the Information Science Building. Phoebe Sengers is steeped in concentration as she works in the quiet solitude. Suddenly her focus is interrupted when she hears a colleague enter her neighbor Simeon's office and exclaim: "Working so late all by yourself?" Up this point, Phoebe had been unaware that anyone else was still in the building, but she spontaneously shouts: "He's not by himself – I'm right next to him!"

From this exchange, the seed for the Affector program was planted. Phoebe and Simeon realized that although they do sit next to each other, in fact physically only a meter or two apart, the intervening wall effectively prevents any knowledge of the other. They therefore decided to build a virtual

window powered by a video camera and distorted video display between their offices to promote awareness of each other's emotional presence.

Design Objectives

In the first document produced regarding Affector (then called Tinge-atron), the goal of the system is described as an installation supporting ambient emotional awareness. Like a magic window (or a tear in the fabric) it shares something of mood/ambience rather than a direct window into 'physical reality.' It is intended to reduce the 'cubicality' of the office and perhaps, as Phoebe and Simeon suggested, even increase the degree to which one could ascertain if the other wants to go for a cup of coffee. The original goals of the system are to increase the affective sense of each other and to increase the number of their physical interactions.

The designers also indicated three objectives for the design itself. First, the design would be ambient, in that it would operate at a peripheral level and require minimal action. In other words, it would not demand a high degree of attention or intervention in order to communicate this sense of emotional presence. Secondly, the design would protect privacy and minimize the feeling of surveillance. Finally, the system would operate without an internal model of emotion. In other words, rather than developing a symbolic system like Miro where the dots represented sociability and the background color represented happiness for example, Affector would operate, initially, at a more sub-symbolic or demonstrative level. In the words of the system designers: "The system should not directly model user emotions, understood as discrete and well-defined units, but rather give continuous, rich, and potentially ambiguous background sense of emotion" (Sengers, Boehner, Warner, and Jenkins, 2005).

In articulating the system objectives, the designers were also clear about what the system would not be. In particular, they did not want to create a straight video window or a presence system. They were not interested in simply knowing if the other was in or out of the office, they wanted a sense of the affective presence or the emotional aura in the office over time. Secondly, they were not interested in a system for increasing productivity. Many presence awareness systems for the office are developed with the explicit purpose of improving work practices (e.g. Cadiz, Venolia, Jancke and Gupta, 2002; de Guzman, Yau, Gagliano, Park and Dey, 2004), but Affector was designed to create a sense of connection among friends who happen to work in the same building.

Design Strategies

In order to meet the above objectives, the designers identified four design strategies to guide their eventual implementation. First, one of the objectives is also a design strategy on its own: the decision to not include an internal emotional model in the system code. For this strategy, the designers looked to the work of Rodney Brooks who "argues that systems can appear intelligent and exhibit complex behavior without complex representation and manipulation of abstract information. Instead, Brooks's work is based on defining effective connections between sensors and effectors so that when the system is placed in a complex environment, a complex sequence of actions is triggered which can be narrated as intelligent behavior" (Sengers, Boehner, Warner, and Jenkins, 2005, p.2). For the Affector system, this would translate into systematically distorting video feed information based on dynamic environmental cues as opposed to based on a previously coded internal map of cues, their meaning, and the resulting display.

Secondly, the designers would use the strategy of autobiographical design (Sengers, 2006) for creating systems that are personally meaningful and draw on rich details of subjective experience. Autobiographical design should not be confused with the maligned "I-methodology" approach in HCI where designers use their own experience as a resource for designing systems meant for others (Akrich, 1995). The I-methodology approach falters because the user and designer are not the same person; the designer assumes that by designing for him or herself, this will automatically translate to the target group. In autobiographical design, the designer explicitly designs for him or herself and recognizes that through the richness of designing for his or her own peculiarities this offers the system a depth for reinterpretation by others. The benefit of autobiographical design is more in line with persona design or in particular extreme user design, where designing for very specific and even extreme personalities (Djajadiningrat, Gaver, and Frens, 2000), produces more effective designs than does designing for abstract, general, and non-existent caricatures.

Related to the idea of autobiographical design is the strategy of designing for situated use. This strategy is somewhat redundant to articulate as it follows from the previous strategy but I highlight it here because of its importance. The designers specifically talked about the Miro experience and how it 'worked' because the people who were interpreting the displays offered their own assessments of the shared context. The design leveraged the familiarity of users with each other and with the office space. Phoebe and Simeon, as the Affector designers, felt it important to bear this in mind as they developed Affector.

Finally, in order to address their objectives of protecting privacy, encouraging open interpretation and acting at the periphery, the designers used the strategies of ambiguity and defamiliarization in the display. Gaver, Beaver, and Benford (2003) argue that explicitly designing for ambiguity allows users to develop their own meanings of systems. Similarly, Aoki and Woodruff (2005) show how incorporating ambiguity into personal communication systems makes them a more flexible resource for users' personal relationships. Ambiguity and defamiliariation would therefore guide their choices as they developed the distortions to the video window. However, the designers recognize that ambiguity can also be alienating if there are no footholds into interpretation. To this end, they would rely primarily on the shared context described above.

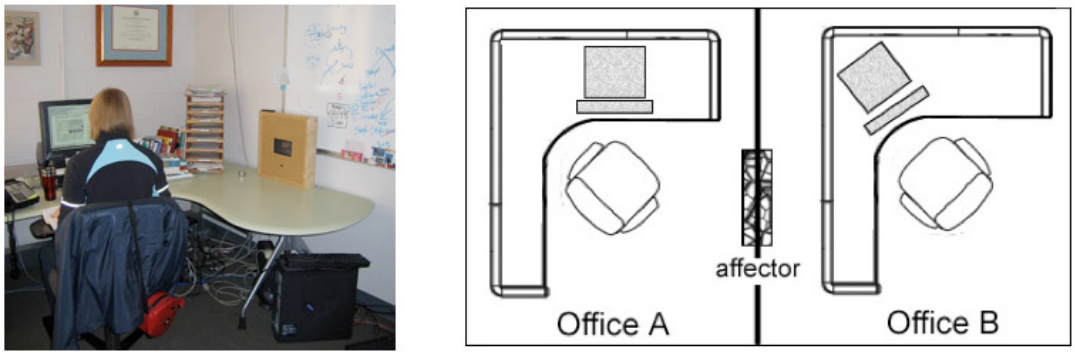


Figure 12. Affector set-up.

Implementation sketch

The eventual set-up of Affector consisted of a video camera in each office and a framed window for the distorted video feed from the neighboring office (see Figure 12). The windows were positioned to be roughly in the same position on the wall thereby simulating an actual window or portal. In its initial implementation, Affector v1.0 consisted of a series of rules that mapped

sensors to effectors. Both Phoebe and Simeon could alter and edit these rule sets through a web editor.

For example, Phoebe may develop a rule called “Green” that measures how much green is detected in each pixel of a video frame or “ColorDifference” that measures the covariance in color (red, green, blue) for pixels in the video that is captured. Simeon might come up with a rule called “Inversion” and give it the property of taking the color property of one pixel and inverting it to its opposite value. The final step then is combining the rules in if-then statements. For example, “If Average Green > 5”, then “Inversion”. This means that if the average level of green in the pixels of the video feed of Phoebe’s office have green levels greater than 5, then the color of all the pixel will be inverted when displayed in the Affector frame in Simeon’s office. A rule that stated “If Minimum Green < 5”, then “Inversion”, the inversion distortion would operate when the minimum level of green value detected across the pixels was less than 5. It is important to note how there is not an intermediate step where “Green” is coded to mean happy and therefore should launch the happy distortion. Instead, the sensors and distortions would be matched based more on trial and error of the resulting output displays. In the original implementation, the rules consisted of being able to detect light levels (e.g. greyscale) and color of pixels (e.g. red, green, blue). A skin-tone sensing algorithm was added early on yet did not work well technically in testing and was eventually rewritten for version 2.0. The effectors or distortions included: inverting color, stripping color out (e.g. to black and white), slowing movement of the video feed, and adding various types of noise.

The designers anticipated in the initial implementation that the range of rules would grow over time and that they could combine the sensors in

interesting ways to create new sensors (e.g. If Green > 5 and Light Level < 5) and likewise combinations of distortions. They also recognized that the initial sensor capabilities they coded were less than optimal and instead were the easiest to detect[34]. In addition, the designers discussed wanting sensors that could detect edges and movement. These were also added in version 2.0 and will be explored in the results and discussion sections.

Evaluation Methods

As an evaluation of an Affective Presence system where affect is conceptualized as interaction and not information transfer, the evaluation objectives have shifted from one of deducing if the 'right' emotion is detected and communicated to understanding how the system is appropriated for the expression and reflection on affect. Specifically, in talking about what would be the appropriate evaluation methods for this project, the designers and myself determined that what we were trying to capture through the evaluation is how as designers and users they narrate what a "working" system is and how they adjust the system accordingly. In other words, the objective is not to determine if the system works but to determine how it is that the designers/users conceive of a working system and how they adjust Affector accordingly. Therefore, the methods would have to serve as prompts for illustrating specific design decisions, surfacing the assumptions and directives behind these decisions, and capturing the implications of these decisions in use.

In the design strategies section, I described the use of autobiographical design as a design strategy, but the evaluation is also a combination of autobiography and biography. My role in the Affector project has been

[34] A number of graduate students worked on different aspects of the Affector v1.0 code including Rev Guron, Yevgeniy "Eugene" Medynskiy, and Eunyoung "Elie" Shin. For Affector v2.0, David Klein joined the technical team.

primarily one of a facilitator searching for prompts to help the designers/users narrate Affector. However, just as one of the design principles for affective presence systems is to support co-interpretation of affect, the evaluation of such systems must also be a collaborative process. Therefore, in the recounting of the evaluation, I will draw heavily from the interpretations of Phoebe and Simeon as well. Along with playing the role of designers and users, they also stepped into the role of evaluators and the methods discussed below were specifically designed to facilitate the sharing of this role.

Questions

The evaluation questions guiding our selection and use of evaluation methods throughout the design and use process include:

1. How do Phoebe and Simeon define a 'working' system? Does this definition change over time?
2. How do Phoebe and Simeon use Affector to develop a sense of each other's affective presence? Do these practices change over time?
3. How does the system influence Phoebe and Simeon's day to day interactions? Do these change over time?
4. What system attributes encourage or impair how Phoebe and Simeon collaborate and reflect on their affective presence in particular and affect in general?
5. How can we evoke rich, detailed narratives of experience?
6. How can we account for and make sense of multiple interpretations in evaluation?

The first four questions are about the design and use of Affector, whereas the last two questions are about evaluating the evaluation itself.

These questions were present throughout the two-year period of this study. Affector did not have clearly time bound periods of design versus use. As a readily configurable system, Affector is meant to be always in a state of both design and use where Simeon and Phoebe can constantly tinker with the types of sensors and effectors at play in the system. Therefore, there was not a set period where we stopped using Affector and began the evaluation (in fact, the design, use and evaluation continues today). Instead, the questions above have been asked from the beginning.

Methods

We used several different methods in order to investigate the questions outlined above. These methods included usage data, interviews and observations, formal and informal documentation (e.g. published papers and emails), and facilitated design/evaluation sessions. The evaluation team was led by myself and included two undergraduate researchers, Liz Goulding and David Klein. Liz and David assisted with the interviews and observations throughout the study. I will describe each method in more detail when introducing the results for each method in the results section.

Conditions

From the period of November 2004 to January 2006, we had several different conditions. Due to Phoebe and/or Simeon being out of town intermittently for long periods of time, the data collected is not continuous across this time period but is focused on certain weeks. This is generally focused on twenty-one weeks when they are both in the office although we do have data from days where one or the other is out of the office. The first condition was the ‘Pre’ condition or the baseline condition where Phoebe,

Simeon and students were coding and designing Affector but there was no system set up between their offices. The second condition occurred from the end of February 2005 to early May 2005 and consisted of a straight video conferencing condition, i.e. a video feed of each with no distortions or filters. During the 'Between' condition, we removed the video conferencing set up. In July 2005, the 'Affector' condition began with the Affector v1.0 system running in both offices. The last condition, the 'Post' condition, began in November 2005 when we took the Affector system down. This period lasted through January of 2006. The chart below (see Table 2) illustrates the different conditions and sources of data collected during each condition.

Table 2. Data sources across timeline of conditions[35].

Conditions																					
	Pre				**Video**				**Btwn**			**Affector**						**Post**			
wk:	1	2	3	4	1	2	3	4	1	2	3	1	2	3	4	5	6	1	2	3	4
	Nov04 - Feb05				Feb05 -- Apr05				Apr05 - Jun05			Jul05 - Nov 05						Dec05 - Jan06			
system looks					—	—	—	—				—	—	—	—	—	—				
system edits									—	—	—	—	—	—	—	—	—	—	—	—	—
f2f clicks	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Inform. docs	A	-	-	-	-	-	-	-	-	-	-	-	B	-	C	D	-	-	-	-	-
Formal docs		E							F	G									H	I	
Inter-view				* *	* *	* *	*	*	* *			* *				* *					
Focus Group															*					* *	

[35] The letters for the informal and formal documents correspond with a list of the documents presented in the results section.

In addition to adding the straight video comparison condition, we had also anticipated having two additional modified conditions to test but these were not included during the v1.0 testing phase. These will be important additions in the next steps. The first condition would be a 'Random' condition where without Phoebe and Simeon knowing, the rule sets would be replaced with a random rule set generator. We felt this would be an important condition to judge against in terms of whether it makes a difference in the design to have control over the rule sets. The second condition we had hoped to test was an 'Information' condition – one created in the spirit of the affect as information approach where emotional presence levels would be given some type of internal emotional model that is then displayed (e.g. Happiness in Simeon's office = 5). These additional conditions would have been useful for challenging the assumptions behind the affective presence approach, however, the current project is still able to address some of these through the conditions available.

Results

In this section, I will describe each method and present the main results in two forms: the 'raw' form and the 'user interpreted' form. The 'raw' results includes things such as look counts or comments from interviews. This same raw data was presented to Simeon and Phoebe and used as prompts for their interpretation, therefore producing more results of the 'user interpreted' form. Although interpretation of data is usually held for the discussion section, it is included here in the results because Phoebe and Simeon's interpretations are the results I was interested in surfacing. From the beginning, we had decided the evaluation of Affector would involve detailing how Phoebe and Simeon

narrated what a “working” system would be. My interpretations of the results in this section will be primarily offered in the subsequent discussion section, although my selection of results here involves a degree of interpretation. To guide this selection, I include the points that Phoebe and Simeon mentioned multiple times, highlighted as important, or explicitly flagged them to me for inclusion.

Usage Data:

There were two types of usage data: 1) information from the web log of changes to and comments on the rule sets, and 2) the system look data recorded by Phoebe and Simeon for the Video condition and the Affector condition. As for the first type of usage data, the recorded changes and comments on the system, there was minimal use of the web log edit diaries. From the launch of the web interface to the close of this part of the study (Jun 2005 – Jan 2006), there were 20 entries, all added by Phoebe. Her comments indicate that the rule set edits were primarily for testing functionality, for instance checking to see if the changes saved properly. The rest of the comments describe changing rule sets to monitor display effects. Most changes were not saved. One rule set was favored: Chunky Black and White (see Figure 13) which Phoebe and Simeon felt gave the display an artistic feel.

Figure 13. Chunky Black and White Distortion for Affector v1.0

In the interviews and in the joint sessions, Phoebe and Simeon discussed whether the lack of rule set editing was due to it being a bad idea or if it was a bad design of the interface (or bad instructions since Simeon maintained he was not aware he was supposed to edit the rule sets). They concluded that it was a combination of bad instructions and bad design plus the need for more time with a working system. Because much of the design work was on stabilizing the system, they had yet to get to the point of playing with and reconfiguring the system in the way they had imagined. For version 2.0, they have a new web interface that makes editing rule sets easier, Simeon is aware of his participation in changing the rules, and the program is becoming more stable.

The second type of usage data attempted to measure how often Phoebe and Simeon used the Video display or the Affector window in terms of

how often they looked at it. To measure this, they each had a clicker on their desk near the display and were instructed for each look to up the count by one on the clicker. Phoebe and Simeon agreed this would be most meaningful for them if they only counted looks where they actually registered the window, i.e. they would not count it if their eyes simply passed over the display. We recognized from the beginning that this was a difficult metric to capture and an awkward measurement method. First and foremost, one of the defining criteria for the Affector system was for it to be ambient and therefore a click system to determine usage required non-ambient interaction. Secondly, both users felt they clicked inconsistently, either forgetting during the day to log counts or forgetting for whole days at a time. In reflecting on these limitations, both Phoebe and Simeon felt the usage numbers were a low estimate of use. The numbers were therefore low for each day they counted but there were also entire days when they would forget to count[36].

As Phoebe and Simeon recorded and reported their counts, they often included comments on their raw score such as whether they believed it high or low and why, so to some degree they were aware of the raw data counts throughout the project. For low daily counts, they would primarily attribute this to the other person not being in the office. When they were busy themselves, this usually resulted in the system not being used at all, or at least not recorded. For the high counts, these were attributed to something interesting happening in the other person's office: e.g. a funky new haircut, an interesting outfit, or a lot of visitors. High counts for Affector were also attributed to the

[36] Simeon confessed to forgetting often. One factor influencing the disparity between Phoebe's relative consistency and Simeon's relative inconsistency is that, due to hardware malfunctions during both the Video or the Affector condition, for several days Phoebe could see Simeon but not vice versa. Although at one point, Phoebe switched machines because she felt guilty about being able to see Simeon and not the other way around.

system ‘looking so cool.’ In fact, one of the highest counts for Phoebe (28 counts, her highest was 34) occurred on a day when Simeon was not even in the office but she commented that she was just so excited it was working and it looked so cool[37].

Once this usage data and their comments were collected over a period of time, the evaluation team would periodically present the results to Phoebe and Simeon during the interviews or during the focus group sessions. The system data was presented not as conclusive results but as a stimulus or prompt to encourage interpretation, for instance to compare their usage across different conditions and to interpret any patterns or differences they saw. I asked during one of the design/evaluation sessions if they felt they used the Video system or the Affector system more. Both felt that the Video was more attention demanding and therefore would probably have a higher count. To check this hypothesis, I pulled data on the weeks from these different conditions when they were both in town (although both weren’t recording which is why Phoebe’s is higher). This resulted in 11 days averaged for Phoebe’s Video looks and 8 days averaged for Simeon’s; for the Affector looks, Phoebe had 17 days recorded and Simeon had 10 days[38].

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[37] During the interview and the design/evaluation sessions, Phoebe commented that she felt like this happened a lot – that they used the system even when the other was not around. Their clicker data however did not support this. The only day reported during the Affector condition of this happening was on July 5 from Phoebe when she logged 28 counts. During the video condition, Simeon logged numbers on 3 days when Phoebe was absent and they were his lowest counts and Phoebe only logged one day during the video condition when Simeon was out. However, they still had the impression that they used it when the other wasn’t around probably because they looked at the system at times during the day when the other was absent.

[38] In order to control for the variety in their recording and for the large difference in the days recorded (6 days), between the Video condition and the Affector condition for Phoebe, I also looked at a subset of the data where I only averaged the counts on days where both Simeon and Phoebe had logged counts. This meant I had 8 days for the Video condition and 6 days for the Affector condition. The highs, lows, and averages were all comparable with the results shown above, with Video being used more and Phoebe using Affector more than Simeon.

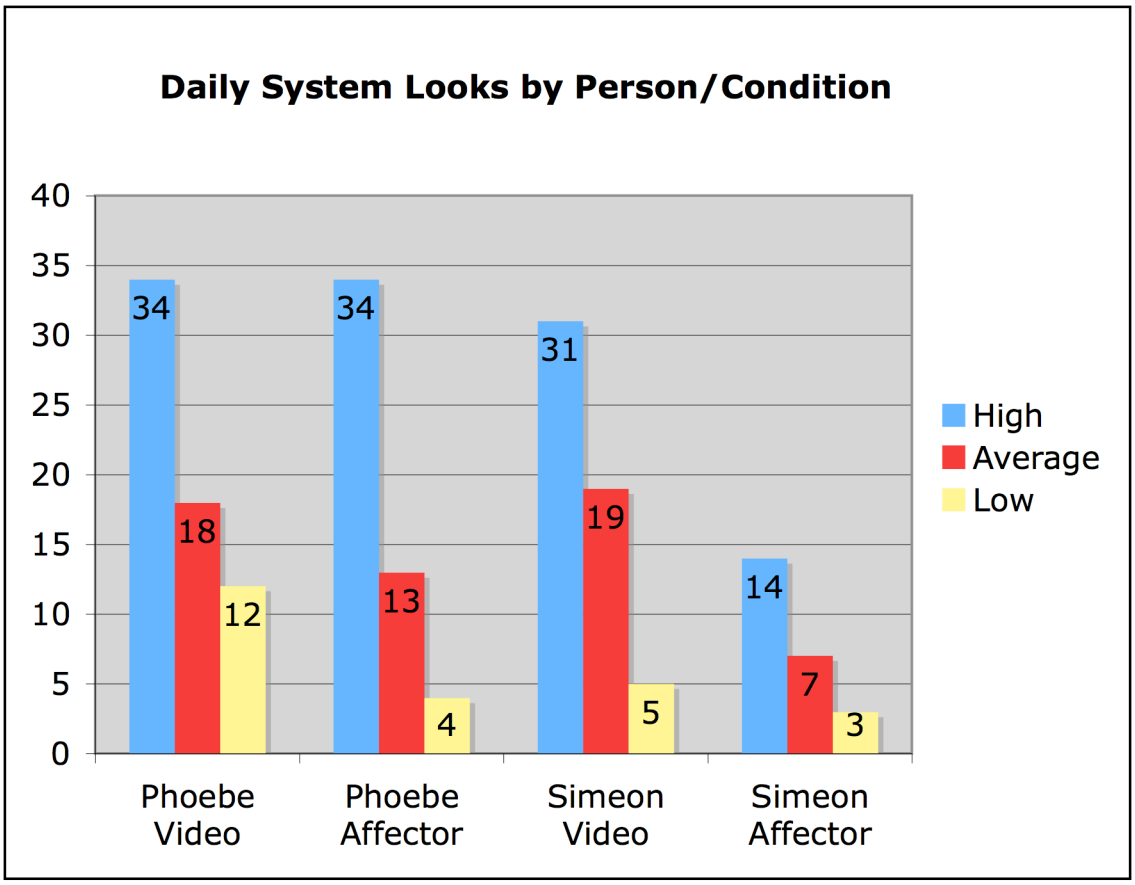

Figure 14. A bar chart comparing Phoebe and Simeon's look data (clicker counts) for the Video and the Affector systems.

The system data collected from these weeks generally supports their hypothesis that the Video system would produce more average daily looks (see Figure 14).

More importantly than the actual numbers themselves however was the sense that Phoebe and Simeon made of them. From the interview discussions and the design/evaluation sessions, their impression of the system look data was that it perhaps served as a rough indicator but they had low confidence in their accuracy. Perhaps more than the accuracy however was the feeling that

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With this data for Phoebe, the average Video looks per day was 18 and average Affector looks was 15. For Simeon, the average Video was 23 and the average Affector looks was 8. (numbers rounded to nearest whole number).

the process of using the clickers took away from the original design goal of ambience, as anticipated. Their preference moving forward would be to configure the system so that it could take an indiscrete measure of gaze for Affector v2.0 (launch TBD). Until this capability could be implemented, they would continue with the clickers but instead of assessing the information periodically, they would assess the information on a more regular basis. This would serve both as a reminder to use the clicker and also would help them remember what might be happening at the time to influence the numbers. The issues Phoebe and Simeon experienced with the system data, in terms of accuracy, were largely the same with the face-to-face interaction data, the next data source described.

Face-to-Face Interaction Data:

The face-to-face interaction data was collected for a much longer time period as they began charting their interactions from the start of the project in November 2004 and carried through to January 2006. We used the same kind of clicker system that we used for the system usage. For the face-to-face interactions, Phoebe and Simeon chose to track four areas: the kitchen (chosen as a common/social space), the area directly outside of their offices, inside Phoebe's office, and inside Simeon's office. In each area, there was a clicker suspended from the ceiling to record interactions. For their individual offices, we had two clickers suspended. One clicker was labeled P for Phoebe and the other S for Simeon. When they found themselves in a face-to-face interaction, they would click the clicker based on who initiated the interaction. For instance, if Phoebe went into Simeon's office, she would click the P clicker but if Simeon called her into his office, he would click the S clicker.

The idea behind collecting this information was to present it to Phoebe and Simeon during the interviews and the design/evaluation sessions (described in the following section). We did not anticipate that the usage data would become a pivotal part of the analysis where we would make statistical assessments of the variations in their patterns and attribute it to the conditions with or without the Affector display. Instead, we were interested in what sense Phoebe and Simeon would make of the data – would they believe it had significance? How would they narrate changes in the data? Would they cite Affector as a contributing factor or would they explain the data through other factors?

The face-to-face clicker data collected for this study ranged from November 2004 until January 2006. The clicker data was collected, recorded, and then the clickers were reset to zero weekly by students working for the Information Science program. Again, there were large periods of time when either Phoebe or Simeon was out of town, or occasionally one of the students would forget to log the data for that week, so the information presented here is for the weeks where information was recorded: 4 weeks for the Pre condition, 4 weeks for the Video condition, 3 weeks for the Between condition, 6 weeks for the Affector condition, and 4 weeks for the Post condition. Coincidentally, the Pre condition weeks and the Post condition weeks ended up occurring at roughly the same time periods but a year apart (2 weeks at the end of the winter semester and 2 weeks at the very beginning of the spring semester). This became important for comparison as both Phoebe and Simeon, but primarily Phoebe because of teaching duties, commented that they would expect interaction to be higher at the start of the semester.

According to the graphs shared with Phoebe and Simeon during the interviews and design/evaluation sessions, there were no strong discernible patterns in their face-to-face interaction levels, although interactions seemed to be lower during the Video and the Between conditions and interactions were highest during the Post condition. From the numbers, Phoebe and Simeon concluded that they don't interact enough in the kitchen at all to make counting in that space useful and most of their face-to-face interactions occur in their offices. One point from the data that caused some distress during the design/evaluation sessions was a perceived pattern that Simeon initiated more face-to-face interactions than Phoebe[39]. Phoebe wanted the results to show more parity in their initiations, although she countered this difference by pointing out that she used Affector more. Simeon suggested this might mean that she was happy enough with Affector, and therefore her need to interact with the real Simeon declined – an opposite effect of what they were trying to design for. But according to the numbers collected, during the time period when Affector was running, their average face-to-face interactions stayed roughly the same with the Pre condition yet interactions during the Post condition increased. All three of these conditions were higher than the Video or the Between condition.

At the very beginning of the project, both Phoebe and Simeon hypothesized that their interactions would go up during the use of the Video and Affector, but more so with Affector. During one of the design/evaluation sessions, they discussed one possible reason for an increase in interaction

[39] According to the numbers, there were two (out of 5) periods where there was a relative disparity in initiations – in the Between condition, Simeon initiated on average 6 interactions to Phoebe's 1, and in the Post condition, Simeon initiated on average 8 times to Phoebe's 5. During the other three conditions, they were about equal.

during the Affector condition would be due to talking about Affector and they discussed whether they needed to control for this kind of interaction (i.e. whether it was a confound). They decided that this was a feature and not a fault. As Simeon stated, “It’s fun [to talk about Affector].” Yet, they also speculated that they would interact more because Affector would encourage a greater ‘sense’ of the other person. The example they gave in the beginning was whether they would know if the other wanted to go for a cup of coffee because they could tell the if person was feeling social or not. Although Phoebe indicated that giving up caffeine in the middle of the project negated this as a possible outcome, the data did not support a narrative of increased interactions. Instead, interactions seemed to decrease from the Pre condition to the Video condition to the Between condition but then increase slightly in the Affector condition and jump in the Post condition. Furthermore, they believed that the numbers for their interactions would spike prior to a launch of the system as they worked out the kinks, whether Affector or the Video. Again, the numbers did not confirm this hypothesis. These are the ‘raw’ results collected – but what is interesting is how Phoebe and Simeon chose to interpret these results. One possibility would be to explain why they didn’t interact the way they anticipated, but instead, they felt the more resonant explanation was to doubt the numbers’ accuracy (see Figure 15).

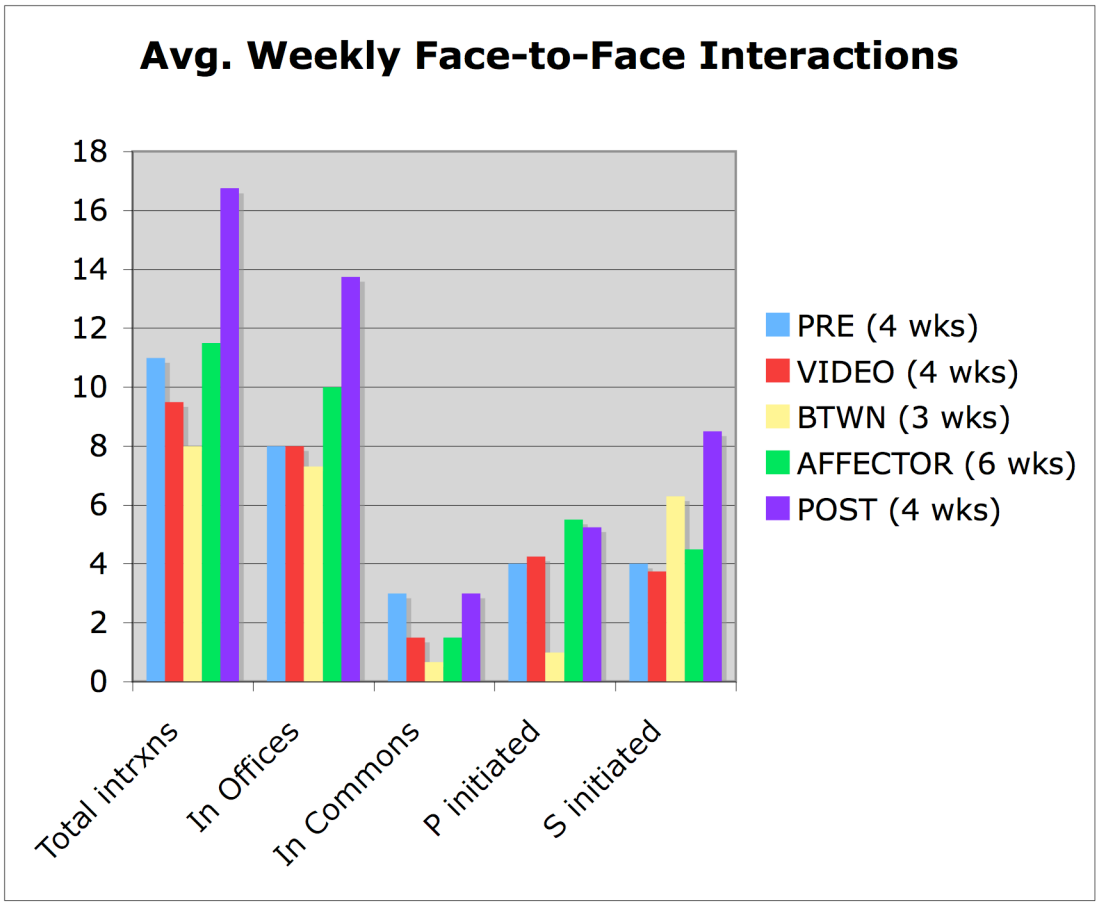

Figure 15. The average face-to-face (f2f) interactions across conditions. Total interactions are combined scores of the In Offices (Phoebe's and Simeon's) plus the Common area interactions. Total interactions also equal Phoebe (P) initated plus Simeon (S) initiated.

During one of the design/evaluation sessions, we discussed if the face-to-face interaction counts suffered the same limitations as the system counts. There were a couple important distinctions according to Phoebe and Simeon. First, Phoebe had predicted that the system clicker data would be easy to use since one wouldn't even have to get out of the chair to click it, but that the face-to-face clickers were more troublesome. If she forgot to click after returning from Simeon's office, she'd have to yell over to him to get him to click it for her. Throughout the course of the project, though, the reverse started to happen. Clicking the face-to-face clickers became second nature to them, and

the system clicks became more annoying. They both described how they would enter the other's office with their hand raised as they walked toward the clicker – it became an automatic movement for them. In contrast, with the system usage method, the clicker took away from its intended ambient nature. One distinction in these scenarios could be that the face-to-face interactions in each others' offices tended to be intentional and a conscious break from another activity whereas looking at the displays tended to be unintentional at first – something that would draw their attention away from an existing activity. The other important distinction discussed was that during their intense periods of interaction leading up to a system launch, a long intense interaction registered the same as a quick hello. If they worked together in Simeon's office for 5 hours, that would only register as one click. Therefore, although the number of interactions did not spike according to the data we collected, the duration of these interactions most likely did but was not captured in the data[40].

Overall, the face-to-face interaction data proved an interesting point for discussion but inconclusive. At the end of the project, the question remains whether or not they believe that Affector v2.0 will increase or decrease their face-to-face interactions. An increase could suggest they have a better sense of when the other is ready for a break, needs a break, or is feeling social. But a decrease could suggest that the kind of companionship and friendship they get from spending face to face time with each other is replaced somewhat through the Affector window. From the interviews and design/evaluation sessions, however, the importance of the effect on face-to-face encounters seemed to become less of an objective. Although in the original

[40] Simeon also suggested that if they were going to and from each other's offices rapidly during the design periods, it was likely that they only logged their interactions once as well.

documentation, increased interactions had been hypothesized as a measure of success, in later discussions they focused more on the interactions through the system: the sense of each other from the presence of the window.

Interviews/Observations:

The next set of results presented focus on data collected through interviews and observations. A portion of the time during the interviews was spent reflecting on the usage and face-to-face data, and those results have been reported above. For this section, I will report on additional impressions that were shared through the interviews and observation. For the observations, the evaluation team would observe Phoebe and Simeon and their use of the system. Through the observations, we were primarily interested in capturing spontaneously any interactions witnessed as well as how Phoebe and Simeon manipulated the set up of the system. Did they, for example, move the frames or move the camera? How did the system become part of their office environment? For the interviews, a single interviewer would enter one of the offices and ask a series of questions. The same questions would be repeated in the other office. The order of which office was approached first would be alternated.

Fourteen individual interviews were conducted, seven with Phoebe and seven with Simeon across the different conditions. The interviews were generally short, lasting from 10 to 15 minutes and were videotaped to allow for future review. The interviews included the following set questions:

- How would you describe what is going on with Phoebe/Simeon today?
- What evidence were you using to come to this conclusion?
- How would you describe the goals of the Affector project?
- How have your experiences so far with Affector influenced its design?

Additional questions would be added based on their responses and based on what had been happening in the design and use process. These results from our interviews and observations will be presented in rough chronological order starting with discussions from the Pre condition through to Video and onto Affector.

The goals cited for Affector remained relatively consistent throughout the project – both consistent between Phoebe and Simeon and consistent across the conditions. During one of the Pre condition interviews with Simeon, he stated the goal as:

> *"to produce something that affects our awareness of each other and perhaps changes our interactions as a result… I think our most important metric then is going to be whether we look at the system or ignore it, however using it could be a real subliminal thing so hard to measure."* (Pre condition)

According to Phoebe, she noted two goals, one for their own use but the other a broader impact goal. In terms of their own use, she said:

> *"What I hope the system does is give me a sense of the presence of Simeon in the other office, so I can glance up and get a sense that someone is sort of sharing the space with me and maybe I can tell a little bit about how he's feeling, in the same sense of working in the same room with someone and you aren't interacting but you have a sense of their mood. At the same time, I'm hoping I don't feel like I'm on Big Brother."* (Pre condition)

As for the broader goal, she went on:

> *"I'm hoping that one of the things we can learn from Affector is the lesson from AI that you don't have to represent everything and you can just have things directly connected to the world and pass information around about the world*

> *without representing it. I'm hoping to show that these ideas should be taken up in ubicomp too – it would be more privacy preserving [than the current model of sticking a sensor everywhere to build a model of the whole world]"* (Pre condition)

Therefore from these very first interviews, Phoebe and Simeon establish that the system will be about gaining a sense of the other, in particular a sense of their mood or affect, in an unobtrusive (ambient) manner that preserves privacy.

One of the objectives of the interviews was to determine how Phoebe and Simeon used the different systems – the Video or Affector (or nothing) – to develop a sense of the other. Therefore, the first question we always asked in the interviews was "What is going on with X today?" (where X is the other person). In answering this question during the Video condition, both Phoebe and Simeon would talk about events they noticed happening in the other's office, primarily the presence of other people as an indicator of something different happening. "Normal" mode would be working at their computers but the mark of something else happening appeared as interruptions to this normal mode. They both commented early on how facial expressions were of little use for determining mood even though they could easily see each other's expressions through the camera. As Phoebe commented:

> *"Normally, he's just looking at his screen and he has his regular usual expression, so that's just kind of the default. If I see that, I presume nothing's going on. But otherwise sometimes you see there are people in there with him so I assume a social interaction of some sort, whether it's work related or not."* (Video condition)

Later, in one of our design/evaluation sessions, Phoebe and Simeon picked up this thread again about facial expressions for determining emotion. They commented that when you are alone, and in both the Affector and the Video condition they still considered themselves alone, you don't think of using facial expressions to convey emotion – in fact you aren't thinking about explicitly trying to communicate or express emotion at all. Therefore on the flip side of this, it would not make sense to try to interpret the facial expression as a conclusive sign of emotion.

Throughout our interviews with the Video condition, both Phoebe and Simeon refrained from making any pronouncements about the person's mood based solely on the video footage. If they hazarded a guess on what the other person was feeling, it was backed up with other corroborating information. Most often, they indicated simply asking each other how they were feeling. But the Video and the Affector condition did often serve as a prompt for this conversation (e.g. "I saw there were a lot of people in your office today, are you super busy?"). For the Video condition, Phoebe and Simeon declared that it was not a system about mood. Simeon felt it was more a proof of concept that the mechanics worked. Phoebe also wondered during the Video condition if we were still boxing ourselves into thinking that an image on the screen could correlate with an identification of mood. The image might become one piece of evidence in the collaboration of establishing a sense of mood, but the image by itself could not be mapped like that. I will return to this result below when discussing their impressions of the Affector condition and its ability to invoke a sense of mood or affect.

Overall, the biggest complaint or critique offered about the video condition was that it was not ambient enough. Because all movements were

broadcast, even the slightest movement of the other person would cause a flicker in the display and this flicker would be enough to draw one's attention to it. Both Phoebe and Simeon mentioned that they hoped Affector would be less of a distraction – that the distortions would be "faded" or as Simeon said:

> *"I don't want to be aware of things in real clear detail exactly as they happen. I want it to be more ambient. I think that is what we always had in mind."* (Video condition)

The distraction of the movements on the screen would often cause Phoebe and Simeon to interact with each other through the video window (e.g. "I see him start moving so I wave to him and he waves back"), and this may have led to their assumption that they were interacting more in the Video condition. According to the physical face-to-face counter data, they interacted the least during this condition and the Between condition.

There were four aspects of the Video system that they identified as particularly liking: its physical form, the heightened sense of context, the privacy/presence balance, and the anticipation of the other. For the physical form, it took them some experimentation to get the camera angles as they wanted and moving the video conferencing software from their desktops to separate machines, but eventually they were happy with the physical configuration. They noted liking the position of the laptops so that they would be approximately back-to-back on other sides of the wall – therefore creating a sense of a virtual window. They felt this would be augmenting even more when they had the physical wooden frames of Affector. Second, they both mentioned that the window gave them an expanded view of their shared surrounding context. They liked hearing something outside of their office, in

the common space, and then checking the window to see if the other had heard it or responded to it as well. Or, as Simeon stated, wondering if he saw Phoebe leave her office if she would perhaps come toward his.

As for the privacy concern, they were both surprised that the Video condition did not feel invasive. They found it much more pleasant than they'd anticipated and worried more about being the watcher than the watchee. Simeon speculated that their unconcern with surveillance was due to their pre-existing friendship and the fact that it was typically just one person on the other side who could see him. This is related to the last point of anticipating presence: the Video window gave them a sense of the other and this came to be something they looked forward to having. Phoebe remarked how much she enjoyed looking at the window when Simeon cut his hair for Alaska – how it was fun to look over and see his bald head. Both mentioned that without the window, they wondered where the other was and they had not done this prior to experiencing the Video connection. Both also described a sense of disappointment when this potential of seeing the other was taken away at the close of this condition.

All four of the aspects that were liked during the Video condition improved during the Affector condition according to Phoebe and Simeon. They both commented during the interviews on liking the form of the Affector frames – that this physical form gave it the feeling of a special object and by positioning them in relation to each other it further emphasized the 'tear in the wall' idea. They also continued to enjoy the expanded sense of context (i.e. seeing how each other responded to their shared context) and the privacy factor improved because the details were more obscured. Finally, they continued to look forward to having this sense of the other because they could

still tell when the other was in the field of view even if things like facial expressions were obscured.

In terms of what they liked better than the video condition, they commented on the aesthetic and intriguing feel of the display: that it looked like an "*art work*", "*comic book*", "*pen and ink drawing", "a movie*", and "*poetic, even if you can't read shit in it*". As Phoebe commented:

> *"I feel like I'm looking at a picture of him as opposed to looking at him. It feels very unreal in some sense and unobtrusive…"* (Affector condition)

The distortions further helped in the objective of making the display more ambient. When they were drawn to look at the Affector display, it was because something interesting was happening either aesthetically, because it was fun to look at, or because the distortion would augment larger movements. The Video condition, in contrast, augmented all movements no matter how small and would therefore draw their attention even if nothing interesting was happening.

Despite Affector improving on the Video condition, they also discussed in the interviews that Affector v1.0 was a far way away from Affector v2.0. Simeon suggested that it was still too pictorial – that he wanted more distortions to the image to take away even more detail. Both Phoebe and Simeon also expressed concern that it was still about presence and not about affective presence. Simeon felt one important fix would be adding a sense of history in the display – for instance, creating ghosts of movement that would linger in proportion to how big the movement was. He stated:

> *"I'm interested in this idea of having something that you look at in an instant, but it tells you something across a longer ranges of time."* (Affector condition)

He reasoned that a still image or snapshot can only tell him so much about what is happening in the picture, but a series of snapshots laid on top of each other would be more evocative of the scene. Phoebe also discussed how the distortions and the sensors would need to be improved, how they had only recently implemented sensors to detect motion and skin tone.

During one of my observation sessions, I was fortunate to witness an ah-ha moment transpire in Phoebe's office after asking her what was going on with Simeon. She started interpreting the Affector display in much the same way that she had narrated the Video condition. She could tell the body outline of Simeon and could therefore talk about what was happening in his office in terms of body position, other people entering the office, etc. Her assessment of this display to me was that it looked cool but it still wasn't communicating emotion. At that moment, Simeon leaned back in his chair and put his arms behind his head and the distortions changed dramatically. Phoebe bolted upright and exclaimed,

> *"Wait!! There was emotion! Right there!! You can tell exactly how he's feeling."* (Affector condition)

This experience combined with a number of other events and their frustration with the 'too pictorial' nature of the display culminated in the design decision to focus on augmenting large or fast/abrupt movements. Around this same time, Phoebe had visited with Simon Penny who she had worked with

on the Traces program at Carnegie Mellon University. Part of Traces is about augmenting an individual's movement through creating semi-autonomous ghosts or agents that fly off of the person's arms and legs. She also reflected on her work with Joe Bates at Carnegie Mellon on creating believable agents where movement played a critical role in defining the emotion of a character. Seeing Simeon's movement and recognizing it as a proxy of emotion caused these other known experiences of motion as a rich communicative medium to surface again. I will further explore this theme of motion as a proxy for emotion in the results below from the Documents and the Design/Evaluation Session.

Documents:

As Phoebe and Simeon are not only designers and users but also researchers, this project could also draw from research papers written about the experience. At various stages of the project, different publications were written that reflected what was considered to be the most interesting and important parts of the project. In addition to formal documentation through papers and grants, I also used as a source email correspondence between Phoebe, Simeon and myself. The designers often used email to signal to each other when they had a new thought about the design or if they'd encountered a problem. They also used email to alert me of something they felt was important to capture for the evaluation.

The list of formal and informal documentation of note includes (see Table 2):

A. *Tinge-a-tron* initial project inception email. November, 2004
B. *Big Ideas Affector* email, August 1, 2005
C. *Genius Affector Insight* email, September 29, 2005
D. *Sensors = Effectors* sketch, October, 2005

E. *Evaluating Affector: Co-Interpreting What Works*. Phoebe Sengers, Kirsten Boehner, Simeon Warner, and Tom Jenkins. Submitted in December 2004 to the CHI 2005 workshop on Innovative Approaches to Evaluating Affective Systems. (accepted)

F. *Affect: From Information to Interaction*. Submitted in May 2005 as a full paper to the 2005 Critical Computing conference. (accepted)

G. *Closing the Affective Gap*. Phoebe Sengers and Michael Mateas. Submitted in May 2005 to the National Science Foundation. (accepted)

H. *Autobiographical Design*. Submitted in November 2005 to the Experience Design Workshop at the 2005 Critical Computing conference. Later revised for the Experience Design Workshop at CHI 2006. (both accepted)

I. *The Disenchantment of Affect*. Phoebe Sengers, Kirsten Boehner, Michael Mateas, and Geri Gay. Journal of Personal and Ubiquitous Computing. (in press)

I will discuss the formal documents first. The formal documents started with a paper (E in the list above) on how to evaluate Affector. This is interesting as it suggests that along with the initial design concept, the evaluation was being considered from day one. The second and third formal documents (F and G in the list above) focus on the theory of affect as interaction and how this translates into design and evaluation implications. The fourth published paper (H in the list above) detailed the design strategy of autobiographical design. Finally, the last paper (in the above list) was a refinement of the earlier theoretical papers and presented the idea of affect as a lived experience. Reviewing the papers along a time continuum did not suggest any major

changes in the design, evaluation or theoretical ideas. What is important in terms of results from these papers however is the fact that they were reviewed and accepted by an outside community of peers. As Phoebe had stated at the beginning of the project, one of the goals was to explore an alternative design space to the traditional model of Affective Computing. The fact that the ideas were accepted as worth consideration and further exploration by conference review boards and in particular by the National Science Foundation suggests a receptiveness to and interest in advancing this alternate approach.

In terms of results from the informal documents, they corroborate most of the results discussed already – such as Phoebe and Simeon's surprise about liking the video condition, feelings of disappointment when the video was removed, and feelings of disappointment when Affector was broken and eventually taken down. Phoebe often commented to me through email about enjoying Simeon's company in the manner that she'd hoped for when the project idea first came about:

> *"I'm in my office with the door shut. And Simeon is in HIS office with the door shut. And he's still keeping me company. That's cool!"* (Affector condition)

In addition to these general informal emails, there were two emails sent detailing key project changes. One email sent on August 1, 2005 from Phoebe to myself and Simeon was called "Big Ideas about Affector" and the other email sent on September 29, 2005 from Phoebe to myself and Simeon called "Genius Affector Insight". I will summarize their message here.

In the “Big Ideas about Affector” email, Phoebe realized that in order to augment movement in the manner that they wanted to, they needed to rebuild the sensor to effector mapping. In the current system, the video sensor would measure some condition and return a value about the whole image. If this value reached a certain threshold, then it would trigger an appropriate distortion. Phoebe realized however that the sensors needed more direct impact on the distortions:

> *“For example, we want to display ripples from areas in the image that have movement, rather than using movement to trigger a generic ripple distortion…Distortions represent the data from sensors directly rather than just being triggered by them.”*

In this way, the sensors and the distortions would have to be deeply intertwined. In the “Genius Affector Insight” email, Phoebe concluded (and claims that Simeon already knew this) that making the sensors and the effectors or distortions intertwined pushed to its extreme meant that these were actually the same thing. For instance, in the previous design, to trigger a distortion based on skin movement, the rule set would require mapping a sensor rule (e.g. If color = skin) to a distortion rule (e.g. change to black). What would happen now is that you would layer distortion rules (e.g. skin distortion combined with pixilation distortion). This idea was further corroborated as she worked with David Klein, a student on the project, to make new sensors. In order to see if the new machine vision sensors were working, David made each sensor also have a visual component – so rather than returning a number or value for the entire image, it changed the value of each pixel in the image and displayed a new image. In this way, he wasn’t just designing

sensors but sensors with a visual component or display, i.e. he was creating sensor/distortions (see Figure 16).

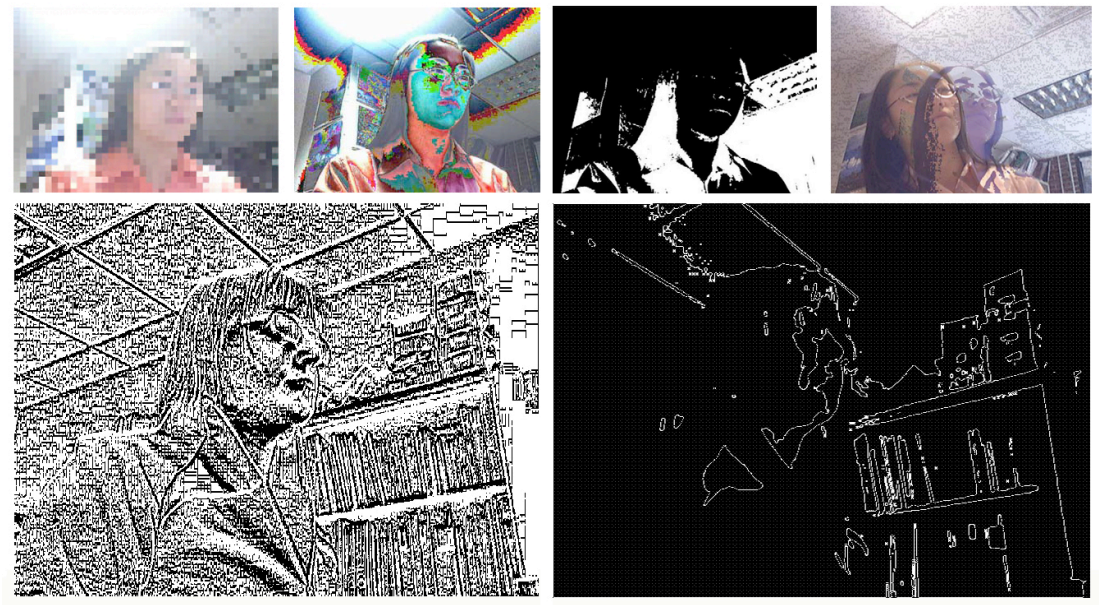

Figure 16. Screen shots of Affector distortions. The top line are first round distortions when sensors and effectors were separate, the bottom line are distortions when sensors and effectors were intertwined..

In reflecting on the importance of these insights, Phoebe suggested that it veers from but is compatible with the Brooks model that had been their original inspiration. She suggests the difference is due to the degree of human interpretation required of the output (rather than wanting the output to 'do' something) and the potential complexity of the output available. In a Brooks model, he has fewer outputs to control – e.g. a limited set of motors – and he is designing for some level of functionality – e.g. robots vacuuming your house. In the Affector system, there are hundreds of pixels to control – a far greater complexity field. Therefore, the complexity of the input should be matched by the complexity of the output (as opposed to reducing the

complexity of the input into a smaller degree of variation allowed by the output). Furthermore, the 'doing' is more rooted in the realm of the human interpretation. A Brooksian robot for example can vacuum the house and humans can interpret the robot as having some intentionality or even some emotion because the actions seem purposeful. However, the primary focus is on getting the robot to vacuum the house, the side result is that people will interpret the actions as meaningful. In the Affector case, the primary focus is on Phoebe and Simeon interpreting the displays.

Design/Evaluation Sessions:

Finally, in addition to the short interviews with Phoebe and Simeon individually, we also coordinated design/evaluation sessions with both of them present. Whereas in the individual interviews we wanted to get a sense of their personal opinions (and to see if they matched each other), in the group sessions, we wanted the designers/users to engage in dialogue about the project. Since the key thrust of evaluating affective presence systems, in general, and Affector in particular is elucidating how users make sense of the system, our strategies involve creating points of reflection for users to articulate this process. The design and evaluation sessions were designed specifically to help Phoebe and Simeon create a rich narrative about their experiences. Whereas in traditional HCI evaluation methods, self-report is regarded with a degree of suspicion, the Affector, the users self-report is exactly what we wanted to draw out.

The evaluation team's role then was to provide interesting topics for discussion in order to try and surface points of agreement, disagreement, change and confirmation. We held three joint sessions – one in the middle of the Affector v1.0 project and two toward the end of the project in January of

2006. As the final set of data presented, I will focus only on new results or new articulations of results already presented.

The first design/evaluation session took place after Affector had been running for approximately two weeks. During this session, Phoebe called for a return to first principles and they discussed the original metaphor of a tear in the wall and the influence of Brooks's idea of limited internal representations. They agreed that both the metaphor and the goal of limited internal models were still accurate. They wanted to create displays that didn't necessarily represent emotions but were open ended enough and based off of meaningful changes so that they would stimulate reflection on emotion. They reiterated that the Video condition did not work because:

> *"you can't tell how someone is feeling by staring at them" and "we don't want to* ***stare*** *at the window. One thing we've talked about over and over is giving a view of the window over time."* (Affector condition)

In reviewing the current Affector state, they agreed that what worked was that it did not intrude on privacy, it had more aesthetic quality than the Video, and it was a step in the right direction to augment motion. In terms of what didn't work, they listed that the sensor functionality was not meaningful enough, the sensor to effector mapping was slow (note this was addressed later by cleaning up the code), there was no 'at a glance' sense or no history, and the rule set editing interface was too difficult. For the wish list, they talked about wanting distortions that were perhaps modeled after A-life algorithms and distortions that left traces or ripples. Simeon also suggested that in addition to augmenting big or quick movements, it might be interesting to augment the other extreme as well of no movement over a long period of time.

Overall, however, the meeting summary was that Affector was better than the Video condition but still a somewhat low-resolution video itself. To improve it required better sensors/distortions that focused on movement and history.

The second joint design/evaluation session happened at the close of this phase of the project in January 2006. I organized this session to have more structure than the first session and in particular I developed a “Pivots and Divots” exercise for producing a milestone chart of the project detailing the high points, the low points, and the surprises along the way. The session started with Phoebe and Simeon entering a conference room where the table was covered with artifacts from the project to date. The white board had a timeline with 5 stages of the project outlining the bottom axis. I explained the exercise to them and asked them to take 10 minutes to write individually on single post-it notes all of the highs, lows, and surprises they could remember from the project. After 10 minutes, I asked them to put their post-it notes along the timeline and to discuss them with each other as they did so. Next, they were instructed to return to the table and read through the artifacts available for fleshing out more of the milestone story. The artifacts included quotes from emails, the clicker data charts, the documents itemized above, and images of Affector screen shots.

As this exercise was designed to review the history of the project, the discussions primarily confirmed the results that have been discussed above, but it did provide a reconstruction of the whole project for Phoebe and Simeon. For example, by using different color coded post it notes and placing them along the timeline, they could readily see that Simeon had more investment and interaction in the system during the hardware building stages and Phoebe was more involved during the software phase as this was how they divided

responsibilities. As they walked through filling in the outline and reviewing the project notes and artifacts, they also reenacted the ups and downs of the project. They became animated about the highlights: such as the physical form of Affector and when Affector two-way first worked. They also became despondent about the low points: such as their initial realization at the beginning that they would have to abandon Linux and building the system became more difficult. Phoebe became especially depressed from the realization of how long Affector had been down and the code rot that had ensued. The meeting ended though with a return to higher spirits because Affector v2.0 was 'vanishingly close to completion' and it would be 'so cool.'

At one point during this session, Phoebe compared the presence information from Affector with other office presence systems such as Instant Messaging. She differentiated a buddy icon in her buddy list as similar to the sense of Simeon in the other office. The buddy icon she said was an "information token", something that she wouldn't necessarily reflect on. But seeing Simeon's presence through Affector had more meaning because of their physical proximity and the shared context that they had. As Simeon commented:

> *"It's part of me being 'there'…not just that I'm online or something."* (Post condition)

In discussing how they used Affector I asked for clarification in terms of whether, as the designers, they were conscious of reverse engineering it when they looked at the displays. Did they, I asked, think about the mechanics when a certain display fired or did they just think about what it meant? Phoebe's response was that the rule sets were not sophisticated enough yet, so they

really had only been using one distortion the whole time. She speculated that she might think about the mechanics more with version 2.0. Simeon had also not been playing with the distortions so this was not something he thought about either. As a follow up, I asked if they thought about what was happening in their own offices and how this might be triggering something in the other's display. Both Phoebe and Simeon commented that when they looked at the Affector display, they generally only thought about what the other person was doing and not necessarily about what they looked like or how they were influencing their own display on the other side. They only thought about their own appearance if they did something goofy (e.g. changing out of one's bike shorts late at night) and then suddenly remembering that the Affector window was running.

As a final point from the second design/evaluation session, Phoebe and Simeon returned again to the issue of removing a representational model. Their dialogue went as follows:

> *P: I think even in Rod Brooks' approach, even though he is trying to get away from as much representation as possible, there is still representation in there. There is no doubt about that. When this sensor is triggered, then this motor is going to start turning because the designer knows that it will make the robot turn in the direction it is supposed to. So to some degree it's specious. But on the other hand, in [Simon Penny's] Fugitive, there is still an explicit emotional model and I still wouldn't want that.*
> *S: I think…ok…so, we are detecting movement in the image but we know that this is movement of the person. So we're designing that system for the sensing of a person. Which is in a sense modeling the movement of the person, it's just a very imprecise handle on that.*
> *P: And it's extremely situated. But that would agree with Brooks too. That because we know the system is in a particular situation…and in fact we're not really sensing*

movement, we're really sensing the sudden changing of a pixel color.
S: Right so we've got one thing that is a proxy for one thing which is a proxy for another thing.
P: Right so we're not really sensing movement, we're sensing a sudden change in the image and from that we're presuming movement and presuming from that that this is something that we want to see.
S: So switching the light off would produce a ghost.
P: Yeah, but that's ok.
S: That's fine.
P: Yeah, it tells you a change in state.
S: You would probably learn over time what that meant.
P: Yep.
(Post condition)

I highlight the above exchange because it digs deeper into their first principle of removing any representation and also speaks to their insight into using movement as the proxy for emotion. This doesn't change the original design goals of Affector in terms of what they want to do but it demonstrates refined thinking in terms of how they will get there.

Overall, the Pivots and Divots exercise was useful and confirmed the storyline that had been developing throughout the Affector interviews and previous design session, however I did not feel that the exercise pushed us to new insights or new discussions. Therefore for the final design/evaluation session, held a week later, I tried three different techniques to generate new discussions and perhaps looking at the same data in new ways. As the previous session had been an exhausting review with Simeon and Phoebe experiencing emotions such as guilt, because of the non-parity in their initiation of interactions, and frustration, because of the realization of how long the project had taken and its current code rot, I started with a fun exercise. Since they had often commented on wanting to decorate the wooden frames, I

brought wallpaper books and found online decorating sites for them to peruse. This started the session with a different level of excitement than going over data that they'd been reflecting on for some time. In terms of results from this exercise, there is not much to report other than they approached decorating the frames in order to say something about themselves (e.g. Phoebe wanted her frame to say "this is a woman with no taste") or to make the frames aesthetically pleasing (e.g. Simeon chose the jungle leaf print because it simply appealed to him). Their top choices then were as follows (Figure 17):

Figure 17. Mocked up Affector frames. Phoebe's top choice (left): black and white flocked, Simeon's top choice (right): urban safari.

For the second part of this session, I asked pointed questions based on the previous session but meant to provoke new directions in the discussion. Due to the challenges with the clicker data for example, I proposed an extreme design change that required them to 'invoke' Affector, for example by pushing a button that would then display all the distorted changes from the other office since the last time the button was pushed. There were two objections to this idea. First, it would remove the peripheral nature of the display and this was

one of the non-negotiable design principles. Second, it meant that you would witness 'all' of the changes that happened in the speeded up display. Part of what they liked about Affector was its ephemeral nature. In other words, something really interesting could be happening on the display – such as in Simeon's ghost analogy, his ghost could be floating across the screen with flames shooting off his arms – and Phoebe could miss it because she was reading her email. They both liked the fact that they could miss something really cool since the ephemeral nature of the display made it more like the ephemeral nature of the everyday. However, they did think that there could be something interesting in a display that not only responded to what it saw in one office but what was recorded in both offices. They marked this as a suggestion for further discussion.

One other point that was raised based off the earlier design session and in the interviews was the question of whether they felt Affector in its current version was for inducing emotion or reflecting emotion. Simeon took the question to mean whether he thought about his own emotions or Phoebe's and he replied that he thought more about the latter. But Phoebe took the question to mean whether the displays were more about reflecting Simeon's emotion (in her case) or inducing certain emotions in her. I shared that the impetus behind my question was from reviewing their interviews and emails for descriptions of emotional impressions or reactions to Affector (and the Video condition). It appeared that they often described how the system made them feel – for instance, feeling disappointed if the other person wasn't showing up in the window, feeling excited about the possibility of seeing the other, feeling content when the other person was in the window. This led to the following exchange:

P: I think it's a little mood inducing in that when you look at it, you have the sense that there is someone else there. And that you have company and in that sense it's mood inducing. But it's also mood reflecting because you are reflecting on the other person's mood or it reflects the other person's mood as well.
S: I think of it as allowing me to reflect on Phoebe's mood and that may induce my mood. I didn't notice any component of my reflection on my own mood.
P: If you think about what Affector does well in v1.0, it was the sense that Simeon was sitting in the other office and you could get a vague sense of what was going on…so maybe the mood inducing worked better than the mood reflecting right now." (Post condition)

The final exercise in the final design/evaluation session will close this section on results. For this exercise, I developed a variation on the repertory grid technique (Fallman, 2005, based on Kelly, 1955 and Bannister and Fransella, 1985) that involved five steps toward generating discussion on the salient dimensions of Affector. For the first step, Phoebe and Simeon brainstormed a list of defining dimensions – the qualities they felt essential for differentiating Affector from having no system at all, having a physical window, and having a video window. In step two, they would choose the three dimensions they considered most important. For step three, they would refine these dimensions further in terms of defining the polar ends of the dimension (e.g. non-ambient to ambient). In step four, they would take the three most important dimensions and rank where the following systems would fall: No System (i.e. just the wall), Hole in the Wall (i.e. a physical transparent window), Video (a video conferencing window), Affector, and Dream Affector (i.e. the system that they aspire to build). This step would allow them to

discuss the relative differences between these systems and sets up the final step: discussing how to close the gap between Affector and Dream Affector.

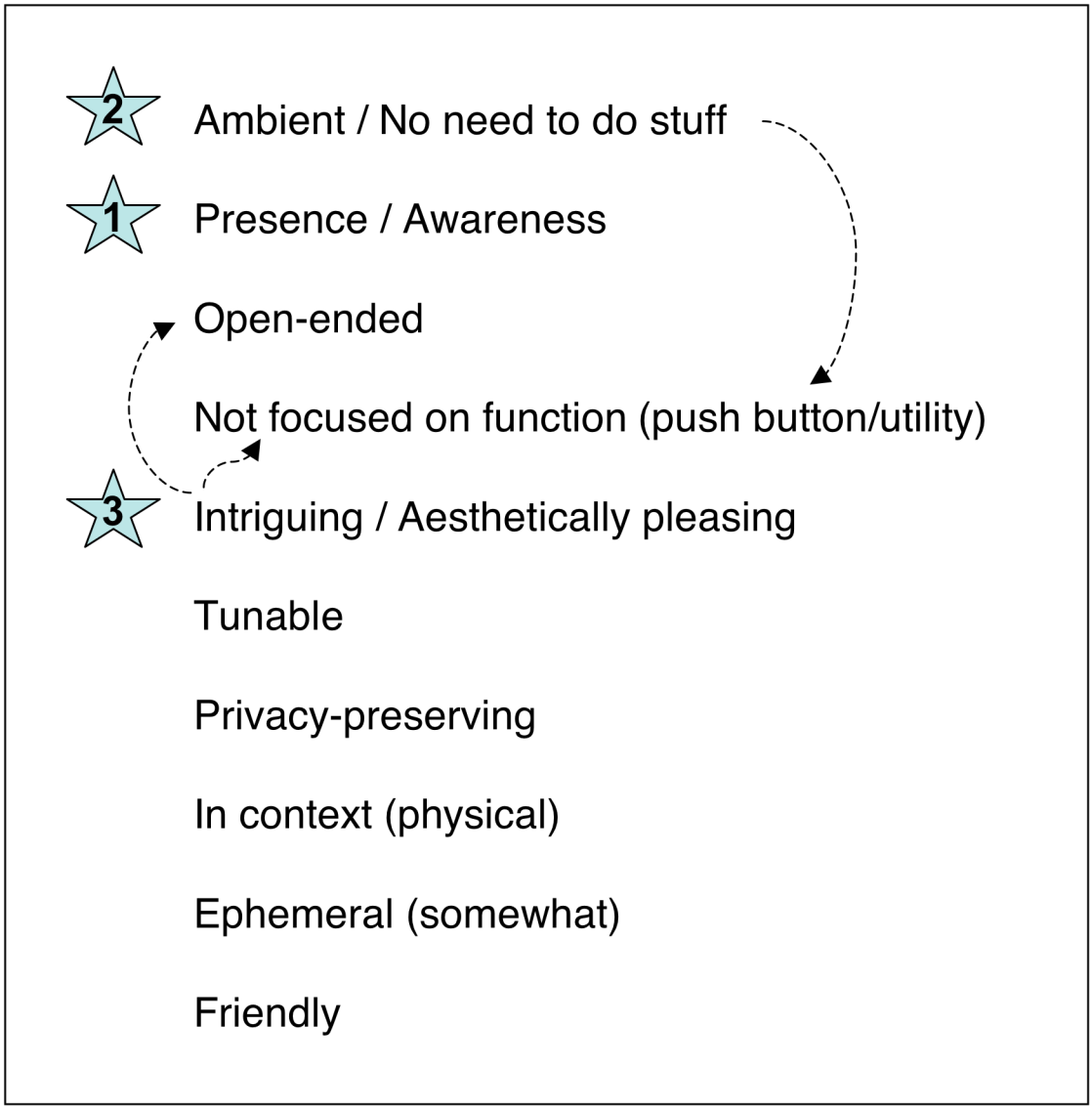

Figure 18. Dimensions listed in order from the first one thought of to the last. The stars mark the most important, the arrows represent related dimensions.

In the generating and prioritizing steps 1 and 2 (see Figure 18), Phoebe and Simeon produced a list of important qualities for Affector and immediately identified presence/awareness was the most important. The reasoned that

presence/awareness was the definition of what they were doing and all the other qualities were about doing presence/awareness in a different way. Simeon chose ambient for number 2 and Phoebe agreed but also voted for the Intriguing, Aesthetically pleasing one. She noted that this was not necessarily one that they were originally thinking about but that now she felt Affector embodied the Open-ended idea. Simeon agreed that something open-ended had less to do with having a well-defined function, an important distinction for Affector. I asked where 'affect' was – why wasn't this a dimension on their list? They felt that affect came through presence and awareness, and through being intriguing and aesthetically pleasing. I then asked about 'motion' since this had figured so prominently in their new thinking. Phoebe replied that motion was the means to the end –the way things done but not the goal.

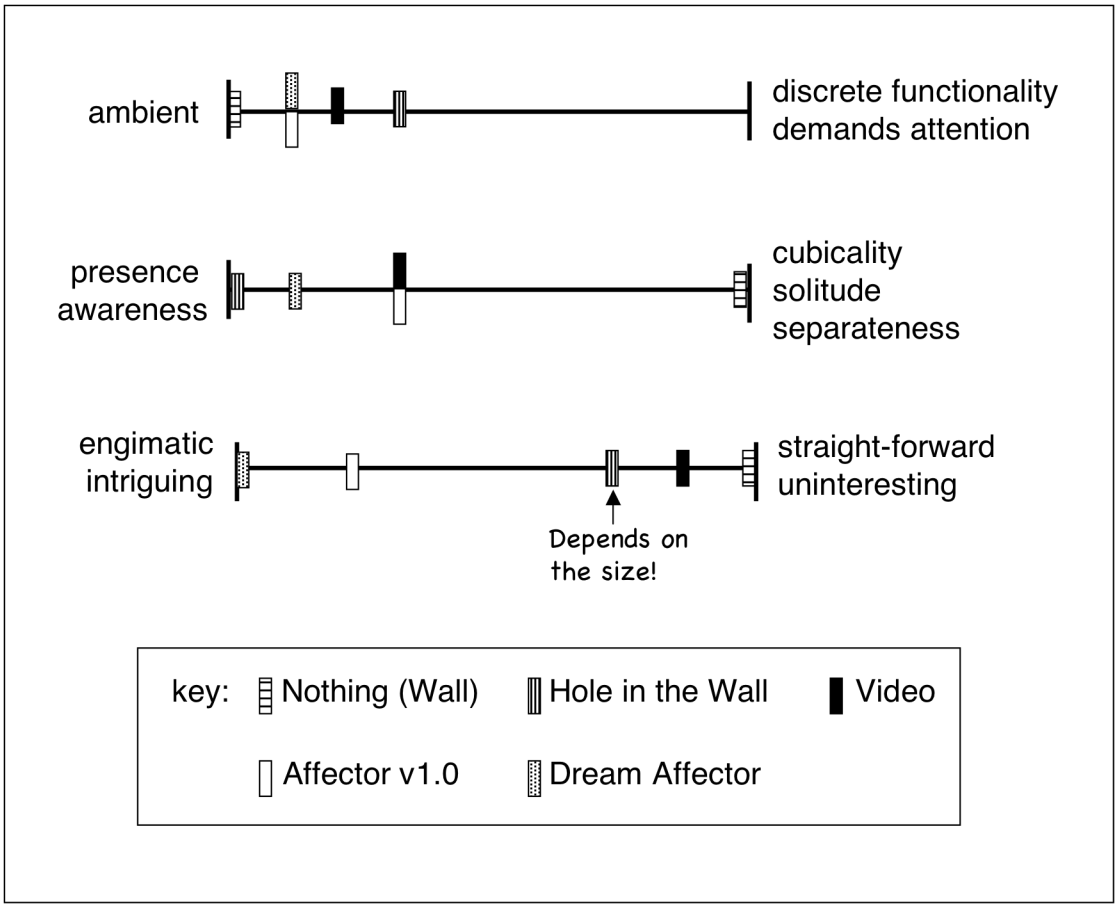

Figure 19. Rating the 5 different 'systems' according to chosen dimensions.

In steps 3 and 4, they now created the polar ends for these dimensions and placed all of the systems along the axis (see Figure 19). Phoebe and Simeon realized that for the dimensions they chose, they didn't actually want Dream Affector to be all the way to one extreme – for both the ambient and the presence/awareness dimension, they wanted Dream Affector to be a little bit to the right. The profile they were working the most against was simply having nothing. They remarked that the hole in the wall could potentially be enigmatic if it was shaped oddly like a key-hole or a heart, but even then that would be more awareness than they wanted. In comparing what they accomplished with Affector v1.0, there was less difference between Affector v1.0 and Dream

Affector than between Affector v1.0 and the Video, meaning they had moved closer to their goal.

Phoebe and Simeon were aligned on where they would put almost all of the systems except for two points of negotiation. They disagreed at first whether the Video condition was more or less enigmatic/intriguing than the Hole in the Wall. Since the Hole in the Wall would let sound through they wondered if it would be more straight-forward. However, they decided that a hole in the wall, especially a little one, would be weird so that raised its enigmatic score. Next, they disagreed whether Affector v1.0 had more presence/awareness than the video. Phoebe felt that the video seemed to tell you more than it did – that its 'photorealism' increased her expectations of being able to tell what was going on and she was then disappointed. Simeon felt that Affector didn't improve upon the presence/awareness of video but Phoebe argued that Affector got rid of some of the distraction (the noise or the clutter) and focused your attention only when something potentially meaningful had changed. Ultimately, they put Affector v1.0 and the Video at the same spot.

In order to close the gap between Affector v1.0 and Dream Affector, they felt on the presence/awareness dimension they would need to address the need for history in the distortions and for the enigmatics dimension, they would need more interesting sensor/distortion rules to play with. Simeon suggested that they also needed time in order to play with the rules and to learn to interpret them. He said:

> *"[Dream Affector] is not going to be immediately obvious and pictorial. We need to nurture our relationship with Affector. I*

don't mean that entirely facetiously. It's going to be a partly learned thing."

We ended the discussion by considering whether the axes were related – for instance if they improved the enigmatics if that could possibly change how ambient the system was. Although they felt this could be possible, they also agreed that Dream Affector was within their grasp.

Discussion

The presentation of the results thus far further demonstrates how design and evaluation in an affective presence approach differs from the affect as information approach. Whereas in affective computing the success or failure of Affector might be judged in terms of whether Phoebe could discern Simeon's actual emotions at any given time and vice versa, in this study we were interested in how they reconfigured the Affector goals and design in order to produce what they considered as a working system. This does not mean we precluded the possibility that they would try to use the system to deduce each other's exact emotions – in fact, during the interviews, we pushed to see if this was something they felt they could do. Instead, however, Affector was approached for giving an opportunity to reflect on a general sense of (an approximation of) mood or affect, not a one to one correlation between an internal state and an external display.

Because of our shift in focus, our challenge is to allow Affector to fail. If everything constitutes a success, then there is no need for evaluation. The preceding results however did speak to parts of the design that failed and in the end, they recognized the shortcomings of Affector v1.0 as a low resolution video system. What this type of evaluation allowed for however was a more

nuanced look at the failures and successes of Affector. I will return now to the original questions and use the results for proposing answers.

1. How do Phoebe and Simeon define a 'working' system? Does this definition change over time?

For the most part, the goals of the Affector system remained relatively consistant throughout the project for both Phoebe and Simeon with some interesting caveats. When returning to the final repertory grid that they developed, affect, mood and emotion are absent from the defining characteristics. They suggested this was because affect followed from enigmatically presenting presence awareness. I believe it was also not articulated because of this idea that they were not matching affect to a defined state reflected in an information display. Sometimes they may get a sense of affect, sometimes they may not. Sometimes the sense of affect may only appear every once in a while such as the ah-ha moment in Phoebe's office. The potential for Affect is constant but the sense of it is not.

The non-articulation of affect as a defining dimension may also be due to the way Phoebe and Simeon began to conceptualize the reading of affect. Their first move was toward using the proxy of movement as an index for affect. But their second move was toward using change in general as a proxy of movement which would then be a signal of potential emotional meaning.

Also from the grid and throughout their interview discussions, the importance of privacy diminished and was replaced by enigmatics as a criterion. Although Phoebe and Simeon had always planned to use enigmatics as a design method since they had always planned to distort the video feed, enigmatics became a goal of the system and not just a means to an end. As for privacy, there were three reasons why this was not cited as a central

concern by the end of the project. First, the system was being used between two friends and although this was always the design specification it became more apparent in use. In other words, a camera in their office in the abstract was more scary than the actual thing in the office of someone they know. Secondly, the rise of enigmatics as a defining goal meant that privacy would to some degree be taken care of at least if the enigmatics are implemented in a way to obscure details. Finally, and this last point will be discussed later as well, both Simeon and Phoebe felt more like a watcher and less like a watchee. Whereas they had initially expressed concern about feeling like they were being watched, the reverse happened and they only occasionally reflected on what their partner was seeing.

In addition, one of their early stated goals was not only what they would gain from the system when each was in his or her office but that the system would potentially increase their face to face interactions. Throughout the project, this became less of a stated goal. One possible reason for this is that the system didn't seem to be functioning in that way or at least the evidence was inconclusive in terms of whether it was increasing their interactions or not. But, what the system did do was act as another stimulus for informing interactions. The system may have caused some interactions to occur but its causal capacity seemed to diminish in the way that Phoebe and Simeon talked about it, but its ability to provide a resource to draw upon during interactions remained.

Finally, at the start of the project, Phoebe had articulated a broader goal of appealing to the Ubicomp and HCI community with a viable alternative to abstract world building through models and sensors. The acceptance of these ideas for consideration through published articles and an accepted grant

proposal indicates that this project and the ideas inspiring it have made progress toward this goal. However, the experience with Affector also caused Phoebe and Simeon to rethink what they meant by stripping out representations of the world. In their design discussions, they often referred to what they could sense and what this could potentially mean, such as skin tone to represent a person being in the space and large movements like leaning back in one's chair with arms behind their head to suggest relaxation. They often spoke of representations – for instance movement being a proxy for emotion. The difference in this project however is the conclusiveness of the representations. As a proxy of emotion, movement does not, at least in this current project, replace emotion. It specifically stands as a proxy – meaning an approximation. Its proxy status signals a more open form to interpretation. What will be interesting to chart in Affector v2.0 is whether movement maintains its proxy and open ended status or if Phoebe and Simeon quickly create a symbolic representation chain of distortions to moods to movements.

2. How do Phoebe and Simeon use Affector to develop a sense of each other's affective presence? Do these practices change over time?

Through the priming of the Video condition, Phoebe and Simeon immediately began to discount facial expressions as a means of communicating Affect. In some of the initial interviews, Phoebe would often describe Simeon's facial expression but then she quickly began to rely on other information such as the amount of activity in his office as more valuable indicators of mood. This low stock in facial expressions, because they were 'alone', translated into Affector as well. The need for details in the image, in order to see nuances such as a smile versus a frown, became even less important.

Phoebe and Simeon used Affector to catch glimpses of affect, hints at what one's affect might be. This hinting quality of Affector is partly due to its unfinished state (e.g. waiting for the history distortions) but also because hinting is what Affector will ultimately be about. The combination of supporting ephemeral experiences with ambient displays further dictates that Affector will not be used as a numerical barometer, like Dror's Emotographs, or a snapshot measure of mood. However, despite how they managed to use Affector occasionally for a sense of affect, overall they were both unsatisfied with the final results in version 1.0. In our discussion about whether Affector was about inducing or reflecting emotion, both clearly wanted to move toward reflection. The fact that Affector invoked feelings in themselves, for instance anticipation of the other and comfort when the other was around, was not enough for the system to be working.

This desire to push toward being able to reflect on the other's emotion, and perhaps then on one's own, contrasts in an interesting way with how they were using the system. Both Simeon and Phoebe spoke about 'reading' the system or watching the system but they did not talk about using the system to express emotion. In fact, one reason they said facial expressions were uninteresting to them was because they specifically knew the other was not trying to express emotion to them. Yet, they were trying to be a receiver of potential emotional messages even if they did not consciously use the system as a sender. They rarely thought about what they were doing on their end to express emotion. This may be because of the desire to remain ambient, to not want to require any specific actions to engage with the system. Yet the desire for unobtrusiveness seems very close to the affective computing agenda to unobtrusively measure someone's 'real' emotions without their awareness or

participation. At issue here is whether both sides, expressing and sensing, need to be possible in the system simultaneously. It may be that when the distortion editor becomes more readily usable that this is when we see Simeon and Phoebe attempting to express emotion. Another suggestion that was on the table was including aspects of both offices in driving a distortion, so that Simeon's display is dictated not only by Phoebe's office conditions but his own.

3. How does the system influence Phoebe and Simeon's day-to-day interactions? Do these change over time?

During the interviews, when we asked Phoebe and Simeon to interpret what was going on with the other, they only used the information from the system (whether Video or Affector) as one piece of the puzzle for sensing affect. They never conclusively made an assessment of affect based on what they could see in the window, this was always supplemented with other experiences and factors, such as a previous conversation or knowledge of extenuating circumstances such as being in a coding frenzy or the time in the semester. Rather than assuming this is a fault or weakness of the system, I believe it speaks to its integration in their day-to-day interactions. They did not look to the system to tell them what was going on, they used the system as a new resource for their interactions.

It is tempting to want to make grander proclamations about Affector's influence on their face-to-face interactions. The face-to-face interaction data, for example, could tell the story that the Video condition caused their physical interactions to go down since they simply interacted through the video window (e.g. waving to each other more) or Simeon's interpretation that because Phoebe looked at Affector more she felt less of a need to interact with the 'real'

Simeon. One could carry on to suggest that the reason the Post condition face-to-face interactions were the highest of all interactions was due to an increased need for more interaction. However, Phoebe and Simeon did not offer such strong interpretations of the data, partly because of the suspect nature of the data, although I believe this was more due to the previous point of integration. Furthermore, they ceased to cite as a goal for Affector the desire for increasing face-to-face interactions. Instead, they are focusing more on the sense of each other when they are 'apart' but still together.

This is related to an idea Phoebe started to explore when she mentioned the difference between the sense of the other through Affector and the sense of an other in an instant messaging Buddy list. She likened the Buddy list icon as an 'information token'. It definitely stands for something. It says 'here I am, you can interact with me if you want.' But Affector is not as didactic in what it communicates. In one instant, Affector may be saying nothing but in another instant something interesting might be happening. Affector is not an Information Token but a Meaning Opportunity. It does not dictate when something meaningful has happened and what this means but it leaves open the possibility that something meaningful could transpire.

4. What system attributes encourage or impair how Phoebe and Simeon collaborate and reflect on their affective presence in particular and affect in general?

The Affector system design created a system that crossed several established dichotomies of distance vs. co-located and synchronous vs. asynchronous. It inhabited a different space of co-located but physically separated. This allowed them to play with the idea of an expanded shared context, a result that ended up surprising them in terms of how much they

enjoyed this augmented sense. Phoebe no longer just turned around to see what was happening in the common space outside her office but she also considered what Simeon's reaction were to these events. Simeon suggested that this was another reason why Affector's sense of presence was different than a Buddy icon as a Buddy icon travels with you wherever you happen to be online. A Buddy icon represents you across distance, but Affector is decidedly rooted in a particular place. In addition to occupying a new type of physical space, Affector transcends the dichotomy of synchronous and asynchronous communication. It is synchronous because the distortions are happening as close to real time as possible and it is designed to be ephemeral. However, the desire to include history, to have an at a glance sense of a much longer time period, suggests a degree of asynchronous communication as well.

The use of distortions as a prime design feature of Affector demonstrated how technology can support enigmatic expressions. Whereas in the Affective Computing, and traditional HCI approach, technology is harnessed to support clarity, accuracy of information, and reduction of noise, in this case, the ability to distort the video in systematic but interesting ways obscured clarity and added noise into the picture. Yet, the noise was not random. In fact, Phoebe described the Video condition as having more noise since she didn't know where or when to look at it. By using Affector to augment certain thresholds and indices, noise was added purposefully as a directing device.

It is difficult however to discuss the system attributes in greater detail in terms of hindering or encouraging interpretations of Affect as a large part of the system remained unfinished. One of the goals for the next version of Affector and the next round of evaluation is to gauge how different distortions

are manipulated and the effects of these distortions on Phoebe and Simeon's sense of Affector.

The questions above addressed evaluating the experience of Affector v1.0 and how Simeon and Phoebe constructed a "working" system. The last two questions guiding this case study revolved around the evaluation.

5. How can we evoke rich, detailed narratives of experience?

This was a fundamentally different type of evaluation than traditional Affective Computing approach of evaluating systems for accuracy. In such studies the methods for the evaluation are more well defined. In this study, the focus of the evaluation was on how evocative and configurable the system was for causing engagement and reflection on affect. Methods for this type of evaluation are less common in HCI although I drew from histories of ethnographic and other phenomenological approaches.

Whereas in affective computing the trend in evaluation is away from self-report methods, in the study here the methods focused on evoking rich accounts of self-report. One strategy to aide in this self-report was to reposition usage data as a source for the evaluator's analysis to input for the user's reflection. My data for analysis then shifted from the usage reports to Phoebe and Simeon's assessment of these reports. In order to provide effective prompts however the data had to mean something to Phoebe and Simeon. In the results section, I discussed many of the limitations that they pointed out regarding the usage and the face-to-face interaction data, for instance the credibility of their own recording and the negative effects using the clickers had on the experience of Affector. Phoebe and Simeon offered two solutions: one to remove the clickers in favor of the system measuring its own use (i.e. through gaze tracking), and, in lieu of this technological fix, presenting

the data to them on a more frequent basis. In fact, as strongly as I argued for removing this as one of the prompts because of its inaccuracy, Phoebe and Simeon continued to want to try it (to the point where the face-to-face clickers started becoming second nature).

One further limitation on the usage data in this particular study, however, was its presentation. I wanted to present the data to Phoebe and Simeon in as close to raw form as possible in order to allow their own interpretations of how to manipulate it in ways that would be meaningful to them. I did not want to present the data in ways that would be meaningful to a statistician or a social science researcher who understands the implications of p-values (even though this data would not have lent itself to such presentations and even though Phoebe and Simeon are scientists as well). However, presenting the data in raw form, such as clicks per week or even at the level of clicks per day, makes the search for patterns difficult. Therefore, I presented averages and graphs for them but as soon as I took this step, I felt I was glossing over the imprecision of the numbers into bar charts that by their nature of highs and lows suggest narrative inflections. Although Phoebe and Simeon took the usage data in the spirit in which it was offered, I believe this is an area for future advancement: taking data we are accustomed to analyzing with statistician's tools and software and presenting it to a lay audience for their own analysis.

In the interviews, we followed a set format but also allowed for following Phoebe and Simeon's lead. I found a combination of open-ended and provocative questions to be useful. In terms of open-ended questions for example, asking Simeon how Phoebe was feeling was less effective than asking Simeon what was going on with Phoebe today. This is because the

former phrasing suggests too much that the image simply needs to be decoded and the feeling level will appear as opposed to the idea of feelings being hinted at and constructed throughout a range of interactions and impressions. In terms of provocative questions, generally leading questions are considered undesirable, but asking devils' advocate type questions about the design parameters proved to be a useful way for digging deeper into their first principles.

All of the different sources of data in this project supported each other and were often intertwined. The usage data for instance was used during the interviews and the design/evaluation sessions and the design/evaluation sessions built on all of the data collected. The final design/evaluation session with the modified repertory grid could not have occurred without the other sources but I would like to highlight this as an example of a method that I wish to explore further in future work. Of all of the different sessions, this one engaged their attention the most, evident by the amount of discussion it generated and the number of new discussions it generated as opposed to summaries of past perspectives. I believe the success of this was due in part to concerning myself ahead of time with what the evaluation experience feels like which is why I purposefully started with a fun oblique exercise on designing their frames, then moved to the provocative questions, then ended with the structured but creative exercise with the repertory grid. The grid exercise proved to be a useful way of asking the same question about the goals of the system but in a different way. This opens up the issue of whether or not the goals of the system had actually changed or if it was a function of the way I asked the question that changed the goals of the system. However, Phoebe and Simeon debated on all of the points from the original goal

statement but chose to define Affector along presence/awareness, ambient, and enigmatic. This leads me to conclude that the form of the questioning did not prevent Phoebe and Simeon from choosing the same goals but facilitated articulating and discussing their refinement.

In the final design/evaluation session, I also played with a slightly different role for the evaluator – one that was informed by the roles I adopted in the earlier sessions. During the first design/evaluation session, Liz Goulding and I played a fairly traditional role as evaluators, determining our interview guide ahead of time and although we followed the lead of Simeon and Phoebe, we interjected our questions when appropriate. For the second design/evaluation session, I wanted to take more of a backseat in terms of my evaluator role. I saw my role in this session as a reporter. I wanted to present the data in as raw a form as possible to Simeon and Phoebe. In doing so, I felt this would mark two levels of significance. First, they would have to wade through the data and pull out the pieces they thought were most meaningful to them. Secondly, once they had done this, they would then have to explain what the significance was. My role then as reporter was first to draw up all the facts and lay them out in a way that would allow them to do this (and I discuss the challenges of this above). Then I played a reporter again as I collected their interpretations as the primary data for the results section. This was a useful exercise for creating a summary of Affector but as I mentioned above the third session was designed to try and open up new discussions. Therefore, in this session, I saw my role shifting to facilitator or provocateur. I wanted to create exercises that would focus their attention on producing an artifact (e.g. the dimension chart) but that would provoke discussions in order to complete the

task. I believe future work would help identify when these different roles are most useful for a project and how they can be supported.

6. How can we account for and make sense of multiple interpretations in evaluation?

This final question addresses the shift in roles implied in the move from traditional Affective Computing evaluation methods to Affective Presence methods. In Affective Presence, designs are positioned as a process of co-interpretation between the user, the designer, and the system. Therefore, the evaluation also becomes a process of co-interpretation between the evaluator, the users, and the designers. This stance informs the strategy of sharing data with users throughout the design and evaluation process.

The strategy of mixing roles has a number of implications. For instance, not only does the role of the evaluator, user and designer become muddled but the phases and artifacts of evaluation, use, and design become less distinct as well. The clickers became part of our designed system for instance – in a negative way on the one hand, by detracting from the ambient feel of the system, but in a potentially positive way on the other hand by providing a form of dynamic feedback (similar to a gamer's score while game playing) to Phoebe and Simeon about their use patterns. The periodic interviews and design/evaluation sessions also to some degree became part of the usage patterns. For instance, after our second design/evaluation session, I imagine Phoebe's guilt induced state about not initiating contact with Simeon may have had a greater potential to impact her interactions with him than did Affector.

The desire to allow for multiple interpretations from the data may also be seen in the manner of the results presentation. I have attempted to present the results in as descriptive and comprehensive a manner as possible. Whereas in

a statistical study, the significant results are highlighted and focused into an end result, in this study, there are many results which may be more or less significant to different readers. Furthermore, whereas in an experimental study, the goal is to continue refining the study so that the results will lead to only one interpretation, in this study, I would argue that a successful presentation of the results should support the interpretations I make in the discussion but need not preclude other interpretations. This raises a critical issue, however, and one that this study does not help answer definitively. Such claims for supporting multiple interpretations can lead to criticisms of relativism and the inability to make any general statements from this very particular study. We do still want our evaluations to inform our designs and our theories, and both design and theory are a practice of choice, and choice implies value of something over another.

Therefore, although not a direct response to the charge of relativism, I believe one thing this evaluation does do is highlight the need for criteria that inform our evaluation practices. Much of what I've outlined so far turns several standard approaches to evaluation around – such as strict demarcation between users, designers, and evaluators. This does not suggest that in all cases users should be designers and evaluators or that there is no role for external evaluators or separate designers. Instead, these ideas are offered as alternatives for understanding aspects of affect in system use that may have been left behind in other methods. However, in doing so, this means that many of the criteria we depend upon for judging the evaluation itself become contested – criteria such as whether or not the same results would occur if the same evaluation methods were repeated.

There are many discussions of how criteria for quantitative evaluation do not work for qualitative evaluation and discussions as well regarding whether criteria for qualitative evaluation even make sense. I will outline here some possible criteria for evaluations of the type presented here. One criterion for evaluating experience could be to make the evaluation itself an experience -- i.e. attending to the engagement and provocation of the methods for drawing users in emotionally, physically, and intellectually. Second, valuing methods that surface idiosyncrasies as opposed to generalities: methods that surface, highlight and explore outliers or unique expressions. Third is the idea of methods that produce divergence or are irreproducible – in other words, they are designed so that if a different evaluator used the same methods, they would more than likely get different results. This criterion suggests that methods that allow for and elicit multiple interpretations about what is happening are more appropriate for experience designs than those that seek to converge upon a single story. Finally, continuing to ask what the users will take away from the methods – as researchers, we are well accustomed to making sure we do no harm to our subjects but we are perhaps less accustomed to thinking about what good might result from experiencing the evaluation. This is related to the idea of catalytic validity (Lather, 1991) that often guides participatory action research – the notion that through evaluation the users are empowered to some kind of action or change in either their thinking or behavior. These criteria are only a starting point. Further work is needed for refining how to use these criteria and their role in supporting and negotiating multiple interpretations.

Conclusion

This chapter began with an overview of how affect has been variably defined and how these definitions have in turn influenced the design and evaluation of technology for affect. One of the central points in detailing the story of affective computing in contrast to affective presence is that even without an explicit theory of affect identified or articulated, through the design and evaluation approaches, a driving theory may be deduced. In a sense, the designs and their conceptual models become the espoused theory.

The historical review of affect connected affect with the ineffable through its original conception of mysterious and irreducible. This perspective gave way to a bifurcated view, on the one end there is the scientific numerization of affect and on the other end the artistic indeterminacy of affect. I have shown how the approach in computing has favored the scientific approach of objectifying, codifying and containing affect into a unique signature within the individual. The scientific approach to numerizing emotion allowed for it to enter the laboratory to be measured, normalized, and traded. However, despite the goal of affective computing to enhance the anemic cognitive models of information processing, I have argued that the dependence on the scientific approach to affect has instead reduced affect into an anemic model.

This is not a complete indictment of the approach, as the affective computing agenda has advanced the profile of affect as an important area for research in computing and has advanced our understanding through discussion and exploration of affect. Furthermore, the approach in affective computing makes sense for a number of reasons: computers excel at processing complicated and abstract information, new technology can provide

views and measures into ever more sources of information such as physiological patterns, and one approach toward understanding (and designing for) complex phenomenon is to break them down into identifiable parts. My argument is not against these reasons but against what happens when the identifiable parts start to stand for the whole or when what we can measure stands for what we don't yet have measurements for.

In contrast to the predominant affective computing approach, I have presented the alternative of affective presence to conceptualize affect not as a reducible, internal bit of information but as a socio-cultural process of interaction and subjective meaning-making. Affect as interaction differs from affect as information in three important ways: how the nature of affect is conceptualized and subsequently how technology is both designed and evaluated. In particular, affect as interaction is about affect as the interface between the individual and the social, it is dynamic, and it is 'felt' or subjective. This view requires then design objectives that are about the co-interpretation as opposed to the transference of meaning and evaluations that are about understanding how meaning is evoked as opposed to measuring the accuracy of representation. To examine the potential and limitations of this alternate approach, I presented a case study of Affector, a system designed for reflection between two people on the affective presence of their neighbor in a separate office.

The case study detailed the objectives of the Affector design as two-fold: one set of objectives about the experience the designers wanted to create and one set of objectives relating to the larger questions they were addressing in demonstrating the viability of an alternate approach to affective computing. Regarding this last objective, the acceptance of the project through various

peer reviewed processes as well as the demonstration of a working, valued system speak to the validity of this alternate space. Furthermore, through their design, they have refined how Brooks' model of artificial intelligence for robotics applies to a non-robotic system, where digital information does not need to be reduced to analogue forms. As for their specific design objectives, the designers began with a desire to support their awareness of each other's affective presence without sacrificing their privacy and a desire to increase their face to face interactions. The goal for the evaluation of this system was to both chart how these objectives changed and to illustrate how the designers conceptualized and worked toward a working system. One of the main changes in the design objectives was the elevating of enigmatics and ambiguity as a design goal and not just a design method. This positioning replaced both affect and privacy as specific design goals. The increased emphasis on enigmatics highlights the need for further work into understanding how to design for and evaluate systems designed for openness to interpretation.

The importance of enigmatics is also implicated in the realization that Affector 'hints at' instead of represents affective states. Affector does not present information tokens of presence, as a system such as instant messaging does, but it creates meaning opportunities. At times, Affector will provoke a sense of affect but at times it will not. The sense of affect will be generated over time, and always in concert with other resources from their shared surroundings. The hinting quality of Affector is similar to the shy sensing of the Home Health Horoscope, another project in the affective presence consortium. In Affector, the hinting is underscored by the designer's constant recognition that they are only ever approximating affect. Although it is

often tempting to fall into the desire to build mappings (e.g. if we detect a coffee cup, then what would it mean?), they always returned to the idea that what they would sense was change, and from this they would infer motion, and from that they would interpret affect. This chaining of meaning suggests the approximation and the building of affect.

The designers also recognize the hinting of affect is at play when the expression of affect is ambient. During their experimentation with an open video channel, they both quickly discounted facial expressions as a sign of affect. They argued that facial expressions are less meaningful for constructing affect when not meant as a form of communication. This has implications for affective computing studies that rely on more unobtrusive measures of affect, but it also has implications for the design of Affector. In future versions, as designers begin to play with the distortion rule sets, it will interesting to see how the designers as users reconceptualize Affector again. Will they try to express themselves through the distortions? Will the distortions become mapped to how they are feeling? In other words, will the hinting of affect overtime be replaced by a language of Affector?

The design of Affector not only demonstrated a viable space to the affective computing approach but it also suggested a new space for design that crosses several other dichotomies in HCI. It designs for a space that is at once both distant and co-located and suggests new features for such a space such as supporting the awareness of an extended shared context. It also designs for a tempo that is at once asynchronous and synchronous – with historical information presented ephemerally. Playing with the implications of this new space and tempo will be part of Affector version 2.0.

In addition to some of the suggestions for the next version of Affector already mentioned, one of the larger questions is how to take lessons from this very specific design, one created by the designers for themselves as users, to a more general context. On the one hand, we anticipate Affector being part of a larger group of case studies from the affective presence consortium where the question of generalizablity is answered through looking at a range of studies across a range of contexts to look for more general lessons. But this question also speaks to the limitations and challenges of Affector and the current study. Although this case has identified a number of evaluation methods and a start at thinking about new criteria, more work is needed for understanding how to evaluate systems designed for reflection and openness to interpretation.

Ultimately, although this case study of this chapter is about the design and evaluation of technology, it is a case study about affect. The design and evaluation of the technology becomes an attempt to articulate a particular theory of affect, one where affect is created and not found. Both a theory of affect as found and a theory of affect as created can take an approximation view to affect as ineffable. In the found approach, we will never fully know the ineffable aspect of affect but we can continue to approximate it through identifying and measuring component parts. The danger with the found approach is that the parts begin to replace the absent whole. In the approach to affect as created, the ineffable is also approximated because we recognize that it will continue to change as we continue to study it

Chapter 4. Interpretation and Communication

Language communicates less than one desires and more than one intends.
-- Arthur Bochner and Carolyn Ellis

The previous case studies demonstrate the practice of reflective design as a method for understanding how interfaces with the ineffable are designed. I began by first examining the dominant approach for designing interfaces with the ineffable where an ineffable experience is first reduced into a codifiable and discrete representation. In the museum case study, the dominant approach to technology as tool transforms the ineffable aesthetic experience into a discursive explanation transferred from the enlightened to the uninitiated. In the affect case study, the experience of emotion is objectified into observable information indices capable of intact transference from one to another, and the scientist (or the designer's algorithm of affect) is the authority over the experience of affect. The second step in reflective design is to propose and demonstrate the potential for an alternate design space, one originally defined as an approach for augmentation, where the richness and complexity of ineffable experience need not be formalized into a static expression. Although both the reduction and augmentation approaches depend on some level of abstraction and representation, in the reduction approach the representations became static and difficult to both recognize and change. In the most extreme examples, the representation begins to stand for the experience itself. In the augmentation approach, the challenge becomes one of making the representations both visible and open to transformation. This objective led to re-articulating the augmentation approach as one of designing for openness to interpretation.

In exploring the interpretation approach to designing interfaces with the ineffable, the case studies revealed a number of challenges in terms of existing practices of design and evaluation in HCI. Both case studies grappled with how traditional HCI methods run into limitations in this alternate approach, for instance questioning where the line between design and evaluation lies and the respective roles of the designers and users. Both case studies also struggled with the balance of how to use ambiguity, or openness to interpretation, effectively as a resource without spiraling into a lack of uptake, alienation, or the irrelevance of design and evaluation. Some of the key challenges in designing for interpretation require more exploration into what designing for interpretation means and what the subsequent issues are for evaluation.

The questions and challenges provoked in the case studies motivates a need for more grounding and explanation into the process of interpretation. In the following sections, I will begin with an overview of new thinking in the field of HCI regarding interpretation, some identified strategies for design and evaluation and the directions of future research. I will then turn to examining how the field of communication can add to this examination of interpretation. The link between communication and interpretation seems like an obvious fit as the process of communication could be conceived of as the process of interpretation. Furthermore, if the movement in design is toward understanding how users actively reinterpret designs, in other words how users adopt the role of designers when using systems, then communication research provides a valuable resource for understanding everyday acts of interpretation. In particular, I look to research in language use where people act as both the designers and users of the everyday technology of language. Drawing from

the relevant insights in communication theory and methods, I will then return to the case studies and suggest how this lens would influence future directions. Finally, in the last section of this chapter I will reverse the examination of what communication can bring to the field of HCI regarding the role of interpretation and explore what an HCI design practice for interpretation can bring to the field of communication.

Re-thinking Interpretation in HCI

Interpretation has always been a topic for consideration in HCI. Researchers and practitioners of HCI consider how designers interpret user needs and requirements, how users interpret a system interface, how a system interprets a user's input, and how evaluators interpret the user experience with a system. In recent years, however, the role of interpretation has been elevated as well as redefined. This elevation and redefinition has led to a number of different slants and perspectives, including calls of designing for appropriation (e.g. Chalmers and Galani, 2004), designing for hackability (e.g. Galloway, 2004), designing for openness (e.g. Sengers and Gaver, 2006), and under-designing (e.g. Brand, 1994). What all these different names have in common is the desire to recognize the gap between design and use as an interesting space to explore, an opportunity as opposed to a problem. In this section, I will draw primarily on new work from Sengers and Gaver (2006) on designing for multiple interpretations.

Motivations

In support of the focus on interpretation, designers and researchers generally cite at least one of four interrelated arguments that I will refer to as ubiquity, complexity, awareness and control, and/or inevitability. The most

common lead-in argument suggests that the increasing ubiquity and embedded nature of technology calls for more concern about interpretation. Digital technology is no longer an isolated interaction but something that we encounter everyday and therefore the issue of interpretation becomes more prominent and prevalent simply because we are called upon to do it more. Second, the everydayness of these encounters suggests a widening of the technology agenda as design moves from circumscribed work tasks to addressing more complex human experiences including those of an ineffable nature. In this move, technology becomes more connected with intimate and rich experiences.

Following from the first two arguments about the ubiquity of technology and the complexity of experiences designed for, one common design response is to increase the complexity of the technology. This ubiquity and complexity of technology tends to contrast with existing usability goals such as ease of use and user friendliness. This mismatch then often leads to a desire to bury or hide the complexity and range of technology systems from the user. The user need not trouble with how a device works, only that it works. This movement toward making technology invisible leads to what I will call the awareness and control argument. The desire to hide the role of technology raises concern for designers aiming to support rather than direct interpretation. It has also raised privacy concerns as technology becomes more proactive and the users' awareness and control over a system's impact on their lives decreases. Finally, the inevitability argument for focusing on interpretation points to the growing recognition of how users reinterpret and shape designed systems (Oudshoorn and Pinch, 2003) in unanticipated, and potentially more valuable, ways. Historical reviews of new technology argue that to some

degree, the designer's intentions do not matter as it is impossible for a designer to predict or direct use, yet some designs may have a greater degree of interpretive flexibility (Bijker, 1995) allowing for a wider range of adoption.

Supporting Multiple Interpretations

The motivations behind the current focus on interpretation are reshaping how interpretation is conceptualized for HCI. Sengers and Gaver (2006) argue that in the past the gap between the interpretations of users and designers was presented as a problem to solve. One solution to this problem was to lead users to the right interpretation of the system (e.g. what button to click) and its use (e.g. what it is for) through clues in the system design. An alternate solution, explored through user-centered design and participatory design, suggested reframing the problem from one of shaping users' interpretations of the designed system to shaping the designers' approach. Both solutions however take as the goal closing the gap between an original intention for the design and the ultimate use. Alignment of interpretations is the objective, i.e. there is a 'correct' interpretation and everything else is 'incorrect'.

Sengers and Gaver (2006) suggest an alternate way of thinking about interpretation where multiple interpretations are desired and supported by the design rather than in spite of it. Gaver, Beaver, and Benford (2003) provide a foundation for the value of this perspective by demonstrating how a system that invites multiple interpretations can be fun, engaging, mysterious, and delightful. In the case studies of designing for the ineffable, I have also tried to demonstrate how ambiguity, or the space for multiple interpretations, became an important objective. In this view, the goal is not to narrow interpretation into

a single matching point of view or consensus but to allow for multiple interpretations.

Sengers and Gaver clarify the charge to design for multiple interpretations by articulating where and when multiple interpretations are desirable. User interpretation, they explain, happens at a number of levels. The lowest level, one that could be called usability, involves identifying how to use inputs and output effects of the system interface. This is the level primarily of asking 'how', such as "how does this button work?", or "how do I submit this form?" Generally, at this level matching interpretations between the designer and the user are desired. For example, in the Key Table system designed by Gaver and colleagues, the designers wanted users to clearly understand that the force and direction by which their keys (or whatever object) landed on the table would tilt the picture frame situated above the table. Although the mechanics of the system were simple and clearly described, how to interpret this – the higher levels of interpretation – were left open. At the second level, what I will call the impact or effect level, users interpret how a system may be used. The question here is "what for", either what was it designed for or for what is it actually most appropriate. With the Key Table for example, the users focused not on the relationship between their keys and the tilt of the frame as the designers anticipated but on the image of the dog that was chosen to occupy the frame. Finally, the third level identified by Sengers and Gaver is where the user interprets how the system relates outside of its specific use and speaks to the values embedded in or reflected by the system. This is the level of significance, the why or to what effect question, i.e. what the system means about or for the individual, his or her social group, and the surrounding culture. Returning to the Key Table, the designers were interested in learning if

the use of the system would cause reflection perhaps on other forms of technology in the home, technology in general, or other patterns in the home such as table clutter or comings and goings in the entryway.

Sengers and Gaver explain that multiple interpretations may be desirable at different levels of the system, although they qualify that even that simple suggestion is complicated by the nature of system design. Conceptually the three layers may be pulled apart, but in actuality, they are interrelated. For instance, although multiple ideas of what button to click to send a form does not sound like a desirable outcome at the usability level, there may be times when playing with the system level usability is a tactic for encouraging a greater range of higher level interpretation. However, in general, the interpretation that Sengers and Gaver and others in this field speak of occurs at the top two levels. The above discussion introduces a new perspective developing in HCI where multiple interpretations are desirable and designed for as opposed to considered problems to be overcome. In the following section, I will outline a number of the design and evaluation strategies offered for this new approach.

Design Strategies

Several researchers and designers working to develop systems that allow and facilitate multiple interpretations to emerge have been experimenting with different design strategies. These are presented as a list below with brief explanations but references to more comprehensive discussions.

Access to System Innards

The first design strategy is perhaps the easiest to imagine but one of the more difficult ones to actuate. It suggests that appropriating a system is

simply a matter of users opening it up and recoding or rewiring it. This is largely the push behind the design for hackability agenda (e.g. Galloway, 2004). Although advances continue in the form of open system platforms, easier programming and scripting languages, and earlier education for this type of literacy, access to the systems innards is a limited approach. For starters, advances in easing access must keep pace with ever changing systems and their increasing complexity. In addition, not all designers want to relinquish this amount of control[41].

Exposing the Seams

In this second strategy, instead of giving the user explicit access to alter the code level, the user is given access to knowledge of how the system works. This approach is described well by Dourish (2004) regarding systems that display their context and by Chalmers (Chalmers et al., 2003; Chalmers et al., 2004) as 'seamful design'. For example, Dourish suggests that users may want to know that they have switched network coverage on their wireless devices as opposed to this happening behind the scenes. Chalmers also challenges the idea that coverage should be something seamless and invisible to users. He suggests exposing the gaps in coverage provides impromptu design opportunities for users to appropriate these gaps as 'safe zones' where they are hidden from any form of connectivity or more formal design opportunities, such as building distributed games that leverage these dark spots as part of the game functionality. The strategy of exposing seams calls for computing to be more translucent than transparent or invisible.

[41] Tarleton Gillespie (2006, 2007 forthcoming) is examining the reverse of this design strategy and its implications: namely how technology developers are preventing, both legally and technically, the capability to 'peek under the hood' and alter (or simply learn about) how the system works.

Under-designing

The strategy of under-designing has gained favor partly in response to feature creep and bloat of system design. Many designers draw from the lessons of architect Stewart Brand who advocated a 'less is more' approach to buildings. "An important aspect of design," he writes, "is the degree to which an object involves you in its own completion…This is what makes old buildings interesting to me. I think that humans have a taste for things that not only show that they have been through a process of evolution, but which also show they are still part of one. They are not dead yet" (Brand, 1994, p. 11). Under-designing is the approach followed by Strong and Gaver (1996) and Joseph 'Jofish' Kaye (2005) in designing systems for communicating intimacy at a distance with minimal bandwidth as opposed to the tendency to assume that something as rich as intimacy needs rich representations. In these systems, the richness is gained through the user's interpretations of simple or minimal representations.

Surfaces for Personalization

Höök[42] identifies surfaces of personalization that allow users to leave their mark on a system as an important strategy in the design for interpretation. She makes the analogy with traces of physical erosion in the environment suggesting how and how often a site has been used. The idea of users leaving their marks through system usage became popular through the work of Chalmers, Gay, Höök, and others with regards to social navigation (e.g. Burrell, Gay, Kubo, and Farina, 2002; Chalmers, et al., 2004; Höök and

[42] Personal communication and from an unpublished draft of Kia Hook tentatively titled "Enabling appropriation and sense-making through building upon familiarity."

Svensson, 1999): how current users may take the experience of past users as a guide to inform and perhaps enrich their own use.

Framing

In many systems, the most narrowing feature of the system has nothing to do with the system itself per se (e.g. its form and features) but with how the system is introduced and framed. A frame may direct or give hints for prompting interpretation in unexpected ways. For instance, Mateas describes how his Terminal Time system was received differently when introduced as a system about the future of documentaries versus when introduced as a performance (Domike, Mateas, Vanouse, 2001). Gaver and Sengers (2006) explore the use of minimal framing by providing users with a 'topic' but not an exposition. For instance, with the History Tablecloth, Gaver and colleagues provide the topic of the piece through its name. The tablecloth functions by glowing in areas where objects have remained for long periods of time, suggesting that the history of objects on the table might be interesting to think about. What this means, however, is left unarticulated.

Characters and Extreme Characters

A popular source for design strategies to design for interpretation is the arts and humanities as these practices intentionally (or not) produce works considered open to a range of meanings. Wright and McCarthy (2005), for example, explore film and literary theories, in particular the work of Mikhail Bakhtin, for insights into using character design as opposed to generic personas. Blythe (2004) suggests literally drawing from literature or other sources of deep complex characters, for example, designing for Anna, the distraught Russian, or Romeo and Juliet, the star-crossed lovers. This is

related to the idea of extreme characters, advocated by Djajadiningrat, Gaver and Frens (2000). Whereas minimal framing and under-designing leave room for interpretation by getting out of the way, extreme and well fleshed out characters leave room for interpretation by providing a range of details for users to identify as significant and resonant. It is the very particularity of the characters that allows for their generalizability.

Layering complexity

The approach of layering complexity entails designing for multiple audiences and multiple experiences at once, but the complexity as a whole need not be appreciated at any given moment. For instance, the charm and success of many cartoons is that they address both a children audience and an adult audience at the same time, but neither group needs to fully appreciate the others' interpretation in order to enjoy the show. As an alternate form of this approach, Sengers and Gaver use the example of Simon Penny's autopedagogic interfaces where a system changes its complexity through use. This means that a user's initial interpretations of a system will become challenged in further uses with a system drawing out more complicated interactions and assessments of meaning.

Blocking dominant interpretations

The design strategy of blocking dominant interpretations is related to the strategy of defamiliarization discussed below because its intention is to remove the most common or familiar interpretation from the range of possibility therefore forcing the construction of new unexpected interpretations. As an example of this approach, Sengers and Gaver describe the Drift Table (Gaver et al., 2004), a type of coffee table with a small portal on top through

which one can see a moving video of a landscape seen by air. The most common interpretation of the table anticipated by the designers is that the table would be about 'traveling somewhere specific'. In order to foil this interpretation, and make the user develop alternatives, there was no way to speed the video up or enter exact coordinates for the location over which one wanted to hover. Instead, users could only place weights on the table to gradually drift over the scene.

Defamiliarization

Many of the design strategies above highlight the system experience as something 'different', this is what is meant by the design strategy of defamiliarization where the users' expectations are confronted. There are several ways for doing this. First, is the process of augmenting the 'otherness' of the system as described earlier with Mateas's (2001) articulation of 'alien presence'. Sengers and Gaver argue that what this does is downplay the system's authority and leave more space for user interpretations. This requires the user to engage more with the system to understand his or her influence, and allows more freedom in interpreting the output since it is not tied to a definable cause. Another approach, related to alien presence, is to add randomness to the system, similar as well to the idea of layering complexity and challenging consistency described above. When the system changes often, this denies stagnant interpretations and forces not only multiple interpretations among users, but also multiple interpretations for one user.

In their article on designing for emergent ambiguity, Gaver, Beaver, and Benford (2003) outline a number of strategies for defamiliarization that shock or puzzle the user, for example by introducing disturbing side effects of the system, juxtaposing incongruities, or by providing drastic over-interpretations

of the system that the user will challenge. These techniques were inspired by examples from art practices, such as Duchamp's Fountain (described in chapter 2). In contrast to over-interpreting information, the opposite may also be effective by under-representing information. For instance, Sengers et. al's (2002) use of enigmatic drawings in the Influencing Machine (described in Chapter 3) encouraged a range of interpretations because the drawings were more iconic than symbolic. Chalmers and Galanti (2004) also describes the role of imprecision and uncertainty as assets in designs where interpretation and heightened engagement is desired: for instance, they explore how the imprecision of location aware systems in associating content with a pinpoint location can trigger more awareness of place.

The list of above strategies is not exhaustive or exclusive but a short list of techniques current developers are experimenting with in order to design for openness to interpretation. In the museum case studies, I drew from the strategies for personalization and defamiliarization. For the Affector case study, the designers drew from primarily from the strategies for defamiliarization for the goal of designing for ambiguity. Both case studies involved a degree of framing. In reviewing the strategies as a list, they appear as a palette for mixing and matching. However, as this type of design research continues, understanding the interaction of the different strategies would help designers anticipate their effects. Furthermore, many of the strategies fly in the face of traditional usability studies and the designers experimenting with these approaches are careful to point out that the move beyond usability does not mean that usability no longer matters. In fact, just the opposite holds: without a baseline of usability, users will not have the opportunity to reach the higher levels of interpretation regarding how to use the system and what it means.

Evaluation Strategies

Because the design methods enumerated here are directed toward supporting multiple interpretations, the traditional HCI evaluation methods of assessing the convergence of interpretations will not suffice. Instead, the evaluation methods draw from interpretive forms of inquiry (Denzin and Lincoln, 2000) asking how it is that interpretations form and what range of interpretations result. The list of evaluation methods is somewhat shorter than the design methods suggesting an area needing more attention. The methods will be described according to two objectives outlined by Sengers and Gaver (2006): drawing the user into the evaluation process and supporting multiple interpretations.

Drawing Out User Interpretations

As the emphasis for evaluation is on interpretation, the methods must help surface how it is that users are engaging with the system at the higher levels of interpretation. Example methods for doing this include using guided journals with provocative prompts encouraging users to reflect on their use of the system such as employed for the VIO system (Kaye et al., 2005). The Affective Presence consortium has also been experimenting with the design of different provocative prompts or stimuli that encourage user reflection. The repertory grid dimensions exercise, described in chapter 3, for building an architecture of Affector is an example of this type of prompt. One of the tactics described during the case studies for further drawing out user interpretations is the use of dynamic feedback. This was described in detail during the Affector case study where system usage and face-to-face interaction information was presented to the users for their own interpretations. This tactic enlists users in the analysis stage of data collection and transforms results into input or stimuli

for the user's assessment and articulation of how the system is working (or not working). Petra Sundström (2006) and colleagues use another approach to draw users in and draw out their interpretations by training them to act as evaluators during their use of the eMoto system. A user is paired with another user and each acts as the 'participant evaluator' of the other's experience – documenting the other's use with a video camera and field notes. This encourages the user to step outside of her own experience to assess that of another, in the process encouraging further examination of her own use.

Finally, Sengers and Gaver (2006) discuss the importance of longitudinal studies for interpretive analysis. Longitudinal studies account for how a single individual's interpretations may change over time – an important method when design strategies such as layering complexity are used. Both the museum case study and the Affector case study require longer periods of use. In Birdscape, for instance, we tried to design for an experience that might not be apparent on an initial visit but return visitors would notice over time. This requires being able to access and track return visitors. The Affector case study occurred over a long period of use and its assessment involved articulating how the design goals and objectives for the system evolved. Future evaluations of Affector will examine how the use of the distortions influences these objectives and how the pattern of distortion use changes over time.

Supporting Multiple Interpretation.

If a system involves multiple users, then the methods described above partly address the goal of evoking multiple interpretations as users will likely focus on different aspects of an experience and their personal impression of the system use. In addition to drawing out multiple user interpretations, Sengers and Gaver (2006) also indicate the need to draw out the designer's

interpretation, not just of the system prior-to-use but also of the system-in-use and the perspective of different evaluators. They suggest for instance drawing on the concept of the “crit” used in the arts and architecture fields where on a regular basis other commentators are called upon to evaluate a piece of work. This could be likened to heuristic evaluation techniques popular in HCI where experts analyze systems along predefined criteria. However, art crits tend to be less formal and standardized in terms of following a predefined checklist.

Senger and Gaver also suggest looking outside the design field to fields such as psychoanalysis, forensic anthropology, or documentary film-making. Each of these fields may yield new interpretations of how users are interacting with systems. For instance, with the Drift Table and the Key Table, the designers hired a documentary filmmaker to interact with the users and create a narrative about what the filmmaker believed was happening. In drawing out the users, the designers, and the filmmaker’s perspectives, the evaluation of theses systems subverted a single authoritarian point of view on what the system was about, whether or not it worked, and why.

As a match to the design strategies of designing for openness, the evaluation strategies also result in openness. In fact, the evaluation strategies, as illustrated in the case studies, become part of the design strategies. In other words, the line between evaluation and system design is difficult to tease apart. Making these distinctions seems to make less sense than in traditional HCI design and evaluation studies. Yet the challenge with the evaluation methods here is that even though they have changed their objective, from matching interpretations to eliciting and examining the construction of multiple interpretations, the evaluations still should address typical HCI functions of

guiding current and future design choices for a particular system and providing a rich resource from which to assess applicability in other design scenarios.

Open Issues

There are several open issues to highlight regarding the design and evaluation methods illustrated here and the new directions in HCI regarding interpretation. First, there is not a clear point of view on the interactions between multiple interpretations. Is simply a range of multiple interpretations desired? Should the interaction between these different interpretations be facilitated? Designers of this point of view have articulated the desire for 'co-interpretation' or the 'negotiation' of meaning in system design where interpretation occurs between the designer, the system, the user, and the evaluators. Does 'co-interpretation' mean co-present, coordinated, or collaborative? Furthermore, do more interpretations and greater range of interpretation signal more success, in the same way that creativity studies measure creativity through the number and qualitative difference of ideas generated?

Second, the design and evaluation methods described here underscore the importance of the particular and the idiosyncratic. The argument is that rather than abstract generalities, it is the particularities that become the basis for generalizing lessons. The open question then is what exactly is generalized? Designers from this point of view are reluctant to suggest they are building taxonomies of the design space and some suggest that the word design principles too strong a term and in practice could result in the very codification they want to avoid. Kia Höök and her group at SICS attempt to develop what they call 'mid-range' theories inspired by the idea of memes, that identify practices and their relevant situations but shy away from grand unified

theories[43]. The tool kit of design and evaluation strategies listed here could suggest a list of memes but it fails to address how these strategies play off each other. There is little guidance for a designer now to choose which strategy to use. I have noted a number of times for instance how defamiliarization is a difficult balance to strike – are there certain situations where this is more alienating than others and an alternate design strategy should be employed?

Finally, designing for openness requires striking a balance between providing constraints, a traditional designer role, and anticipating emergent interactions. In discussing ambiguity, or the space for multiple interpretations, Gaver, Beaver, and Benford (2003) emphasize how ambiguity is not a design strategy or a design attribute but an emergent phenomenon of the situation. In other words, ambiguity results or emerges based on the interaction of the designed system, the context, and the people involved. The difficulty, however, in studying ambiguity is that most studies tend to take on one of these components. For example, designers tend to focus on strategies since this is what they can control. This makes intuitive sense but the danger is when ambiguity slips from being an emergent phenomenon to becoming conceptualized as an attribute, or something that is designed into the system. In the following sections, I will take up the idea of ambiguity from another perspective, from the field of communication and language use. I will look at how perspectives from communication may provide additional resources for responding to the open issues in the re-thinking of interpretation in HCI.

[43] http://www.sics.se/~kia/ideas/computing.html

Re-Thinking Interpretation in Communication

The potential of communication theory as a resource for designing for interpretation seems obvious. Communication, according to some theorists, is itself a process of interpretation. In the following sections, I will examine the perspectives of communication that address the process of interpretation and in particular the parallel development of perspectives supportive of multiple as opposed to convergent interpretations. I begin with an overview of communication theories, broadly at first outlining some of the major issues with regards to interpretation and narrowing to a focus on ambiguity in language use. I will then examine the issue of moving from theories of interpretation to methods of studying interpretation and review obstacles in the translation from theory into designed system.

Communication as Individual and Mechanical

The development of communication as a field parallels the narrative paths of both art and affect discussed in the case studies. This is not surprising. As a history these fields are responding to similar events in time and their developments influence each other. The museum chapter started with a reference to the Greek temples of the gods, the affect chapter started with reference to Greek philosophers' conceptions of emotion, and communication also traces its roots to the period of Greek rhetoricians. I will briefly outline the history of communication as a field, however, starting from the Enlightenment: a pivotal period also in the history of museums and affect. Several contemporary communication theorists (e.g. Peters, 1989; Shepherd, 1999; Baxter, 2004) point to the Enlightenment period as providing the two core principles underlying the modern day discipline of communication: the completeness of the individual and the predictability of mechanical transfer.

The focus on the individual during the Enlightenment led to a prioritization of internal mental states. The individual was held as "the source of significance, the arbiter of meaning, and the locus of reality" (Shepherd, 1999, p.156). Significance was not only 'in' the individual, but 'bound' in the individual as self-contained and discrete from others. Bakhtin referred to this as a view of the monadic self: "a hermetic and self-sufficient whole" (Bakhtin, 1981, p. 273, as cited in Baxter, 2004, p.2). Since internal states such as thought, emotion, goals, and motivations were seen to direct the act of communication, the implication of this view was to consider communication as merely a vehicle within existing disciplines such as psychology, anthropology or economics.

As a vehicle, communication was further perceived of as mechanical and ideas simply transferred intact between minds. This mechanistic transfer view gained popularity through the development of new communication technologies such as the telegraph, telephone and radio during the late 1800s and early 1900s. With the rise of distance communication, Peters (1999) argued that this new form of mediated communication appeared easier and more romantic than the difficulty of face-to-face language work[44]. According to Peters (1999), the mechanical process of communication technologies, whether by analogue or digital signal, began to redescribe interpersonal relations: "communication in this sense makes problems of relationships into problems of proper tuning or noise reduction" (p. 5). Overall, the empiricist focus on the individual combined with this mechanical vehicle view meant

[44] This sentiment about the superiority of mediated versus unmediated communication is later echoed with the introduction of computers, prompting Licklider and Taylor (1968) to speculate that people would soon "be able to communicate more effectively through a machine than face-to-face." (p.21).

communication was seen as a process of transference and success was measured in terms of accuracy, efficiency, and effectiveness.

From these early philosophical beginnings and technical advancements, Peters (1999) marks spikes of interest in communication around the world wars. After the First World War, there was a renewed interest in communication technology as a tool for war, but also in communication itself as a means for peace through attempts to promote forums for dialogue. The effects of war also spurred a new breed of philosophers and artists, such as the Dadaists and Surrealists, to critically challenge the view of communication as a neutral vehicle. However, the mechanical view of communication continued to gain steam and legitimacy with the development of information theory and the introduction of computer technology during the 1940s and 50s. Shannon's Mathematical theory of Communication, for example, served to further intertwine communication with information. Whereas Shannon proposed to discuss communication of information at the syntactic level with information sources, signals, channels, and noise, his collaborator Weaver began applying the theory to human communication as well with information sources replaced by minds (Radford, 1994).

The view of mathematics and engineering as esteemed sciences led to an institutionalizing of information theory for communication as a field (Peters, 1986, 1999). Architects of this institutionalization, such as Harold Lasswell, for instance, defined communication as 'who says what to whom in which channel with what effect' and Wilbur Schramm divided the study of communication into messages, channels, audiences, and effects (Slack, 2006). Peters (1986) goes on to argue that the fledgling field of communication was desperately grasping at such theories even if not properly understanding them or

marginally using them because of the perceived scientific credibility (see also Craig, 1999). Shepherd (1999) argues that this legitimization move suggests what is needed to improve communication processes is not theory but engineering. Interpretation in this engineering view of communication was a 'decoding' process. There was one right interpretation and it involved matching the sender's original message with what appeared on the receiving end. In this way, the history of communication regarding interpretation echoes closely the traditional view of interpretation in HCI.

Communication as a Process of Construction

The view of communication as a product of a mechanical process directed by an autonomous individual is largely out of favor in contemporary theories of communication although as I will discuss later, the legacy of this earlier development remains. Part of the revision of this foundational approach was due to another legitimizing move, reframing communication from an effect to a cause of internal states. In other words, rather than conceptualizing identity as influencing the practice and form of communication, in the new approach, communication influences identity. As a primary process, it warrants a discipline of its own. As Deetz (1994) rallied his fellow communication scholars: "If we are to make our full social contribution, we have to move from studying 'communication' phenomena as formed and explained psychologically, sociologically, and economically, and produce studies that study psychological, sociological, and economic phenomena as formed and explained communicationally" (p.568). This shift entails framing communication as a process, some say a constitutive one, rather than a product. The role of interpretation also shifts in this view, from one of an

individual decoding a message to collaborators jointly constructing a message in action.

This move to a view of communication as a primary process requires shifting momentum away from the foundational views of individualism and mechanics. This counter movement can be found brewing toward the end of the 19th century. At this time, Hegel and Kierkegaard and other philosophers began to challenge the primacy of the individual. Philosophers such as Dewey, Bakhtin, Heidegger, Habermas, and Marx continued different aspects of this movement away from the primacy of the complete individual into the beginning of the 20th century. Hegel's philosophical project, for instance, was about contradictions between opposing terms such as subject and object and his response was to see them as intertwined, to create a third space, and to consider "meaning as public rather than psychological" (Peters, 1999, p.118). Dewey referred to this type of third space between people as the potential for new worlds. Identity then becomes constructed from the outside in, or from this space in between, through interaction and communication.

This expanded view of the individual defined through interaction corresponds with the complicating of the simple mechanical view of communication. Hegel, for example, described communication as a dangerous and tragic effort far more difficult than simple mechanistic transport (Peters, 1999, p.118). Kierkegaard continued this thread, describing communication as a process of "revealing and concealing, not of information transfer" as people continue to unfold themselves in "an allusive enterprise of hints and evasions" (Peters, 1999, p.129). Heidegger took the revision of the mechanical view a step further. It was not just that communication consisted of more than syntactical exchanges of information or even semantical constructions of

meaning. For Heidegger, communication was about disclosing new worlds and opening up otherness (Peters, 1999). Communication in this sense is constitutive of identity, reality, and experience.

The emergence of the constituting role of communication continues into contemporary perspectives, such as a view of communication as 'relating' (Condit, 2006) or 'transcendence'' (Shepherd, 2006). In describing communication as relating, for instance, Condit is careful to point out that she does not mean a relationship between discrete entities but between entities continuously in the process of formation. She uses the metaphors of stars, where the gravity and energy of one constantly pulls on and influences the other, thereby changing each mass as well as their relation. In more earthly terms, Condit states, "[relationality] does not privilege the isolated things created by words over the processes of creation and disassembly which makes for the constant changes in beings." (Condit, 2006, p.6). Similarly, Shepherd advocates a view of communication as a "simultaneous experience of self and other…overcoming one's (current) self to become more than what one was through connection with the other" (Shepherd, 2006, p.22). He clarifies that this 'self' is not found as a pre-given entity that we must work to uncover but as something that continuously evolves through our experiences and connections.

Since one's identity is forged through communication, the process of communicating intention and meaning cannot be a simple mechanical transfer. Shepherd (2006) argues that a definition of communication based on accuracy and transmission is a 'hopeless' one. If accurate transmission could occur, then further conversation would be unnecessary. "After all, once I 'get' your message, or meaning, the task of communication has been accomplished and

we have no further need to talk" (Shepherd, 2006, p.26). Yet if accurate transmission cannot occur, why bother attempting to talk at all? The fact that a middle ground exists between these options can be seen perhaps most usefully through an examination of everyday language use. Therefore, in the next two sub-sections, I will look first at theories of language use as constitutive communication and then in particular at theories of ambiguity and interpretation in language.

The Linguistic Turn

The discussions above outline a philosophical and conceptual shift in defining communication as a process of construction. More specifically, this construction can be seen to happen through language use. In Heidegger's philosophy, for example, he argued that all 'seeing' was actually a 'seeing as' and that all 'seeing as' was a form of language use (Heidegger, 1934; Deetz, 2003). We cannot approach the environment or the other without an act of interpretation, influenced by culture, and consequently actively reconstituting the outside world. The roots of interest in language use and in particular its structure for constituting how we talk about and therefore experience the world can be seen in the development of semiotics and structuralism.

Pierce, one of the founders of semiotics, proposed in the late 1800s a theory of signs (e.g. icons, indexes, and symbols) that stood for objects and were addressed to interpretants. The relationship between the sign, the object, and the interpretant was one of possibility, not set meaning. In this sense, Pierce's conception of meaning is similar to the emergent phenomenon of ambiguity discussed by Gaver and colleagues. Whereas Gaver focuses on the designer's manipulation of system attributes, Pierce focused on the language producer's manipulation of signs. In Pierce's view, communication between

people can never be entirely definite, there is always room for interpretation. "There are no sure signs in communication, only hints and guesses" (Peters, 1999, p.268). Similarly, in his study of language, Saussure[45] identified the arbitrary relationship between the signifier (the linguistic sign) and the signified as the structure of language. He stressed a focus on how language functioned as a social activity and he depicted language and thought as two sides of the same coin, one influencing the other. These ideas spread and morphed through the arts, philosophy, and critical theory. For example, the importance of structure for meaning-making inspired an examination of its political implications as a determinant force. Ultimately, these views bled into post-structuralist approaches where signs are not only arbitrary but fluid and at times even non-referential.

In analyzing the structure of language, its functionality, and the constructive act of language use, several theorists have outlined maxims, principles and constructs guiding language in action and aiding interpretation. H. Paul Grice (1975), for example, developed four maxims directed at speakers to help facilitate the coordination process of meaning. These maxims, which could be considered as design principles for language producers, included things such as quantity (i.e. make a statement as informative as possible but not more than it needs to be), quality (i.e. be truthful and backup evidence), relation (i.e. be relevant), and manner (i.e. avoid obscurity, ambiguity, redundancy, and disorderliness). Around this same period, John Austin (1962) was developing the idea of speech acts, also a structural theory that identified meaning in the speaker's intention or what the

[45] Saussure died in 1913 and his most famous work *Cours de linguistique générale* was written posthumously from the notes of his students and published three years later – an interesting exercise in interpretation between signifiers and signs.

speaker was trying to do through the act of speech (such as telling, asserting, requesting, asking, etc). Examples such as Grice's maxims, Austin's structural theory, and later Searle's speech acts (Searle, 1969) provide explicit articulation of implicit rules by which language use is coordinated.

Yet, as Clark (1996) cautioned, these rules and maxims are rules of thumb, conventional practices but not beyond challenging. For example, Grice's maxim of avoiding ambiguity to support coordination of meaning is violated with common expressions of metaphor, deception, irony, and other forms of ambiguous language. Because of the relevance of ambiguity for the design spaces I have been exploring, I will look at several instances of ambiguous language use including irony, equivocal expressions, deception, metaphor and idioms in more detail below.

Interpretation and Ambiguity

Despite its apparent contradiction to conventional language use, ambiguous language is prominent in everyday discourse, suggesting something that we have developed an ability to negotiate. Insights into how this happens therefore should help designers understand and anticipate how ambiguity emerges. The potential for ambiguity is ever present, as argued above regarding the fluid relationship between signs and meaning. Almost every expression, according to Clark (1996), has more than one conventional meaning. The process of co-interpretation between a speaker and a respondent depends upon Clark's related principles of common ground and joint salience.

Common ground is "the sum of mutual, common, or joint knowledge, beliefs and suppositions" between communicators (Clark, 1996, p.93) and it is around this shared base that people coordinate their actions, in this case their

use of language. If two people enter a face to face conversation, they build off of their initial common ground of a shared symbol system (e.g. English or French), shared perceptions (e.g. common physical fields of view), shared conventions (e.g. turn-taking in conversation), and so on. This process of drawing from and building new common ground occurs through successive presentations of evidence and inference. The selection of evidence to present and its interpretation is guided by the property of joint salience: the most salient, prominent, or conspicuous solution with respect to the participants' current common ground. In order to coordinate meaning when every utterance could have multiple interpretations, Clark explains: "We select the lexical entry that 'best fits' the utterances in context. But what 'best fits' comes down to really is joint salience – which sense is the most salient solution given our current common ground" (Clark, 1996, p.78).

The example above of choosing one's words in terms of their perceived salience for a specific other suggests one type of ambiguity arises when the salience is mistaken or what is salient for one person is not for another. For instance, someone assumes a shared reference point or conventions, such as an American speaker in Britain asking for the bathroom and a British person in America asking for the toilet[46]. In such situations, Clark claims that ambiguity is resolved and joint action accomplished through repair work. Evidence from the respondent suggests he or she misunderstood the request and the requester can then frame the question differently. In this eample, ambiguity is a coordination problem, or a suboptimal state for joint action, where ambiguity

[46] In Britain, a bathroom is literally a room with a bath tub whereas this term is more generic in America. In America, if you asked for the 'toilet', this would appear crass but this is acceptable in Britain. This is somewhat of an exaggerated example however as many Brits and Americans can figure out what is needed and recognize it as an example of two countries divided by a shared language.

must be diminished on the way to common ground and mutual understanding. However, in the following examples I will look at specific types of figurative or ambiguous language where ambiguity or openness to interpretation is an intended state and yet still largely abides by principles for coordination.

Irony

Irony (e.g. Clark, 1996; Hancock, 2004) is an example where language use appears to violate maxims for coordination yet is readily understood in everyday discourse. Clark introduces the idea of 'layers' to explain how this happens. At layer one, conversants talk about what really is. They enter into alternate layers when an imagined reality is required. Suppose two people walk into a third friend's house and they are confronted with lava lamps, black lighting and velvet posters of Elvis. Person A turns to person B, raises his eyebrows and says "Nice décor." Person B, knowing Person A's impeccable tastes nods and says, "Yeah. Long live the King." In this exchange, A & B are operating at two layers of communication. In layer one, they agree to jointly pretend that the actions in layer two are true. In layer two, they act out an alternate reality, namely that the characters they are playing both like the décor. Ambiguity in this sense does not necessarily exist in the exchange between A and B as the evidence of B's uptake indicates he understood A's intention and agreed to join the pretense. Instead, ambiguity here exists between the layers for someone on the outside. Irony works through the same type of collaborative action Clark describes with less figurative talk but by adding an additional device of 'in-groups' and 'out-groups'.

Deception

Clark argued against viewing deception as a type of coordinated action since the participants in the conversation have different goals and are not working toward a shared reality. However, White and Burgoon (2001) argue that deception also requires coordination and follows a discernible pattern of interaction. This issue of requiring mutual goals and intention will be taken up in a later section, but it appears that deception could easily still occur within Clark's frameworks of language use. In fact, it is possibly the speaker's awareness of conventional maxims that allows for developing a layer of imagined reality that the speaker and respondent construct together. One difference is that the speaker realizes two layers are operating whereas the respondent does not. Ambiguity here exists in the sense of multiple interpretations between the in and out group, just as with irony.

Equivocation

The development of coordination through ambiguity may also be seen in explanations for use of equivocal language. "Equivocation is nonstraightforward communication; it appears ambiguous, contradictory, tangential, obscure, or even evasive" (Bavelas, Black, Chovil, and Mullett, 1990, p.28). Bavelas is careful to distinguish equivocal language from deception because something subtle is happening with the layers of interpretation. In Bavelas's construction, equivocal language is more precisely defined by explaining what it is for, namely as a response to an 'avoidance-avoidance' situation. When caught between two poor alternatives in a communication exchange, Bavelas predicts that equivocation will occur. For instance, imagine Person A received a terrible haircut and asks his friend Person B what she thinks about it. Person B doesn't want to tell the truth and

hurt her friend's feelings, but she doesn't want to lie. Therefore, she chooses something that does not do either, for example responding, "I love it when your hair gets blonde like this in the summer." She deflects the real question and provides a true compliment instead. Note however that equivocal communication is often a way of saving face, and also operates on the principles of common ground, where both parties could agree at the reality level that their act of communication reaffirms their friendship whereas at the imagination level, they take B's comments as a non-response. In another scenario, however, A could choose to interpret B's response as an affirmative – that maybe she thinks the cut brings out the highlights in his hair. Equivocal communication then can lead to disparate interpretations or mutual ones.

Metaphor

A fourth type of ambiguous language use involves the use of metaphor. The richness of metaphor employed in poetic language suggests its openness to interpretation as well as our capacity as readers of poetry to understand metaphor. For instance, in the poem "Because I Could Not Stop for Death" by Emily Dickinson, she uses the metaphor of a coachman and carriage for the end of one's journey in life. Poetic metaphor leaves room for interpretation because in the comparison of two unlike or normally separate things, many different features may be common or uncommon. Here, too, we can look to Clark's principle of joint salience to suggest what aspects of the comparison will direct interpretations. Yet metaphor in poetry also sparks discussions of what the poem 'really' means, what did the author 'really' intend. In other words, metaphor may be for encouraging open readings or about making the discovery of the intended meaning more engaging.

The nature of metaphor and interpretation is not only at issue in poetic uses but also in everyday ones. Lakoff and Johnson (1980), for example, examine how metaphors such as 'he shot down my arguments' or 'stop wasting my time' promote views of argument as war and time as money respectively (p. 4-7). The argument from Lakoff and Johnson and others is that we don't often realize we are using metaphor and take its figurative meaning as a given. Reddy (1993), for example, provides insights into why the transference model of communication has had such a lasting impact in communication theory. In examining everyday discourse, Reddy points to the prominence of the conduit metaphor for describing successful and unsuccessful communication acts. For example, statements such as "Try to get your thoughts across better" (p.166) or "Your words are hollow – you don't mean them" (168) suggest not only do we use language to transfer meaning from sender to receiver, but that words have an 'inside' to them where meaning can be inserted. Reddy comments that most of the metaphors about breakdown blame the speaker, "after all receiving and unwrapping a package is so passive and so simple – what can go wrong?" (p. 170). This may help explain why linguistic studies focused for so long on the speaker as opposed to considering language a collaborative act. For my review, however, the interesting thing about this example is how easily metaphor ceases to stand as metaphor. With the conduit metaphor, for example, rather than one way of thinking about or explaining communication, it starts to stand for the essence of communication. Rather than opening up interpretation, metaphor can just as easily limit it.

Idioms

The final example of figurative language I will address is the use of idioms. Idiomatic expressions, such as “you’re pulling my leg”, are a type of metaphor but generally function not as a comparison so much as a conventional expression. In this example, “you’re pulling my leg” generally means “you’re kidding me” or perhaps “you’re trying to fool me.” As an example of language use, idiomatic expressions don’t seem to be any different than any other word that might have multiple or subtle shades of meaning depending on use. However, the perception of an idiomatic expression is that its utility is derived from a shared, idiosyncratic, meaning among a group of people. This is interesting in light of the work of linguist Geoffrey Nunberg (2003, cited in Striphas, 2006). Nunberg examined common expressions whose meaning had been taken for granted and the discovery that often people who assume they are using an expression the same way hold different, and even opposite intentions. He used the example of the phrase “on the up and up” and how one person in a married couple meant it as “on the level” and the other partner meant it as “on the increase”. This fascinated the couple to discover that despite their years together and similar backgrounds they could talk past each other and not realize it. Clark’s model would explain this misperception was based on lack evidence that understanding had not occurred, therefore there was no need for repair work. The couple believed they had common ground yet each had a different interpretation. Through the ambiguity of the expression, two alternate interpretations emerged, but without awareness of the discrepancy. At a trivial level, this example seems simply like a misunderstanding – one that was eventually repaired at the couple’s discovery of their differences. The next time one of them uses ‘on the up and up’, they might realize they need further clarification. However, at a deeper

level, the example highlights what we might assume to be a rare occasion that actually happens quite a lot. As Nunberg concluded: “We can never be sure we’re understanding each other…But maybe the wonder of it all is that we manage to muddle through even so.”

In all of the above examples, what is striking is the similarity between how ambiguity and interpretation is defined in communication studies and the trajectory and approach in HCI. On the one hand, ambiguity is a mark of a failure to communicate, e.g. the coordination did not follow existing maxims. On the other hand, if ambiguous language deliberately violated these maxims the ultimate goal is still a type of convergence. In irony, convergence occurs among the in-group; in deception, the convergence is around the ‘false’ story; in equivocal language, the convergence is around an alternate exchange; in metaphor convergence often happens whether intended or not; in idioms we often assume convergence even if it does not exist. Although the constitutive approach to communication challenged the primacy and completeness of an individual and the language use approach challenges the reification of conventions, there is still a sense in which the process is one of matching meanings. In the following section, I will examine whether there is space within communication for the approach to interpretation in HCI being advocated by Sengers and Gaver (2006), namely interpretation that allows and works for multiple instead of single interpretations.

Interpretation: Matching versus Approximating

Roberts and Bavelas (1996) characterize the construction or action approach to studying communication, and in particular language use, as a shift regarding where meaning resides “from *in words*, to *in words and their context*, to *in the speaker’s intention*, and finally, to *in between interlocutors*” (cited in

Kelshaw, 2006, p.156). This still leads to the question of "what" is being constructed. If meaning resides in between interlocutors is it a single shared meaning? Is the goal of communication still a matching of minds, only the direction has shifted from inside out to outside in? The discussion above regarding ambiguity and interpretation suggests that even though we use language designed for leaving room for interpretation, the goal still seems to orient toward a shared meaning. At this point, I could conclude that based on communication theory and studies of language use, designing for openness is doomed from the start. Whereas science and technology studies suggests designing for openness is somewhat irrelevant since people appropriate designs regardless of whether openness is intended, this reading of communication theory suggests that regardless of how open a design is, people will work their way into a shared interpretation that eventually becomes dominant and part of common ground. Yet, I believe this conclusion might be premature. In this section, I will re-examine common ground as accommodating multiple interpretations and summarize new movements in communication theory suggesting yet another parallel development with HCI.

In an early reading of Clark (1996), I found two aspects of his theory that called for further examination. The first was the (deflected) discussion on 'uncommon ground'. Common ground in Clark's formulation is built on common ground, but this begs the question of how common ground begins. Clark dismisses this conundrum as a more apparent than real problem. He suggests that without common ground to start with people likely build up perceived common ground based on misunderstanding, which may later become worked out, as in the idiom example above from Nunberg. The second weakness in Clark's theory is the focus on mutual goals and a narrow

definition of collaborative acts. Based on personal experience working in the field of conflict management, I witnessed collaborative exchanges between people holding opposite views – where each utterance anticipated each counter utterance. In other words, they were mutually working to hold opposite views. Similarly, Pearce (1989) discusses intractable communication patterns as exhibiting this type of collaborative behavior where participants, often despite their best efforts to end a pattern, maintain a type of downward spiral. His patients would say things like: "I knew if I said X, it would escalate the argument, but I just couldn't help myself." As mentioned earlier, new thinking on deception has also challenged the view that communication requires a joint goal. These two questions of uncommon ground and non-commensurate goals, suggests either a re-interpretation of Clark's theory or new theory to account for these phenomena.

Nunberg's analysis of the idiom example helps begin to reformulate ideas around uncommon ground. Nunberg shifted the focus from the moment when the repair work happens to the time period up to this point – the time during which the couple holds different interpretations yet still manages to 'muddle through.' This example is part of a larger argument by Striphas (2006) in his conception of communication as translation. In Striphas's view, there is always a gap of interpretation, i.e. there always exist multiple interpretations of varying degrees of resonance. He uses the practice of translation because the traditional view of translation studies (e.g. from one sign system to another, such as from English to French) is that it is a downgrading of the original message. We accept translation as a necessary evil and we consider it something that happens relatively infrequently, such as when traveling to a foreign country. Whereas a dominant view of communication, according to

Striphas, privileges shared understanding and is biased toward mutuality, translation does not. Striphas's conclusion however is not that translation exists on the margin of the dominant practice of communication, but that translation *is* the dominant form of communication, therefore requiring a new definition of communication. Translation is "always an approximation…always a 'good enough' and never exact" (p. 234). The focus of translation, and communication in general in this view, is on making do, misunderstanding, contingency, and difference. This suggests that rather than repair work marking a failure to communicate, we are always in the process of repair, always improvising approximations and managing multiple interpretations.

The shift in considering common ground and mutual understanding as the dominant state of affairs is also taken up by Shepherd (2006) and Baxter (2006) in their respective presentations of communication as transcendence and communication as dialogue. Shepherd's definition of transcendence, and by his extension communication, is "the simultaneous experience of self and other" (Shepherd, 2006, p. 22). He emphasizes a non-foundational view of self or other but recognizing each as in the process of 'always becoming' – not a 'better sense of self' which implies uncovering something that was always there, but – an expanded sense of self (p.24). Since the 'other' is the flip of the self, we can never truly understand each other as both selves are in the process of change. Shepherd concludes that what we aim for is not "accurate interpretations" of each other, but understanding in the sense of "sympathetic awareness" (p. 24). He unpacks this idea of sympathetic awareness as the sharing of significance rather than meaning: "It is, in other words, the significance of the experience of one another that we share – each of us

becoming more, not by our actions alone, but because of our *inter*actions" (p. 24-25, emphasis in original).

Baxter also addresses the idea of otherness in her approach to communication as dialogue developed through the work of Bakhtin (Baxter, 2006). She argues, "Diversity is the ubiquitous condition of humanity, yet communication scholars partition it off, view it negatively, or ignore it completely" (p. 102). The philosophy of Bakhtin, in contrast, focuses on both difference and cohesion or what he called the centripetal (unity) and centrifugal (difference) forces always at work in dialogue. Dialogue does not require commonality in its objectives according to Baxter (2004). She differentiates it from a Hegelian dialectic that moves from thesis to antithesis and ultimately to synthesis. In dialogue, synthesis need not be the outcome. All dialogue retains elements of the dialectical in terms of a to and fro of difference, but not all dialectics are about dialogue (Baxter, 2004). Baxter's reading of Bakhtin's formulation of aesthetic dialogue resonates with the view of communication as characterized by messiness with only fleeting moments of order or wholeness. She highlights Bakhtin's work against monologic wholeness as possible or even ideal as this leads to hegemony and dominance of the powerful. In contrast, Bakhtin worked for aesthetic wholeness to accomplish "a momentary sense of unity through a profound respect for the disparate voices in dialogue" (Baxter, 2004, p.12).

Peters (1999) also advocates a view of dialogue that does not require mutuality. Yet, he argues against using the term 'dialogue' to describe communication because of its connotations of unity and harmony, what he sees as utopian baggage, and because of the equally likely possibility that dialogue, just as totalitarian discourse, can become a vehicle of hegemony.

Regardless of his choice of term, Peters' view of communication is very similar to Baxter's (and Bhaktin's) and Shepherd's described above. Peters furthers their argument by challenging the assumption that co-located human-to-human communication is the most ideal form of communication, the gold standard against which distance communication or communication between human and animal or human and machine are compared and modeled. If the momentary connection with others is the hallmark of dialogue, then this opens up what is considered communication to include conversing with computers, aliens, and the dead (Peters, 1999). Furthermore, in countering the ideal of co-location, Peters uses as an analogy of an experiment by James Clerk Maxwell in 1873 that demonstrated the irreducible quality of distance. In Maxwell's experiment, he pressed two plates of glass together with the help of pulleys, levers and weights and used a light source's reflected patterns to determine if the plates acted as two lenses or one. Despite eventually welding the plates together because of the force, the pattern always showed that some distance was retained. Likewise, Peters argues that as humans, there are always gaps to navigate even in face-to-face communication regardless of the appearance that distance does not exist.

Yet, Peters takes his argument a step further when he proposes that an 'other' need not even exist for communication to occur. This is what he intends by the title of his 1999 book, *Speaking Into the Air*, and his conceptualization of communication as dissemination rather than dialogue (Peters, 2006). For instance, he suggests that if someone raises his hand as a gesture, this signal does not need to be noticed by anyone for communication to occur. In a more detailed example to justify his position, he proposes a thought experiment with Da Vinci's painting of the *Mona Lisa*. He imagines a scenario where all the

humans on the planet have disappeared yet this particular artifact is left behind for the contemplation of the beasts. The beasts would not understand its cultural significance or even that it represented a human likeness (apparently these beasts were not around when humans were). Instead, the beasts would only consider it a perceptual novelty. Despite this lack of uptake, Peters argues that the painting would still be saying something, even if no one were around to hear it. Both of Peters' examples, however, still suggest the presence of an other. In the former example of the gesture, the gesture was intended for a recipient who simply didn't see it. In the example of the *Mona Lisa*, the painting was also created for an other, yet this other could change from the past, present, to the future. Peters himself confirms this view later in his book when he suggests, "All talk is an act of faith predicated on the future's ability to bring forth the worlds called for. Meaning is an incomplete project, open-ended and subject to radical revision by later events" (Peters, 1999, p.267). In other words, the Geist[47] or irreducible meaning that Peters tries to locate within the *Mona Lisa* represents the potential for communication not the act itself.

Pushed to its extreme, Peters' conception of dissemination as a contrast to dialogue has dangerous consequences. First, it could lead to the same un-hopefulness Shepherd predicted in situations that required perfect symmetry. A view that requires no attempt toward symmetry, however, also suggests communication is unnecessary and futile. Peters' overall argument

[47] Peters borrows the term Geist from Hegel to mean both the material and the spiritual, a third space. He argues that the Geist in the *Mona Lisa* is "entirely autonomous from any viewer's perception of that painting. The painting holds more than the sum of what it is in the eyes of its beholders, and it holds an objective intelligence that can never be reduced to the aggregated individual mental experiences of its viewers." (Peters, 1999, p.116). Peters use of the term 'autonomous' is curious. Although the Geist may be non-reducible to one view or to a simple aggregation of views, surely it is dependent on this disparity of views existing?

does not support this, but parts of his argument, such as the depiction of speaking into the air, deny that the potential for brief moments of connection exists. Peters' dissemination resembles the sentiment of modern and minimalist art from the middle of the twentieth century: the artist speaks and there the art stops. Whether a viewer engages or not is irrelevant. Speaking into the air in its extreme is sound that carries forever, without boundaries of receptors. Furthermore, his arguments for perpetual distance, although on the one hand providing a much needed balance against the valorization of face-to-face communication, on the other hand risk throwing the balance too far toward distance at the expense of ever momentarily transcending the gap. In other words, as the constructive move to language argued against the impermeability and completeness of the individual, Peters' argument could be easily drawn on to support re-closing the individual. If we can never reach across the void, we either must be complete in and of ourselves or we must live our lives as incomplete beings never to find fulfillment. Finally, by denying the role of reciprocity, Peters' argument suggests that it does not matter what someone does. Yet this position does not square with his emphasis on pragmatics: "whatever 'communication' might mean, it is more fundamentally a political and ethical problem than a semantic one." (Peters, 1999, p.30). In this view, the outcome of communication is highlighted as equally important as the process.

A more interesting question that Peters is posing is whether or not the intention to communicate must exist for communication to occur. Returning to the gesture example, in his scenario, a person raises his hand in gesture but it is not seen or perhaps interpreted as merely a reflex. One person intended it as a communicative act, an invitation to join in communication and the other,

while not actively denying it, did not perceive it as such. The flip side of this scenario would be if someone raises his hand in a reflex and a bystander interprets it as a gesture. In this scenario the observer intends to engage in a communicative exchange but the other does not. In Peters' view, the intention *to* communicate, as well as the intention *of* the communication, can be isomorphic. This contrasts with the view of most constructive approaches to communication and language use that require reciprocity of intentions but not necessarily mutuality. Shepherd's view of communication, for instance, suggests that communication is 'voluntary' – it requires volition to speak and to accept, what he argues is an empowering view. As Shepherd states: "communication is not something that happens in spite of you but because of you" (Shepherd, 2006, p. 27).

One way of aligning these two different views is to consider Peters' formulation as having communicative potential. The vision of communication put forth by Peters is at base more hopeful than his metaphors of speaking into the air and irreducible gaps. As he states: "The task is to find an account of communication that erases neither the curious fact of otherness at its core nor the possibility of doing things with words. Language is resistant to our intent and often, in Heidegger's phrase, speaks us; but it is also the most reliable means of persuasion we know. Though language is a dark vessel that does not quite carry what I, as a speaking self, might think it does, it still manages to coordinate action more often than not" (Peters, 1999, p.21-22). The conclusion, one made by Peters, Baxter, Shepherd and several other theorists, is that the coordination of action does not require meaning between two people to be isomorphic.

Based on the above discussion I believe an alternate, or compatible, reading of Clark's formulation of common ground is possible. Joint common ground need not be exact – in fact, the perception of common ground may be enough for coordination or 'muddling through.' Common could be thought of more as 'sympathetic' in the Shepherd sense. After all, we can never completely have a shared reality or as Wittgenstein is often quoted, if we taught a lion to speak we still couldn't understand him (Wittgenstein, 1958). The commonality of our symbol system is not enough to produce symmetrical meanings but is enough to work toward sympathetic ones. Because of this reformulation of common ground, the space for 'uncommon ground' exists as well. Common ground and uncommon ground, understanding and misunderstanding, are not binary choices. In other words, if we agree that the common will never be exact, then we are never exactly uncommon either. This space in between is where communication happens. Arendt commented that this dynamic character of equality and distinction establishes the basic condition for human plurality. She observed, "If men were not equal, they could neither understand each other and see those who came before them nor plan for the future and foresee the needs of those who will come after them. If men were not distinct, each human being distinguished from any other who is, was, or ever will be, they would need neither speech nor action to make themselves understood. Signs and sounds to communicate immediate, identical needs and wants would be enough" (Arendt, 1959, p. 155-156).

In rethinking Clark's framework, his model of interpretation remains unchanged and highlighted in significance. Interpretation is always an approximate link between available evidence (which includes perceived common ground) and intention (see Figure 20). Although a simple formulation,

this has important implications for design, as will be discussed in a later section. The available evidence may be considered of higher or lower quality, but neither the quality nor the quantity of evidence available can guarantee that the link between evidence and intention is complete (Boehner and Hancock, 2006). This reformulation of Clark also spurred me to rethink the inverse relationship I had originally formulated between ambiguity, defined as openness to multiple interpretations, and common ground (see Figure 21). In an earlier paper (Boehner, 2004), I had considered that more common ground would lead to less openness to interpretation, that people would work through openness until they had settled on an agreement or convention. I saw the funnel as operating both ways, but generally in a more narrowing function. To some degree, I believe this is what often happens, that through experience, conventions develop and that conventions tend to limit openness. But, I've reformulated my model in subtle but important ways.

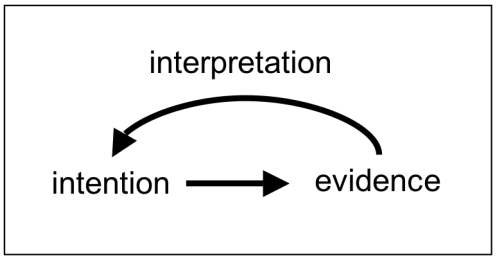

Figure 20. Inferring intention is always a matter of interpreting produced evidence

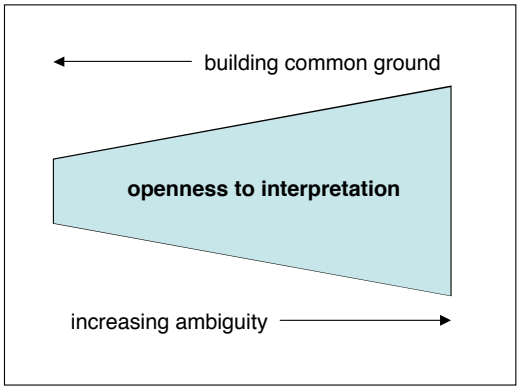

Figure 21. An earlier model of common ground and ambiguity as an opposite relationship

In Figure 22, the horizontal divide in the funnel represents the non-isomorphic nature of shared meaning between people (in this model I'm depicting a dyadic exchange). The shape of the funnel represents the potential space for interpretation, which may be narrower or wider depending on a number of factors. Common ground may also be more or less within this funnel, but it does not map linearly. In other words, more common ground may be associated with a narrower space for interpretation but this is not always the case. Movement happens both horizontally and vertically. Vertically, if the dots are far apart, it suggests a wider gap between interpretations. The horizontal movement represents changes in the space available for interpretation, the dots moving right and left according to a number of factors that define this available space. If the dots exist at different points along the spectrum, it suggests differences in their perception of the interpretation space. For instance if one is at the far right side, she might work harder to make herself understood because of her perceived potential for the variety in interpretations whereas her partner might be more toward the left side thinking alignment (not perfect) is easier. The model does not suggest that mutual alignment is required (the gap depicts its possibility only through momentary transcendence) or even desired by the participants as a goal.

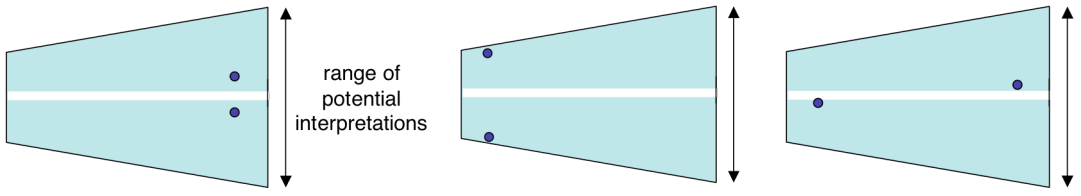

Figure 22. from left to right, two people with a) close interpretations in a wide field of possibility, b) more divergent interpretations in a narrower space, c) extremely close interpretations yet different perceptions of the range.

I do not offer the above as a predictive model but merely as a thinking framework for emphasizing that ambiguity and common ground are not opposing concepts, yet they are interrelated. In developing other work with Hancock (Boehner and Hancock, 2006), we played with the idea of ambiguity as an amoeba, that the shape of potential ambiguity in a conversation or communicative exchange never changes but instead it just changes shape. If one piece of information is pinned down, something else might open up. We found this to be a more radical argument, however, to support. In common experience, there are situations we recognize as having more or less openness to interpretation. If I return to the idea of levels of interpretation introduced by Sengers and Gaver (2006), at the physical level, for example pointing to an oak table and saying to a friend, "I like that table," the interpretation linking my words to my pointing to the physical reality in front of us is fairly straight forward. At higher levels of interpretation, things may open up more. For instance, why do I like this table and why did I choose to point it out to my friend? Was it a suggestion for a present? Was I merely making conversation? Was it an indication that I liked this table but not that table? The argument that all communication is ambiguous is one advocated by many theorists, including those discussed in this and the previous sections. However, the argument that the level of ambiguity stays the same is more difficult to support. In contrast, the funnel or wedge model depicted above suggests movement (horizontally and vertically) but it also illustrates that situations may vary in the amount of openness.

This section on the movement from transmission approaches to constructive approaches in communication theory has paralleled a similar trajectory as the field of HCI. For instance, both moved from a view of

transmission of meaning or use in the abstract to an emphasis on meaning in interaction and in context. The observation that both fields are also reconsidering the symmetry requirement of this interaction suggests a further confluence of interests. In the next section, I will turn from the overriding model of communication as one of construction to a discussion of how this model translates into both methods for studying interpretation and implications or connections with designs for interpretation. This discussion will set the stage for proposing specific suggestions for reviewing the theory, design, and evaluation of the case studies presented in the earlier chapters.

Communication Method and Theory for HCI Design

In this section, I will begin with a discussion of how a conceptualization of communication as construction translates into approaches to studying communication. I will not examine specific methods per se, such as discourse analysis, but instead I will examine the orientation toward methods. This is in the same spirit as Craig (1989) and his interpretation of Kaplan (1964) who focuses on the description, explanation, and justification of methods and not the particular methodological techniques. In this sense then, I am moving from a general theory of communication (communication as construction) to a theory of how to study communication as construction. In the final section, I will make a similar move in considering how a theory of communication as construction influences the orientation and practice of design.

Communication Methods for Studying Interpretation

Although the above section on re-thinking interpretation identifies communication as a field moving from a focus on transmission of meaning to the construction of meaning and a focus on messages to interaction, the field

is far from homogeneous. Several scholars remark that the field is still split rather than a definitive movement from transmission to construction (e.g. Shepherd, 1999; Baxter, 2006). Where this split may still exist is not in the general acceptance of the interaction view of language use in particular and communication in general but in the move from theory toward methods. For example, in a review of communication studies literature from 2000 to 2005, Poole[48] concluded that only ten percent of the publications reported on studying communication as a process, as opposed to the variable view. In addition, if he removed discourse analysis studies from his sample, the number of process oriented studies reduced to less than five percent. Poole presented this as a puzzle and a challenge – if as scholars we define communication as a process, then why do our methodologies and studies not reflect this as well? If interaction and construction has indeed become the dominant view in communication theory, perhaps where the divide still lies is in how interaction is studied as opposed to conceptualized.

In the following sub-sections, I will discuss common approaches to studying the construction view of communication and how these approaches still orient around the construction of a single meaning or interpretation. In pursuit of theories amenable to the construction of multiple meanings or interpretations, new methods of study must be developed. In particular, because support for multiple meanings and the emergent construction of meaning, rather than the location of pre-existing meaning, challenges the goal of prediction, I will explore the alternate criterion of 'usefulness' as developed in the grounded practical theory approach. I will end this section with

[48] Poole, M.S. 2005. "The Study of Process in Communication Research: Old Wine in new Bottles and New Wine in Old Bottles", seminar at Cornell University's Communication Department, Oct.21, 2005, Ithaca, NY.

reflections on how new criteria for methods in theory building and method selection would influence the study of the case examples from chapter two and three.

Legacy of Transmission

The tension between theory and the practice of 'doing theory' or studying a theory in practice, is discussed by several of the theorists introduced above who write about the challenges of a constructive or relational view of communication. Baxter (2004), for example, comments on the difficulty of escaping the legacy of the individualistic and mechanistic pillars discussed in the introduction of this chapter. She observes that most studies in her field of interpersonal communication still frame relationships as a coordination of individual parties where success is measured by the efficacy and efficiency of the coordination as opposed to the quality of construction. Likewise, Deetz (2003) argues for the need to reclaim the spirit of the linguistic turn. He claims that current studies in his field of organizational communication oriented around language and discourse use ultimately recreate the same subject and object dualism that the original phenomenological and constructivist turns sought to overcome. Furthermore, in Shepherd's review of advances in communication theory, he underscores how often terms such as 'breakdown' and 'message production' reflect a continued mechanistic view of communication (Shepherd, 1999). The individual and mechanistic legacies that gave rise to the transmission view of communication continue in the study of construction.

Perhaps the greatest legacy reflected in contemporary research of the individualistic and mechanistic traditions is an emphasis on identifying component parts and predicting causal relations between components. This is

related to the argument Myers (2001) makes regarding the dominant techno-determinism in early computer mediated communication studies. Both Myers and Craig (2001) argue that when a new medium is developed, studies often use socio-psychological approaches of isolating causal variables and predictive models around how certain attributes of the new medium may predict behaviors. For example, during the early years of the Internet, theorists predicted that the loss of social context information would lead to 'de-individuation' (Myers cites Kiesler, Siegal, & McGuire, 1984 as a prime example). The attributes of the medium then would cause or determine certain behaviors reflective of a different view of self. The current interest in online communities and self-expression challenges this techno-deterministic view that the medium's attributes can routinely dictate and restrain behavior in only one direction. As an example of an opposite approach, coming from the determining qualities of the person, in White and Burgoon's (2001) deception work, they explore how a person's interaction position (defined as his or her requirements, expectations, and desires for behavior) can predict their initial pattern of interaction (such as approach, avoidance, reciprocity and compensation). Finally, in Bavelas's studies of equivocal communication, also discussed earlier, the causal element is the context, for instance in an avoidance-avoidance situation, equivocal communication is likely to occur. In these three studies, the causal locus varies from the attributes of the technology to the attributes of the person to the attributes of the situation, yet the relationship remains as a type of linear cause-effect. The question remains of how to study issues of emergence, such as discussed in the very beginning of this chapter regarding ambiguity as a property that emerges from the interplay of people, context, and material artifacts.

Shepherd, Striphas, and St. John (2006) argue that this emphasis on prediction, control, and cause and effect models in studies of communication reflect the scientific empiricism that has guided a large portion of academic research in many of the social sciences. Furthermore, they argue this has led to an increasing interest in the 'methods' of research, at times at the expense of new insights. They write, "the powerfully humanist belief that the inherent sense of an idea – its place in a community, its emergence within an identifiable tradition, or its reflection of a way of life – is the strongest measure of an idea's worth was overwhelmed by method. In an astonishingly brief time, the new empirical paradigm began to declare that what made a theory 'good' was whether it could be proven, where proof was confined to normative and potentially limiting rules of measure and referral" (p.xv). Slack (2006) also comments on an overriding emphasis on methods, not only as predictive of some phenomenon of study, but predictive in and of themselves as refined and replicable techniques. She comments, "when I read studies in communication that find comfort – indeed, mastery – in a restricted 'scientistic' version of method, I am astonished that so many competent scholars seem content with the neatness of their work, the conformity of their method and approach, to the detriment of reaching critical insights about the world they are studying. When Stuart Hall (1992, p. 280) states that 'the only theory worth having is that which you have to fight off, not that which you speak with profound fluency,' he warns us away from taking any theory and reifying it into a paper cutout with which to withdraw from the unexpected richness and complexity of the real world as well as to the political realities of oppression" (p. 230). A particular emphasis on methods, and methods that serve to predict results and verify existing theories, presents a challenge to theories of

communication where meaning emerges as opposed to being found or dictated.

Beyond Prediction and Control

A starting point for matching methods to the view of communication as supporting multiple interpretations or 'hints and guesses', as opposed to coordinated meanings, is to search for new criteria. Criteria such as predictive power and verifiability that dictate both the evaluation of theories and the methods these theories tend to employ are more appropriate for a view of matching meanings in construction as opposed to being open to multiple or missed constructions. As Shepherd notes typical measures of accuracy and correspondence, for example, do not apply in his formulation of communication as transcendence. If transcendence is an 'experience', then as an experience "they can not be right or wrong, accurate or inaccurate, or true and false" instead experiences can be thought of as good or bad, happy or sad, memorable or forgettable (Shepherd, 2006, p. 23). This interest in personal, lived experience is related to the view proposed by Bochner and Ellis (2006) who argue that a cause and effect approach narrows the focus of study to phenomenon that may be explained by instrumentality, the reduction of uncertainty, and the application of rational decision making. Yet, if the interest is in understanding more messy circumstances, such as what people do when their original intentions go awry, when their intentions are at cross purposes, or when they are attempting to 'muddle through' a communication event, then the interest is in eliciting stories of significance from people not in predictive results.

Craig refers to these stories as people's everyday discourse about discourse and he offers this as an example of practical theory making (Craig,

1999, 2006). The discipline of communication itself in Craig's conceptualization is also a practical theory and I will use his framework for thinking about the study of communication in this way to explore alternate criteria beyond cause-effect predictive models. Craig positions formal communication theories as a more abstract and specialized process than the process people use themselves in constructing their own theories about what works and what doesn't in their everyday communicative encounters. Yet, formal communication theories, he argues, have the same objective as these everyday theories in that they guide reflection and choices. When people theorize about their own communicative acts, it is not merely to describe to themselves what they are doing but it is a practice for thinking about why something went awry or how they might go about engaging in a future conversation. Craig argues that this same type of theorizing is desirable in formal communication theory. Whereas scientific theorizing is concerned with *what is* and the goal is to discover general explanations of phenomena with predictive power, normative theorizing is concerned with *what ought to be* and seeks to "articulate normative ideals by which to guide the conduct and criticism of practice" (Craig and Tracy, 1995, p.249).

Normative theories, however, have come under fire as much as scientific theories. In fact, scientific theories when under the most attack could be seen as parading as normative theories, dictating what ought to be, when only asserting what is. For example, in the quote above from Shepherd, Striphas and St. John regarding the need for new criteria, they rail against the 'normative' restrictions of scientific method. In this sense, the normative rules of what ought to be when practicing scientific method directs the reality or 'what is' discovered. The caution with normative theories is in avoiding

statements of what ought to be turning into a reification of existing norms. Craig suggests however that his ideal of normative theory is one that identifies norms that are useful for critically reflecting on practice, not rigidly determining practice (Craig and Tracy, 1995; Craig, 1999, Craig, 2006). Craig also points out the weakness of normative theories that are often disassociated from actual practice, that address universal issues of power for instance but have less to say about how to ground the theory in practice. Finally, Craig differentiates normative theories from rule-based theories that do not propose rules but instead describe human behavior through the rules that seem to optimize or govern certain practices. Like scientific theories, rules-based theories focus on what is in contrast to what ought to be. Craig's concern with what ought to be stems from his belief that the goal of any communication study should be to advance the practical art, or praxis, of communication.

In order to address the charge that normative theory is often divorced from the actual problems and practices of particular situations, Craig and Tracy propose a particular methodological model to developing normative theories, an approach they call grounded practical theory (1995, p. 250). The goal of grounded practical theory is to engage in the "theoretical reconstruction of a practice" (p.252), in this case the practice of communicating. Craig and Tracy's application of grounded practical theory is very similar in spirit to the practice of reflective design in that it begins with existing practices and looks for the assumptions that have guided and continue to guide choices in this practice. In applying grounded practical theory, the practice is narrowed down even further to a particular situation, for instance, in Craig and Tracy's case study they look at intellectual discourse in an internal university seminar series with faculty and graduate students. A theoretical reconstruction looks for ideals

of practice, but not in the sense of uncovering "some inherent unchanging 'essence' but rather to *construct* a tentative, revisable, but still rationally warranted normative model…. The ultimate test of such a practical theory is not, then, like scientific theory, its capacity to explain an existing reality but rather its usefulness for practice and reflection. The underlying philosophy is not realism (theory describes the world) or idealism (theory constitutes the world) but rather a reflective pragmatism (theory informs praxis)" (1995, p. 252, emphasis in the original). In this sense, Craig and Tracy's goal for normative theory has shades of generative theory, in that it is not only about what ought to be, but through critical reflection it can also shape what could be. This discussion begins to identify a possible new criterion beyond prediction: usefulness for practice and reflection. Understanding how to apply a criterion of 'usefulness' requires unpacking grounded practical theory in more detail.

Grounded Practical Theory: Evaluating 'Usefulness'

The key for Craig and Tracy's model is their identification of three interrelated levels where reconstruction of practice takes place: at the technical, problem, and philosophical level. Their starting point, the 'grounding' move, is at the problem level, thereby differentiating their view of normative theory from traditional philosophical views. The usefulness of any norm, according to Craig and Tracy, revolves around how it addresses actually experienced problems. Therefore, in their application of this approach to a specific case study of intellectual discourse in a university department, they begin with an analysis of the participants' discourse and the way the participants talk about their discourse to identify the problems and tensions participants recognize. The table below (see Table 3) identifies the focus of

each of these levels and outlines the case example of examining intellectual discourse between faculty and graduate students during their seminar series.

Table 3. Reconstituting practice at three levels and a case example of each

Level	**Main focus**	**Case Example: Academic discussion**
Technical: the specific communicative strategies and techniques routinely available and employed within the practice	How we work	Assess the general knowledge level of different speakers and questioners. Tailor question difficult to perceived skill level. For lower skill levels, frame questions as prodding suggestions, "have you thought about…" as opposed to "why didn't you consider…".
Problem: the specific problems or dilemmas that bring forth normative (philosophical) reflection and drive the use of specific techniques (i.e. strategic action).	What we focus on, what we deliberate over	When asking questions in an academic seminar, there is a tension between supporting intellectual standards/rigor versus engaging in self-aggrandizing displays of one's own intellect. For instance, asking a speaker hard questions may be seen as advancing debate and the quality of the idea or as showcasing one's own superior intellect.
Philosophical: abstract but elaborated normative ideals and principles that provide the rationale for resolving a problem in one way or another	Why we choose or do what we do	Two competing 'situated ideals' may be at play in academic discourse: the dialectical ideal and the constructive criticism ideal[49]. These contrasting ideals are often held by different people to different degrees yet both are at play. Understanding the ideals allows for greater reflection on how the practice of this setting is informed.

[49] In comparing these situated ideals, Craig and Tracy (1995) identify the following characteristics. The dialectical ideal prioritizes: the merit of an idea; recognizing that ideas will cause strong feelings in others that they have a 'right to express'; and the stance that power differences between people exist but altering debate to fit this reifies the difference – all ideas should be treated equally. In contrast, the constructive criticism ideal: sees people and ideas as intertwined; cautions that expression of strong feelings about another's ideas has the potential to wound and shut down dialogue; maintains that power differences (e.g. between faculty and graduate students) should inform how to frame questions and answers.

In proposing grounded practical theory as an alternative to scientific theory, Craig and Tracy must demonstrate how their approach does more than describe or explain a communication practice. Furthermore, if their goal is not prediction or accuracy, then they must articulate how a good application of their theory is differentiated from a bad one, and indeed how they determine the merits of the theory itself. They argue that the instantiation of their theory is judged, i.e. its criteria of success, by its usefulness to inform critical reflection on practice.

Craig and Tracy describe three possible ways to test this usefulness. For the first approach, they propose sharing the theoretical reconstructions with participants and then assessing the subsequent role these reconstructions have in informing the participants' subsequent critical reflection and practice of communication. For example, in their case study, they could share their resultant identification of normative models and situated ideals with the participants and then assess how the participants use or ignore these reconstructions in their further academic discussions. This process becomes reflexive then as participants engage in new constructions of their discourse affording new reconstructions at the theoretical level. Craig and Tracy describe this test of their method as a type of action research that combines intervention with case study methods. The approach to theory is judged at two levels in this suggestion: 1) whether the grounded framework helps guide the researchers' investigation and articulation of the techniques, problems and situated ideals and 2) whether the articulated techniques, problems and ideals are then re-appropriated by participants. The judgment is in both the process of inquiry and in the final outcome's uptake.

Second, Craig and Tracy suggest that the articulations that result from grounded practical theory could be tested empirically. They describe this test as a functional approach to examine whether practice is more effective (they note that this term would require careful definition) when it approximates the situated ideals versus when it does not. Finally, they suggest a third approach to testing usefulness, similar to a critical theory approach, by taking a broader view and looking beyond the closed session of the phenomenon in question. For instance, the identification of dialectical and constructive criticism ideals that emerged in their case study did not occur in a historical vacuum. Both the researchers and the participants engage in other discourses and are informed by ideals from broader cultures that influence their discourse in any particular setting. The usefulness of their approach in this example depends upon being able to use their framework and findings to look for "antecedents of these ideas and their evolution in the social and institutional context of the modern university" (p. 264). Interestingly, the three approaches to testing their application of grounded practical theory roughly correspond with the three levels they identify within the theory: the problem level (action research approach), the technical level (empirical approach), and the philosophical level (critical theory approach).

Regardless of which approach is taken, Craig and Tracy stress that not only are the criteria different for judging normative theories from scientific theories, but the notion of criteria is also different. Criteria for scientific theory are for accepting or rejecting the theory or its application, but criteria for normative theory are for evaluating its usefulness and therefore not a binary choice between success and failure. "We must not forget that in principle, there is no logically determinate way to verify or falsify normative claims.

Arguments can be made pro or contra a particular normative theory on any number of grounds, some empirically based, some so embedded in the contingencies of a particular situated practice that they cannot be specified in advance by any methodological model" (p. 268). Any normative claim, Craig and Tracy argue, is a matter of "practical judgment, a decision that should always be informed, but can never be strictly determined, by the best available arguments" (p.268). As Shepherd argued, experiences are not right or wrong, but good or bad, more resonant or not resonant. This is related as well to the criteria Baxter identifies for what she calls sensitizing schemes or theories that orient researchers to certain critical practices (Baxter, 2004). Baxter proposes two criteria for sensitizing theories: their ability to be heuristic and allow researchers to see existing practices or phenomena in a new light, and their ability to render these practices intelligible. In Craig's grounded practical theory, it is not only researchers who become sensitized to the critical practices but the participants as well.

In summary, Craig and Tracy's articulation of a grounded practical theory approach offers alternative goals, criteria, and practices for studying communication as interaction open to interpretation. The goal is in identifying the situated ideals or norms informing how choices are made and defined in communication practices, a goal similar to the objectives of reflective design in examining a particular design practice. The emphasis that different people may hold different conflicting ideals and even that the same person may hold contrasting ideals suggests that matching interpretations is not the goal of this approach. Instead, the goal is to understand actions, what transpires or what is, through an identification of what people identify as their own evaluative norms, what they consider ought to be. This is not an attempt to reify existing

norms and resultant practices, however, although this is a danger in normative theorizing.

The criteria for judging the theory and its application involve assessing its usefulness for reflection and for informing practice. Usefulness as a criterion is not subject to verification type tests in terms of a priori and post test matching. Instead, verification may take place through an interventionist approach by assessing how the articulation of ideals influences practice, through an empirical approach by assessing how practices that support some ideals over others produce different results, or through a critical analysis approach to understand the larger historical influences and cultural implications of certain ideals. Although grounded practical theory provides a framework that incorporates the empirical, the practical, and the critical, it stresses starting with the practical in terms of existing problems and tensions of a very particular situation. Like the sensitizing theories described by Baxter, the usefulness of the grounded practical theory approach for the researcher is in describing not only what is happening but in providing heuristics for thinking about why it is happening, what is influencing communication to happen, in certain ways. In addition to Baxter's sensitizing theories, however, by linking the communication theory of researchers with the communication theory that happens in everyday discourse, grounded practical theory is also judged through its utility not only for researchers but also for informing people's actual communicative practices.

Lessons for Studying Interpretation in HCI

The previous section on interpretation in communication demonstrated a parallel movement with HCI in re-thinking interpretation as supporting multiple, not necessarily synonymous, interpretations. In communication, this

move began first with re-thinking communication as the transmission of a message between sender and receiver to the construction of messages between sender and receiver, whether real or imaginary, past, present or future. Yet, most methods for studying communication as construction still focus on the construction of a single meaning or the coordination around a single interpretation of meaning. In doing so, these methods focus on predictive models of cause and effect. Alternate approaches within communication exist however that would allow for the generation of multiple interpretations, such as Craig and Tracy's grounded practical theory described above. Based on this discussion, I will now draw out particular lessons from communication methods for the design case studies discussed in the previous chapters. There are three main lessons I will focus on: the role of empirical studies, the difference between prescription and prediction, and the criteria of reflection.

Empirical work is most commonly associated with the scientific method approach although Craig and Tracy's grounded practical theory provides one example of how empirical work need not be tied to methods for accuracy and prediction. The empirical work Craig and Tracy focus on is in articulating the techniques and skills practitioners use in response to or in anticipation of problems. In other words, they draw out the empirical work of their participants. Yet design work can also be considered empirical[50]. The choices a designer makes in response to certain design problems are the techniques of the designer. The grounded practical theory framework then could present a

[50] Ethnomethodology and ethnography, methods that informed the evaluations in the case studies, are also empirical in that they are driving from observations and aim to provide descriptions. The difference with this type of empirical work is its stance against the strong predictive ability of descriptions in one context for another.

frame for experimenting with and examining different design choices. For example, in the beginning of this chapter, a number of strategies for designing for ambiguity or openness to interpretation were articulated including defamiliarization, scaffolding, and personalization. Yet, one of the challenges is in anticipating and informing how these strategies might interact with each other and with various attributes of the individuals participating and the surrounding context. Using a systematic empirical approach may help build up a catalogue of anticipated responses to certain design choices and situations.

In the museum example, both the Imprints and the Birdscape were designed to use technology for an alternate purpose than distributing information about the art on display. Instead, we tried to draw attention to the experience of being in a museum, in particular the social experience within a unique public/private space. The resulting designs were implemented and analyzed in terms of visitor response, yet although the Birdscape design was informed by the Imprint design, the projects could also be considered stand-alone efforts. Subsequent designs will draw from these experiences but in order to better inform the design choices, looking more closely at how certain choices interact with the range and type of interpretations that emerge would be beneficial. For instance, I have identified 'framing' as an important strategy in how open or closed an installation is for interpretation. The museum itself provides a very powerful frame, as does the specific museum such as the Johnson's fifth floor gallery with windows all around and Asian art inside. Both the Birdscape and the Imprints had framing for their installation as well. For the Birdscape, there was a placard describing what the installation was about and the security guards also had a set story they told about the piece when visitors asked them. For the Imprints, there was also a story about why to

make an imprint and how to use the imprint when the guides were handed out. One simple empirical study would be to systematically vary the framing and capture how visitors interact with the different frames.

A slightly more complicated approach would be to combine two variables and look for interaction across these variables. For instance, another strategy for ambiguity we have outlined is the level of one to one mapping between visitor input and output. Both the Imprints and the Birdscape had high levels of one to one mapping, but altering this would allow for observing how visitor responses might qualitatively differ when the mappings are more difficult to determine. By combining these factors in a semi-controlled testing condition, we could explore how visitors draw on both framing and mapping in their interpretations.

As with the museum case study, the Affector case study also uses empirical methods but could do so in a more systematic fashion in order to draw out broader lessons and influence future design. In chapter three, I indicated how Affector is part of a larger consortium of studies exploring design and evaluation for affective presence. In addition to modifying the design choices and articulating changes in participant responses within a system, a systematic empirical approach can help identify the larger design space across different systems. For instance, the various systems in the affective presence consortium differ in terms of the number of people designed for (dyads, small groups, or large groups), the degree of familiarity people have with each other (intimates, friends, or strangers), and the cultural space designed for (office, home, or public space). Each system is designed for a specific context and the system attributes, as with the museum studies, may vary in terms of the design strategies used. The goal of this systematic

approach within a common framework is to provide a range of specific scenarios and techniques that together create a richer picture of the affective presence space. The grounded practical theory framework could help guide this at two levels: at one level in terms of how the designers define the problem space, the techniques they employ to address this problem space, and the situated ideals that inform these choices; and at the second level performing the same analysis in terms of the participants' interactions with the resulting designs.

The above suggestions could be seen simply as an argument for a typical social science experimental design or a typical iterative design approach. The question then is whether the grounded practical theory adds anything new or different. In my assessment of how to apply this approach, I believe there are several important distinctions. First, the identification of different modifications for design choices is not in the spirit of 'divide and conquer' or the 'brick laying' approach to research. It is not a matter of isolating components, ascertaining their effects and causes, and then building from this set knowledge. Instead, it is a framework for articulating a variety of complex interactions, that will likely change across different circumstances. The point of identifying the components is to illustrate the variety of ways in which they alter and change the interpretation space as opposed to pinning them down in one context and assuming the effect will remain the same. The goal then is to provide a range of evidence for designers, and evidence for participants, but as the previous discussion of Clark's model argued evidence is always a matter of interpretation. Craig and Tracy make a very important distinction between identifying 'influences' and creating a normative model of prescriptions versus identifying 'dictates' and creating a scientific model of

predictions. In continuing empirical work on the museum studies or on Affector, for instance, I do not propose to start with formal hypothesis to be confirmed or rejected. Instead, the empirical work consists in observing how participants and designers alike respond to and anticipate different choices.

Anticipation is similar to but markedly different from prediction. Prediction has clear lines for success and failure whereas anticipation is informed but not restrictive. If we consider prediction a situated ideal of scientific problem spaces and anticipation a situated ideal of interpretive problem spaces, it is interesting to consider how the same techniques might be employed to serve both. For instance, statistical measures need not serve only for verifying truths or rejecting falsities, but could serve the ideal of anticipation and probabilities. Finally, Craig's overall interest in people's everyday theory making regarding their communication also reclaims some elements of empiricism for interpretive studies. Whereas empirical studies have become associated with 'objective' measures, grounded practical theory is keenly interested in subjective accounts. People's own assessments of why they make certain choices and the way people talk about their choices are critical for identifying the situated ideals or norms driving these choices. This resonates with both the approaches in the museum studies and in Affector where the participant's analysis of what was happening was a key source of data.

The move away from verification studies where the desired result is a single interpretation called for the identification of new criteria. Based on the case studies, I proposed criteria such as the level of engagement in the evaluation, the irreproducibility of results, and the catalytic validity of studies that encourage participants to see things in new ways or seek out change. The

criteria explored within grounded practical theory and the related sensitizing theory approach suggest a related criterion: usefulness for reflection. I had previously considered reflection as the type of design strategy, but in this framing it stands as a valuable criterion as well. In Craig and Tracy's interventionist style of testing, the results from Affector and from the museum case studies should be shared with participants in order to determine if the heuristics are taken up in how people reason about or make sense of their experiences. As with our case studies, this blurs the line between design and evaluation when results become input as opposed to output. As Craig and Tracy note, this shifts the emphasis from testing existing theories to constantly generating new theories, identifying emergent ideals and then challenging them in the next iteration. In order to take these lessons further in the case studies, a thorough examination of practices from action science and generative theory would yield valuable insights of this practice in continual theory generation.

Finally, one of the challenges noted within the grounded practical theory approach is preventing the normative, or the prescriptive, from turning into the descriptive, predictive and restrictive. When results are presented as 'what is', these can then in turn perpetuate into what must be. For instance, the starting point of grounded practical theory is with 'problems' or tensions that require choice. But, as critical theory practices have demonstrated, and as the case studies in the previous chapters illustrate, the framing of problem spaces is often guided by unseen choices. In other words, if we only focus on existing problems, such as how to provide more information about art to visitors in the museum, then we may ignore marginal or unexplored design spaces. This is related to the argument for enhancing critical technical practice: instead of only

engaging when there is a breakdown in the technical modeling, one should also question why certain breakdowns happen and not others or what interesting new breakdowns could lead to different practices. This suggests that instead of modeling the three levels of grounded practical theory as linear with the middle layer affecting the top and bottom, a circular model would allow for considering how the problem layer becomes defined.

Communication Theory and HCI Design

The parallels between movements in communication theory and in HCI indicate how both fields could benefit from comparing and contrasting practices. The question in this section is how crossing over from communication theory to HCI influences design. One argument is for keeping them separate, recognizing their similarities but keeping a conscious divide between the practice of communication theory and the practice of designing communication or other HCI systems. For example, Shepherd, Striphas, and St. John (2006) describe the unique role of communication theory as being one step between highly abstract theory such as philosophy and highly practical work such as media production. Communication theorizing that becomes design work, in this view, ceases to occupy this unique space. This view is similar to critical theory approaches to technology design. The goal of this discipline is to describe how technology design happens and the implications of design assumptions and choices as they play out across history and cultures. The role of the critical theorists is as observer, documenter, and commentator, not as designer. Likewise, many communication theorists have adopted design as a subject matter for study but not a practice of their own. For example, in computer supported cooperative work (CSCW) studies, organizational and interpersonal

communication theorists examine how people use computing systems for collaboration. As another example, communication and social science researchers interested in computer mediated communication (CMC) explore how new media challenge or support existing theories of communication. In both of these examples, the line between researcher and designer remains distinct.

Yet, cross-overs between communication theory and HCI design do occur. Sometimes, this influence is unintentional or indirect. Because the field of communication addresses everyday discourse, Craig (2006) argues that it can be 'picked up' by people as it becomes part of popular culture. He suggests this happens through concepts such as 'information overload[51]' gaining media currency or being taught on university campuses. By extension of this argument, some of these people and students who 'pick up' communication theory could be or become designers who then trade on these ideas in their designs. Secondly, and a related idea, communication theory that becomes part of everyday discourse and practices of communication creates expectations and needs for how communication will occur. This, in turn, can influence the needs analysis or requirements process designers go through when creating systems to support communication. Just as the popularization of communication theories may influence designers, the popularization of design ideas may ultimately influence communication theorists and the cycle continues. For instance, the rise and advancement of information theory was spurred largely from developments in computing and

[51] Craig credits communication theorists with popularizing this term although according to wikipedia, it was coined by Alvin Toffler, an American writer and futurist.

communication systems. This theory in turn played a large role in the development of communication as a discipline

Apart from these indirect links, this section will look at more direct, intentional examples of communication theory influencing or providing a resource for system design. I will examine three different examples referred to here as the blueprint approach, the measures into design approach, and the affordances approach. The first two examples will be discussed only briefly as they are less applicable for the design for interpretation or design for openness I wish to explore. I will examine the last approach in more detail through a case example of how the communication theories discussed above could augment resources for addressing a desired design space. I will end this section with reflections on using communication theory as a resource for design for future iterations of the museum installations and Affector.

Theory as Blueprint Approach

In the blueprint approach, communication theory acts not as a resource for understanding a design space but as a predetermined script. It acts not in the normative fashion as described by Craig and Tracy above, where prescriptions of what ought to be are also subject to challenge, but instead results in normative rules becoming codified into the system. One ill fated example of designers drawing on communication theory as a blueprint for design is offered by Suchman (1993, 1997) in her critique of Winograd and Flores' use of speech act theory for the design of a collaborative system called The Coordinator. In this system, the user is instructed to tag his or her communication with illocutionary force labels (e.g. "Informing", "Requesting", "Promising", etc.). Interestingly, Winograd and Flores argued against giving this type of control to the computer system through natural language

processing (NLP) either because NLP at the time was not up to the task or because the situated nature of illocutionary acts would always require human intervention. By creating a facility however that required people to make their implicit intentions explicit, Winograd and Flores believed this would ease the coordination process as well as educate people about their specific and the general practice of communication.

However Suchman and others (e.g. McCarthy and Monk, 1994; Shapiro, 1994; Button and Dourish, 1996; McCarthy and Wright, 2005) point out the dangers of this approach. In Suchman's analysis, Winograd and Flores were actually violating the theory they sought to uphold, namely Austin's (1962) and Wittgenstein's (1958) view that language happens in action and that it is impossible to theorize language apart from its use. When Winograd and Flores used Searle's (1969) taxonomy of speech acts, they were positioning this ordered taxonomy as components of a 'plan' that a speaker follows implicitly. What the Coordinator would do is help the speaker articulate this plan. Yet in Suchman's analysis, language use (and the identification of language acts) occurs in action – specifically in interaction, not prior to action. Therefore, rather than supporting language as a collaborative activity, the Coordinator resulted in a very controlled, hierarchical, and scripted form of communication.

One assessment of this example could be that Winograd and Flores simply picked the wrong theory. Suchman notes, for instance, that speech act theory has been subsequently attacked by conversation analysts for overlooking the interactional structure of talk. Yet, McCarthy and Wright underscore the more challenging issue. Winograd and Flores espoused a view of language and action as self-regulating, as something that a structure could

not be imposed on. It was from this perspective that they challenged the rational foundation of computer science and argued instead for a phenomenological approach. Yet, when attempting to use a theory of language that resonated with this view in design, they contradicted of their own intentions. The question remains then of how to use theory of construction to guide design without reifing the theory as dictation.

Measures into Design Approach

A second example of how communication theory may directly influence designs is when measurement techniques developed through theory become incorporated into systems. This example is closely related to the physiological measures section discussed in the chapter on affect. Physiological measures, such as heart beat or galvanized skin response have a long history in detecting an individual's emotional state. As these measures continue to gain popularity, they are becoming incorporated into affective computing designs, such as a video game that will respond to a player's inferred increase in excitation or stress. Likewise, psycholinguistic theories also have a long history of detecting cognitive and emotional states through the word choices people make in their communication. Linguistic analysis involves strategies such as counting the number of words used as well as the word content (what people talk about) and the style of word choice (how they talk about it) to determine qualities of the individual and his or her intent (Pennebaker, 2002). In the past, this counting and sorting analysis happened by hand but eventually became a prospect for automation through the development of software and algorithms for classifying words based on either identified or emergent patterns of language use. An example of such a program is the Linguistic Inquiry and Word Count (LIWC) application developed by James W.

Pennebaker, Roger J. Booth, and Martha E. Francis[52]. Pennebaker refers to some of the new methods employed within LIWC as 'meaning extraction methods' that use word choice, such as the frequency of "I" versus "we", to detect personality traits as well as detecting behavior such as the act of deception.

The conceptual leap from software used as an aide to help researchers analyze language patterns to software that designers employ to build systems that respond to language patterns is an easy one to make. I have already presented one example of such a system, the Batliner et al. (2003) study in the chapter on affect, with the automated call-in help center that used linguistic analysis to determine a caller's level of frustration. In this study, the researchers described how system performance deteriorated when the call-in systems moved from the laboratory to the field. They concluded that the models measuring frustration needed refining to focus on odd linguistic behavior and repetition in addition to prosody. Yet the conclusion from a perspective of affect as interaction as opposed to information suggests that refinement of the model still proposes that affect is found as opposed to emergent or created in interaction. In other words, the poor performance may not be improved by making the model more complex. This same caution is warranted when thinking about how to apply LIWC software as the input mechanism for other applications. It is one application for the LIWC software to extract meaning for a researcher's analysis and interpretation, but it is another matter when this extracted meaning has implications beyond a user's control. In this scenario, the criterion of accuracy is not simply a measure of success but an essential requirement. The call-in center example may not

[52] See http://www.liwc.net/

raise red flags, but imagine a LIWC enabled system for sniffing out deceptive practices in a corporation through analysis of email. A small margin of error should not be tolerated. Yet, if meaning is constructed through language use and not extracted from language production, building a system around the assumption of exact meaning must be handled with caution.

As an ad-hoc experiment, I tried two online LIWC demonstrations that proposed to analyze my writing style and extract information about my personality[53]. In the first test, I was instructed to look at a picture of two female researchers in a chemical laboratory and write about the characters for ten minutes. According to what I wrote, my need for power, affiliation, and achievement are below average. I used zero self references and was below average in my use of social words. I was above average in references to both positive and negative emotions and in my use of big words. I found the low scores on power and affiliation interesting because I had been trying to write my story about the researchers as a power struggle drama – the women affiliated with each other against the male establishment. But something in my word choice or style did not register this through the LIWC.

On the second test, I looked at a picture of a branded water bottle and was told to describe it in writing to someone who couldn't see the bottle for 5 minutes. The results of my sample suggested that I was a highly functional and tactile thinker and about average in verbal, visual and contextual thinking. What I found interesting in this test is that I had interpreted the instructions as meaning I was describing the bottle to someone who is blind – not that they can't see the bottle but that they can't see anything. Therefore, I was very

[53] See the TAT test (http://www.utpsyc.org/TATintro/) and the bottle test (http://utpsycorg.liwc.net/Bottle/) from James Pennebaker's research group at the University of Texas, Austin.

careful to describe things that I thought would be meaningful for a blind person, such as what would you do with it and how it might feel if you held it. These tests were not taken under experimental conditions and I am not presenting my experience with them as evidence for or against the strength of LIWC. Instead, I present them as a thought experiment. As an exercise, I enjoyed seeing what the system had to say about my writing and I enjoyed the chance for reflection on my personality and how I might demonstrate it in my writing. What I found troubling however was contemplating a scenario where this personality information is used as input to a system without my ability to intervene or negotiate with it the meaning it has extracted.

An alternate example of using linguistic measures as input into design is demonstrated in Böhlen and Mateas's Office Plant #1 installation, also described in chapter three. This robotic sculpture of a plant responds to a linguistic analysis of a user's email traffic and assumes different shapes and emits various sounds based on this analysis. The movements between states for the office plant are quite slow, the user will likely not notice change as it is happening but will only occasionally note that the sculpture has changed form. When this recognition occurs, it is an impetus for reflection on what traffic may have caused such changes. In this system, the reflective potential of the linguistic analysis is shared rather than hidden.

Both the blueprint and the measures approach for design run the risk of enabling the Platonic forehand introduced in chapter one. The Platonic backhand is the abstraction process of theory making, such as Searle's identification of various speech acts, or model making, such as a textual classification of positive or negative words. The Platonic forehand then comes in when these abstractions begin to stand for and direct the emergent

meaning. The theory and measures no longer describe what is happening but they direct what happens next as they become codified in the design.

Affordances Approach

The final approach to how communication theory can influence design is intentional but more indirect than the blueprint or measures approach. In other words, its indirectness is not the same kind of osmosis or casual 'picking up' that Craig described earlier but instead involves purposeful reflection. This approach takes its name from the idea of affordances first put forth by environmental psychologist J.J. Gibson (e.g. Gibson, 1979) and popularized in design by Don Norman (e.g. Norman,1988). Affordances are not one to one mappings between actions and material attributes, nor are they one to one mappings with specific qualities of a situation or traits of an individual. Instead, affordances describe a narrowed range of possibility through the interaction of material form, context, and individual traits including experiences and expectations. Gaver (1996) explores the idea of social affordances with the example comparing the desirable location of top floors (i.e. away from street level) for an office setting versus the desirable location of bottom floors for a retail setting. The affordance in this example is not 'elevation' but 'accessibility'. Elevation describes the material form or property of being higher or lower. But the affordance of accessibility begins to explain why the different settings would value one form over another, i.e. a retail store would prefer easy foot traffic whereas an office would not. It is important to note that affordances describe potential actions, they do not dictate actions. For instance, a retail store may desire a top floor to convey a level of inaccessibility and therefore exclusivity.

For communication theory and design, the affordance approach advocates a deeper understanding of why certain conventional practices develop – what affordances emerge through the combination of people's needs and expectations, context, and constraints of material artifacts. For instance, in a previous section Myers (1999) critiqued the techno-determinism view that tends to ensue with the introduction of any new technology. With the introduction of the internet, scholars predicted and attempted to gain evidence for how the lack of social context and the isolation of connecting online would lead to loss of community and de-individuation. However, by taking a step back from this one way approach of form dictating action, communication theorists interested in the flexibility and tenacity of people's ability to express themselves and form community could lead to anticipating how the constraints of the new medium will be re-appropriated for these ends. If for example, community or individuality is considered an affordance, then understanding the effect of new material constraints becomes a type of contingency theory building where one looks for what variation of material constraints, situations, and practices will enable this affordance to still emerge.

As another example, Aoki and Woodruff (2005) recently looked at how the affordance of ambiguity is influenced by different constraints of personal communication systems (PCSs) such as mobile phones. Aoki and Woodruff referred to this ambiguity as 'space for stories' or multiple interpretations. In particular, they were interested in how space for stories in communication exchanges allows for face saving practices, such as when person A fails to call person B back and can later explain his oversight because of being out of town, or missing the message, or being sick, etc. Aoki and Woodruff's central argument is that the goal for 'perfect communication' design in PCSs is

infringing upon the space for stories and subsequently the ability to be unresponsive while still maintaining harmony in a relationship (what they identify as 'saving face').

Aoki and Woodruff argue that features of mobile phones such as being 'always on' or transmitting more information about our communication partners will reduce the ability to be unresponsive and still save face. As a reversal to this trend, they suggest the need for designing space for stories, or designing for ambiguity and openness. As an example of such a design, they develop the construct of a lease service for mobile phones. Similar to the idea of buying a bank of minutes, a person can purchase a bank of leases for different communication partners that have varying conditions such as expiring out of lack of use or over time. The benefit of such leases, according to Aoki and Woodruff, is that if a person no longer wants to continue communicating with a partner, he can simply let the lease expire. This effectively would allow the person to avoid having to discontinue contact directly or if confronted about the lack contact, he has an array of stories handy: e.g., the lease expired and he forgot to renew it, or he doesn't have enough funds to renew it, or he can only afford so many leases at a time. However, what happened in the transition between wanting to design space for stories and in proposing the lease idea is that Aoki and Woodruff switched from designing space to designing stories. They switched from ambiguity emerging from the situation to trying to design ambiguity into the lease service as a feature. In examining this move, Hancock and I conducted an analysis of how communication theory, particularly theories of language use discussed in the previous section, could ameliorate this slippage (Boehner and Hancock, 2006).

Our first move in addressing the weakness of the lease design from Aoki and Woodruff was to demonstrate that in all communication, space for stories exists. The space for interpretation may be more or less open, but every communicative act is a presentation of evidence based on interpretation, followed by another act of interpretation. As Peters (1999) argued, even face-to-face communication must navigate the gap of difference whereas in the Aoki and Woodruff argument face-to-face communication was positioned as less open to interpretation than mediated communication. This argument led Aoki and Woodruff to warn that by attempting to stop the gap with ever more present and pervasive communication devices, we could effectively close this distance, and remove the space for explaining away unresponsiveness and saving face. Yet current perspectives on communication theory suggest the gap is ever present. This move suggests that it doesn't matter what Aoki and Woodruff or designed. However, our second move was to challenge the assumption that more information is mapped to less ambiguity. As discussed in the previous section on ambiguity in communication, the relationship between amount of information and degree of openness to interpretation is not linear. More or less ambiguity may emerge in a situation but it does not map directly to the amount of information available. This returns us to the rethinking of common ground: not as a binary relationship between common ground and uncommon ground or between understanding and misunderstanding, but something more nuanced like Shepherd's idea of sympathetic awareness. If we think of interpretations between people (or a person and a system model) as isomorphic, then we would design for exact communication or exact miscommunication (such as in the case of the

leases). But if we think of communication as a continual approximation then we design for space.

By drawing on communication theory, we returned ambiguity from a design strategy or attribute to an emergent property or affordance of how the situation, people, and material artifacts interact. Furthermore, we speculated why this kind of slippage and the technodeterminist tendency described by Myers often happens. When new technologies are introduced, often the most salient aspects of the situation are the new constraints of the medium, in particular how it might limit or alter current forms of communication. This difference makes these features stand out – their salience increases both for designers and for users. But over time, users either work around or with these constraints, developing new conventions and practices that begin to have more salience than the particular material form. Salience changes over time. For instance, Aoki and Woodruff examined how a group of college students interacted in an experiment with a push to talk radio, yet they failed to elaborate the context of the interactions, i.e. they failed to describe the baseline salience of the radio's features. The context, such as the students' familiarity with such radios or the framing of the experiment, is critical for understanding how ambiguity emerges with the constraints of the medium. The same experiment with a group of emergency relief workers or security guards familiar with such radios would likely tell a different story about how the attributes of the radio led to the affordance of ambiguity.

This turning to communication theory not only provided a way in for understanding how the objective for designing for space quickly turned more into designing stories, but also led to the development of a number of design ideas or heuristics for keeping the story space more open. We proposed five

design ideas and examples (Boehner and Hancock, 2006) described briefly here.

1. Design for Opposites: in order to leave space for stories, the constraints of the system should enable opposite experience. In the case Aoki and Woodruff were designing for, the constraints should support both responsiveness and unresponsiveness. For instance, the lease idea only seems to support temporality, otherwise, why lease? Consider instead the effectiveness of Caller ID for both choosing to accept a call and choosing to decline a call.
2. Design for Salience: conventions form around information with joint salience – information or interpretations that people through experience and expectations agree are the most prominent. Designs that increase points of reference that can be shared and made meaningful in use increase the opportunity for making interpretations. For instance, we proposed building phones that provided even more information about the situation – such as the signal strength of the caller and the callee at the time of the call. In this example, both the caller and callee would know what the other knows in terms of the call. This increase in information can lead to new space for stories as opposed to less. Overtime, this information may become a critical part of the story space or it may not.
3. Design for Something Else: this is a call for oblique design. If the goal is to support the ability to be unresponsive then design for some other activity with an eye toward how this might be appropriated for unresponsiveness. For example, the eMoto system (described in chapter three), was designed for communicating emotional tones in

multimedia messages. A receiver of a message might draw on this emotional information as an explanation for why there had been a delayed response (e.g. ‘Oh, she seems sad’) thereby preempting the need for her partner to explain her delay.

4. Design for Extremes: this heuristic pushes on the idea of shared culpability (e.g. blaming the lease) suggested by the leases and pushes it to its extreme. Imagine a personality phone that has an agent with its own unique personality. It may randomly decide when to delete messages from your voice mail. Whereas the lease idea is designed for specific targets, the randomness of the personality phone appears less premeditated. (see Figure 23).

Figure 23. A phone with a hang-over.

5. Design for Over-Interpretation: this heuristic for keeping the design space open suggests starting with the original intended interpretation and augmenting it. For instance, rather than explaining away unresponsiveness, why not draw attention to the unresponsiveness?

This led to a design idea for a pause embellisher in instant messaging. Some IM clients show ellipses when someone in typing, but nothing is happening when there is a pause in the conversation. A long delay could mean the other person is thinking, he got a phone call, he went to the bathroom, etc. The pause embellisher would create some kind of animation visible by each party allowing another explanation for unresponsiveness, “sorry, I was watching my pause.” (see Figure 24.)

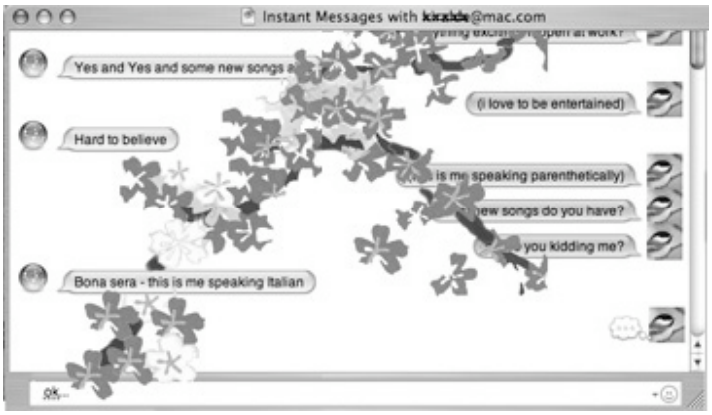

Figure 24. Cherry blossoms taking over the screen in the pause embellisher.

These design ideas are offered as works in progress. I imagine not many people would sign up for a phone with a hang-over that could potentially lose important calls. The point of illustrating these ideas was to attempt to think about ways of designing for openness and in particular to demonstrate an alternate approach for using communication theory to influence design. In developing these, we drew from communication theory and the idea of ambiguity as an affordance, a property defining the range of potential interpretations based on material constraints, the situation, and the people involved.

Lessons for Communication Theory in HCI Design

The descriptions of the various approaches for linking communication theory to design explore the benefits and obstacles of crossing between the parallel tracks. In terms of obstacles, both the blue print approach and the measures into design approach describe scenarios where the theory of what is becomes codified into what must be. Although with the measures approach, I also outlined how using measures such as linguistic analysis may draw attention to norms or patterns of communication, in the Craig and Tracy sense of grounded practical theory, and in doing so cause an opportunity for both reflection and change. The approach I explained in the most detail was the affordance approach. In this approach, communication theory is a resource not a plan of action for thinking about emergent affordances, in this case the affordance of openness to interpretation or ambiguity.

Specifically, the critique of one approach toward using ambiguity to design for unresponsiveness led to the development of five design ideas or heuristics for thinking about affordances instead of attributes. These design ideas could spark suggestions for reconsidering the museum installations and the Affector program. For example, the design for opposites call suggests that in focusing only on the alternate experience of presence I limited the type of interpretations. Perhaps if I created displays that equally augmented the art on display and the presence in the gallery, this would allow for more openness in interpretation. The suggestion to design for salience points to the suggestion that arose in the Affector installation for depicting not only the partner, but what the partner sees. Providing this kind of mutual feedback is commonplace in video conferencing systems. It would be interesting to experiment with whether or not this kind of feedback is seen as useful or if Affector works only

through its indirect instead of intentional communication. The design for something else was also partly a conclusion through the design of Affector. The project began with a desire to display 'affect' but then progressed toward more and more oblique or indirect proxies of affect. To design for extremes, I could imagine using this in the museum installations to direct displays toward extreme presence situations – for instance designing for when a visitor is the only person in the gallery or designing for when a particular room is near capacity. The extremity of the situation and designs might catch people's imaginations and resulting interpretations more vividly. Finally, the design for over-interpretation suggestion is similar to the previous one except instead of designing for an extreme situation, an ordinary situation is made more extreme. For example, in Affector, we moved toward augmenting change that reached a certain threshold so that large movements such as leaning back in one's chair would fire lots of distortion effects. Yet, it might also be interesting to think about small indiscernible movements that we would not pick up or notice with the naked eye but could demand attention in the Affector window. For example, we could focus the Affector lens only on the computer keyboard to capture only the movement of their hands, or a shot of their left foot, or train it on the person's eye. Augmenting invisible movements might cause different types of reflections and interpretations of activity and therefore mood.

This list of heuristics then provides a useful set of prompts for both thinking about how the case studies evolved and why certain aspects of the designs may have worked as well as thinking about alternative implementations to try. At the same time, however, this list is not complete and it was originally developed in response to a different design scenario (ambiguity and unresponsiveness). Its usefulness is as a thinking tool, not as a

checklist. As a checklist, I would simply be substituting communication theory as a blueprint for another predetermined strategy. Instead, in the spirit of the mid-range theories explored by Kia Höök or the sensitizing schemes of Baxter (described earlier), design heuristics or ideas that result from considering the interplay between theory and design are useful guides. Overall the biggest benefit from communication theory for the case study designs, has been in refining the concept of what it would mean to design for openness to interpretation.

Design as Process for Communication Studies

The previous sections of this chapter explored how existing and new developments in the study and theory of communication, in particular language use and ambiguity, could inform a practice of designing for openness to multiple interpretations. In this final section, I will look the other way, namely in terms of how insights from the practice of design influence the field of communication. Some of these ideas have been explored already in drawing parallels and identifying cross-overs between the respective fields. I will return to these themes in the following treatment of four important areas where HCI design offers insights and opportunities for the field of communication. These areas include: refining concepts and criteria, the expanded role of participants, the challenges of interdisciplinary work, and the increased interest in the arts. Before I introduce these areas, however, I will begin by first clarifying an orientation toward design as a process, and how it is this orientation I believe to be the most valuable for communication.

At a recent seminar on constructing theory in communication, M. Scott Poole identified design theory as a promising new area for communication

studies[54]. This relevance is partly due to Poole's aforementioned observation that although many in the field define communication as a process, there exist few methods for studying communication as a process. Model building in computing design offers one process approach, but he suggests that system building (and subsequent study of use) presents a further addition to the toolkit for process studies of communication. Yet, in reviewing Poole's summary of design theory and his selected articles as exemplars for system building, it appears that Poole is drawing from a very narrow view of design. Poole's view of design does not benefit from many of the current developments this dissertation has sought to highlight, in particular the practice of reflective design.

Poole presents an instrumentalist view of design – one of building systems as solutions to existing problems. His description of the practice of design is very aligned with an empirical and traditional HCI approach. With this model, the practice of design becomes a method for testing communication theories in the same manner that an experimental study design can test and refine a theory. This idea can be further illustrated by a figure from one of the exemplary articles on design identified by Poole (see Figure 25.)

[54] Comments on Poole's perspective for design theory are drawn from his handouts, including an outline of 'Design Theory' and his slide presentation during his presentation of "The Study of Process in Communication Research: Old Wine in new Bottles and New Wine in Old Bottles", seminar at Cornell University's Communication Department, Oct.21, 2005, Ithaca, NY.

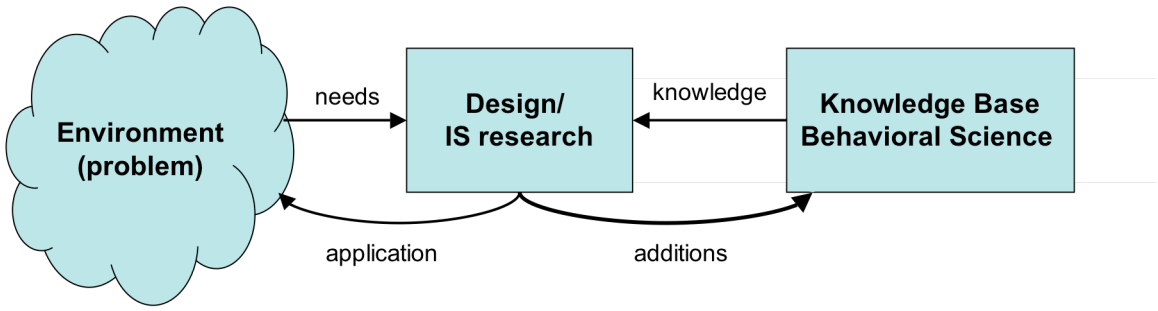

Figure 25. Modified model linking design and behavioral science (Hevner, March, Park, 2004).

In this model above, the design starts with an assessment of a problem in a particular environment and draws from both existing design science research and from the knowledge base of behavioral science research. Once relevant knowledge is consulted in response to user needs, an instantiation of the design is placed in the environment. Evaluations of the design in use and the process of the design generate new additions for the behavioral science knowledge base. The authors of this model state that this approach of explicitly linking behavioral science knowledge with design research knowledge and practice brings together the 'truth value' of science and the 'utility' of design. As they state, "truth informs design and utility informs theory" (Hevner, March, Park, 2004, p.80). It is statements such as this that then leads Poole to identify the overriding criteria or standard of design theory as one of utility and effectiveness and to push for an objectiveness view in both the process of design and the process of evaluation.

Although the instrumental view of design is feasible, if the caution against the blueprint method is observed, the narrowness of this definition of design limits the benefits for communication. Instead, I propose that a broader view of design will be more beneficial. This broader view has been identified as reflective design, a practice inspired by Agre's critical technical practice of

moving computational science beyond its narrow focus on ‘what works’ to considering why problems are framed in a particular way in the first place. Agre’s practice is one of following breakdowns or outliers as an impetus for rethinking the boundaries of a design space, i.e. the centers (what is focused on) and the margins (what is excluded or taken for granted). What reflective design adds to this formulation is not just a focus on why certain problems occur or how problems are framed, but the impetus for asking these questions prior to any breakdown. If traditional design asks ‘how can we fix this problem’ and critical technical practice asks ‘why do we consider this a problem instead of that?’, reflective design asks ‘what new opportunities arise if we invert the margins and centers of our design space?’ This view of design is very different than the one Poole proposes to follow. Poole’s approach to design may be beneficial for periods that Shapiro (1994) identifies as having ‘theoretical confidence and coherence’ where the relationship between theory and application is a directional one with application subordinated to theory. Yet, in cases where theory is in a process of redefinition and exploration, such as the case in the movement in both design and communication for considering interpretation not as an isomorphic goal but a muddling through of multiple possibilities, then this instrumental view of design may be less appropriate.

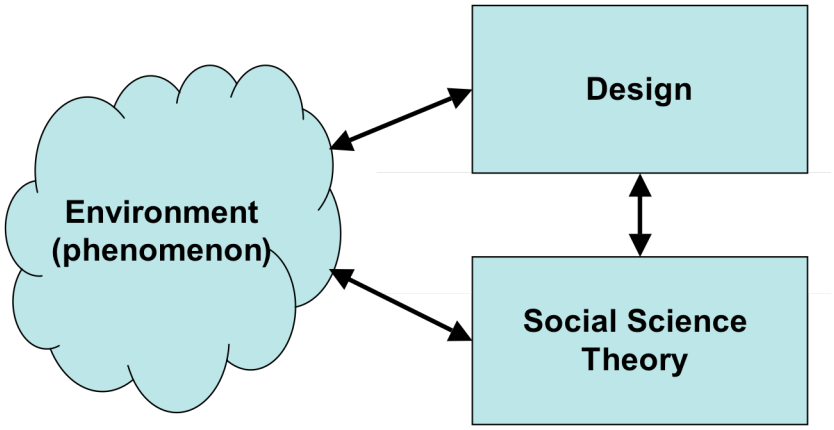

Figure 27. An alternate view of designing as a process of theorizing

In the model above (see Figure 27) depicting the relationship between design and social science theory, I have modified the previous model to communicate how design and social science theory are responding to the same environment but offer different lenses for framing and approaching the phenomenon in question. The phenomenon in question may be a problem or well functioning state. The difference with this model is it allows for both parallel developments and for one to 'drive' the other. But, most importantly, what I want to try and convey with this model is that designing is a way of theorizing[55]. It is at this level, understanding how constructs are identified and modeled, understanding the criteria that directs the research, understanding the values that underlie these criteria, etc. that dialogue between design and communication theory are interesting. With this new orientation of design, not as an instrumental method for solving problems in the world, but as a way of

[55] This argument of design as a kind of theory-making is similar to the link between the social science theory of ethnomethodology and the practice of system design that Button and Dourish (1996) make in their development of technomethodology.

participating in and conceptualizing the world, I can now turn to specific areas where I believe HCI design can offer insights for the study communication.

Concepts and Criteria for Evaluation and Design

An alternate view of design than the one Poole proposes of an instrumental step from problem to solution is to consider design as a satisficing step (Shapiro, 1995), or making best possible choices, in uncertain environments with a range of possibility. In this sense, the process of design is not unlike the process of communication. Despite uncertainty, despite the range of options, despite the multiplicity of interpretations, design is about making choices. Design, as with communication, is a process of 'making do' with material, social, economic, and cultural constraints. I mention the pragmatics of design because the move in communication theory toward one that acknowledges multiple, instead of mutual or joint, interpretations could draw criticisms and charges of relativism. It could suggest a futility to any attempts to understand the process of communication. Yet, the discipline of design has a history of moving forward in the face of uncertainty and unending choice. Furthermore, a design approach that advocates a move toward anticipation as opposed to prediction does not deny that predictions happen or that a level of realism exists in our world. For example, the levels of interpretation proposed by Sengers and Gaver (2006) suggests that perhaps predictability may be more appropriate at the level of the physical or material environment whereas higher levels of interpretation are more open and less under the designer's or communication theorist's ability to control and predict.

As HCI designers release themselves from solely evaluating systems in the model of empirical science, the practice of evaluation opens up. In the case studies I described a number of challenges for evaluation related to the

relativism critique. If all systems are open to interpretation, how do we determine whether more or less interpretation has been achieved, or in fact is desirable? One approach in moving forward within reflective design has been to draw from alternate criteria to scientific constructions of validity and reliability. A rich history of qualitative criteria exists proposing alternatives such as confirmability (e.g. through checking results with participants), dependability and confirmability (e.g. through peer auditing), and authenticity (e.g. demonstrating a range of views represented) (Lincoln, 1995; Seale, 1999). These studies emphasize that rigor is achieved through practices of deep inquiry and thick descriptions, not formulaic application of existing methods (Springgay and Irwin, 2005). Seale (1999) advocates, for example, that researchers considering methods as a form of craft apprenticeship, learning a range of methods but modifying them as the circumstances and their own personal style dictate, in much the same way that an apprentice learns and embellishes from a master artist the basics of painting, drawing, and sculpting. In this view, reproducibility is less valued as is personal accountability (i.e. identifying the researcher's own fingerprints) and ecological relevance. The interest in approaches to qualitative inquiry also responds to the charge that designing for particularities implies that no grander lessons may be learned – that each design is a design from the beginning and for a unique situation. Yet, the qualitative criteria of transferability argues that sensibilities and themes can be found across contexts but it is not as simple as abstracting from one sample population to a similar representative population. An example of taking up this idea of transferability in design research will help unpack this further.

In a recent HUMAINE workshop[56] on evaluating affective systems, Daniel Fallman presented the repertory grid technique as a design/evaluation method. In a repertory grid, users are asked to generate polar constructs to describe something (e.g. a system, an object, an experience) in a way that is personally meaningful to them. For example, in Fallman's lab they have asked users to generate polar constructs to describe shapes resulting in paired constructs such as roundish/squarish, organic/synthetic, clever/not clever. Once a user has generated a construct to describe a shape, the user then rates the shape, e.g. very round to very square and does the same for all the shapes to be reviewed. Fallman stressed that the strength of the repertory grid technique is in the user's creation of the constructs rather than something like a semantic differential technique or a pre-made scale where the researcher makes the constructs. In the latter case, the researcher knows what he or she means by the construct and has to infer if it has the same meaning for the user. With repertory grids, the situation is reversed. The user knows what he means regarding a construct and the researcher has to guess what this is. What this suggests then is that the grids are a useful technique for surfacing constructs and features that are meaningful to users but what exactly they mean is left open.

More pertinent for this discussion, however, is Fallman's observation that when they used the grids to attempt a more systematic analysis across users, for example collapsing constructs by similarity and trying to measure dominant experiences, they ended up with what he considered 'boring' results. For instance, they might learn that the majority of users interpreted a square

[56] http://emotion-research.net/publicnews/chi05ws/view

shape as being more ‘square like’ than the circle shape. What the grid ended up being more useful for was inspiration – finding perhaps an idiosyncratic construct that a user came up with and using this as a basis for future exploration. In other words, when trying to find general lessons about the shapes across users, or for a certain type of users (e.g. women versus men), the results tended to abstract away anything interesting and smooth over the inspiration found in the peculiarities. This is a shift then from analysis to inspiration, a shift from evaluation of results to evaluation as design. But, what the designers found was that these inspirations from a peculiar source often led to the implementation of designs with a broader appeal. This speaks to the idea of transferability, yet further work is needed in order to understand this move.

The inspiration approach to design and evaluation must be balanced, if conducted as a form of research, with the other criteria mentioned such as authenticity. One danger in solely pursuing peculiarities is that single isolated cases could again serve to smooth out the range of differences across users and contexts. If a design researcher only chooses to display the results that speak to him, that make his point, that stand out from the array of more humdrum results, the danger is that instead of an over-reliance on methods what results is an over-reliance on the cleverness of the designer. Yet the combination of criteria, especially those for acknowledging any filters that a designer/researcher puts on results, offer helpful guides for both design and communication theory in addressing practices that are open to interpretation.

Role of Participants

The above discussion about criteria that engage participants alludes to the next area I will describe where HCI design can inform the study of

communication. HCI design has a long history in challenging the privilege of the designer as the authority on the shape and declared success of a given design. Movements such as participatory design, user-centered design, and reflective design have developed strategies for bringing users into the design process as equal stakeholders. Each of these practices has a slightly different focus – participatory design for example brings target users into a design process once a design problem as been established, user-centered design advocates following users in the initial scoping of a problem or design space, and reflective design positions the designers as a provocateur encouraging reflection on existing and new design opportunities where they might not have existed before. But in all three of these traditions, participation from the 'user' is critical.

Participation of 'subjects' in communication research is not a new phenomenon. In fact, the new APA (2001) guidelines advocate replacing the use of the word 'subjects' with 'participants' to suggest this orientation exists even if the research does not reflect a view of participants as more than a source for data collection. Communication theorists who draw from practices of action science, citizen science, and interpretivist research display a sensitivity toward including participants in various stages of the research process. In interpretivist research for example, Lincoln (1995) encourages researchers to commit to a level of relationality between the researcher and participant and to adopt a criteria of reciprocity marked by openness and sharing as they collaborate in what she refers to as the reflexive practice of inquiry. A helpful way to examine the balance of reciprocity is to ask the simple question of every study 'for whom' and 'for what purpose' is the research being done (Lincoln, 1995).

Although participation is becoming a more popular idea within traditional empirical approaches to communication studies, much can still be learned from further advances in design. Reflective design for instance advocates bringing participants in to not only the data collection process or as a member check on the results the researcher produces but as a collaborator in the analysis process. In the museum and Affector case studies, for example, I described the principle of dynamic feedback where information normally collected for research purposes is shared with participants at an early stage and is presented in as raw a form as possible. Although the argument in a controlled study is that the display of results would influence subsequent responses and therefore make it difficult to tease apart what exactly is informing a participant's response, this is an important aspect of reflective design. To return to Craig and Tracy's study of grounded practical theory, if a reflective design stance were added to this approach the development of 'situated ideals' would take place through co-construction of ideals by the researchers and participants. Once ideals or norms were identified, the next phase would be to identify how this increased awareness influences further practices (i.e. do they challenge or abide by the ideals) and perspectives (i.e. do they begin to identify or construct alternate ideals). It is this movement to co-interpretation and full participation that leads Sengers[57] to characterize reflective design as a form of engagement as opposed to a critical intervention. An intervention suggests an external researcher shaking things up, but engagement calls for a commitment to relationality.

[57] From a presentation of Senger's practice at the Values in Computer and Information Systems Design Workshop, August 11, 2005.

Interdisciplinary: Working 'Without'

The case studies presented in the previous chapter illustrate the interdisciplinary nature of HCI design. The museum case study drew from museum studies, art history, art, design, critical theory, learning theory and communication. The Affector case study drew from psychology, sociology, anthropology, design, critical theory, computer science and communication. The field of HCI is marked by its interdisciplinarity just as the field of communication is. Whereas the challenges of working across boundaries tend to be accepted in HCI, the interdisciplinarity within communication is often portrayed as a crisis or lack of cohesiveness. The diversity has led to the field being described derogatively by its own as 'actively ignoring each other', 'a mad hatter's tea party', and 'drafty' (Craig, 1999; Myers, 2001; St. John, Striphas, and Shepherd, 2006). St. John, Striphas, and Shepherd in their 2006 book on perspectives of communication argue for not just greater cohesiveness in the field but more rigorous debate to fend off postmodern paralysis and 'a thousand flowers bloom' mentality that threatens to choke promising seedlings in an overcrowded plot. This climate suggests that an open arm reception might not be forthcoming to yet another perspective of communication (i.e. communication as design or design as communication).

Yet, the synergies between the idea of centers and margins in reflective design (from Agre's critical technical practice) resonates with the view of scholars in the field of communication, such as Craig (1999), who recognize that the differences within the field are largely an issue of foregrounding and backgrounding. For Craig, each different school of thought in communication takes some aspect of communication for granted while highlighting other aspects as requiring further examination. The practice of reflective design is

also about drawing attention to what aspects have been designed for and what aspects have been ignored or marginalized. The interdisciplinary work of reflective design forces researchers to make assumptions apparent and open to debate since they cannot take as a given that their collaborators share the same assumptions and background. The implication for communication is to consider both the differences within the field and crossing borders into other fields not as a threat to the identity of the field itself but as an opportunity for continually refining and re-imagining this identity.

Finally, the perspective of researchers within the arts, a practice that could be described as transgressing boundaries, provides a compelling orientation on the nature of interdisciplinary work. From an outside perspective, interdisciplinary work seems to be an additive process – an accumulation of a greater range of methods and criteria from which to pick and choose. Yet Springgay and Irwin (2005) argue that from the inside, interdisciplinary work is not a patchwork of practices but to some degree about "a loss, a shift, or a rupture where in absence, new courses of action unfold" (p. 898). They use the concept of 'without' proposed by Irit Rogoff (Phelan and Rogoff, 2001) to describe a position and process that does not depend on an existing well defined problem or methodology. According to Rogoff, the idea of being 'without' is "not a form of negation of existing subjects and methods, or a form of lack. [It] isn't turning your back on, or denying, what you had at your disposal previously. It assumes that you had a model, to begin with. You lived it out, so you got as much out of it as may have been interesting at that point. And you've now found yourself in a position where you're actively doing without the certitudes [but] without as yet having produced a hard-and-fast subject or methodology to replace them" (Phelan and Rogoff, 2001, p.34). This

perspective speaks to a form of interdisciplinary work that is not simply practitioners from different disciplines stepping into the unknown with the certainty of their tried and true methods and frames for research. Instead it suggests spaces of possibilities that emerge in the gaps between disciplines that encourage a fruitful period of uncertainty and questioning.

Movement toward the Arts

The perspective of 'without' proposed by Rogoff is also an example of a growing trend in HCI design of looking toward the arts and humanities for inspiration, collaboration, and the creation of new hybrid practices. An interest in arts-based inquiry is growing in a number of areas of the social sciences as well, including communication. Yet communication theory has mainly approached the arts as an object of study – an artistic practice within the field of study, for example the art of rhetoric or the production of creative media such as film and photography. There is some work in the field on the production of art as a form of social science research, for example the work of Bochner and Ellis (2003, 2006) and their production of autoethnographies for examining the practice of communication. The field lags behind the movement in other disciplines however actively experimenting with different forms of representation of research such as poetry, drama, dance, visual art, etc. (Mullen, 2003). These new forms of research seem particularly suited to the aim of designing for, and subsequently evaluating for, openness to multiple interpretations. As Finley (2003) notes, artist-researchers "deal with openness by creating open spaces and multiple entrances into their work" (p.288) and Barone (2001) consents that playful, provocative and expressive research has the ability to "endow features of our experience with more than a single meaning" (p.24). Yet there are two more important aspects of the influence of

the arts beyond a recognition of more open forms of representation. In addition to the product of art, art is concerned about the process and in at least one current trend this process is positioned as dialogic.

In terms of thinking about art as a process, this again suggests parallels with communication which is also described as being simultaneously a product and a process. But the movement in art I find interesting for the field of communication is not a recognition that process leads to a product but a reorientation of the focus. Instead of the product being the ultimate artifact by which art is remembered, there is a growing interest in art that is ephemeral where the participation in the process of art is the experience and the product remains as the residue, an after-thought, or a memento. Applying this same idea to the field of communication would argue that it is not the final research publication, not the final research results which impart the significance of the pursuit, but the process of engaging in the research. This switching of emphasis seems to counter previous statements arguing against the primacy of methods since if we prioritize the process we prioritize the methods by which the research happens. However, I would argue that the previous critiques of methods were of the formulaic applications, methods as templates. This new orientation toward process calls for dynamic methods, what Springgay and Irwin (2005) call 'living inquiry' and Rogoff (Phelan and Rogoff, 2001) refers to as participation that is 'performative'.

As the emphasis shifts to the process of art, or in communication to the process of doing research, the type of results may shift as well. The goal may become not as much conclusions or conclusive results as it is generating new conversations, new questions, new directions. In this sense, it is not unlike the heuristics Craig and Tracy seek in their grounded practical theory – heuristics

that inspire new ways of looking at an existing practice of communication. Furthermore, the role of communication studies becomes even more important in the move toward this type of art, and this type of research. As Kester (2004) has identified the movement in art toward the dialogic – art that is not a 'speaking into the air' approach for generating multiple interpretations but a form where multiple interpretations are part of the give and take between artist and audience through the artistic process. In this way then, just as art can inspire research in communication as a process, the study of communication can inform the practice of dialogic art.

Conclusion

This chapter began where each of the case studies left off: with the goal of designing for openness to interpretation. I started this examination with a review of how interpretation has been approached historically in HCI and how a re-thinking of interpretation calls for multiple as opposed to matching interpretations as a valuable goal in design. This openness to multiple interpretations was argued for as the complex, integral, and intimate nature of technology continues to increase. The observation that users consistently interpret technology in new ways is an opportunity and resource for design as opposed to something that required preclusion. Although a number of strategies have been proposed to increase a design's degree of openness to interpretation, more work is required for understanding how these strategies interact with each other and how the strategies interact with other attributes such as particular situations and people. Openness to interpretation, used interchangeably with the idea of ambiguity, is presented as an emergent phenomenon and this emergence challenges the role of the designer and evaluator.

In an effort to understand interpretation and its relationship with ambiguity, I turned to the field of communication. Communication shares several overlaps with the space of design and the practice of interpretation as well as the use of ambiguity in language suggested a rich area for exploration. Although this chapter seemingly left the concept of the ineffable behind, what transpired began to resemble a third experience of the ineffable. The history of communication shares a number of parallels with both the history of affect and the history of art, all three for example have been compared to mystical transcendent experiences. All three have also endured a period of where the transmission of discrete information dominated. The history of communication studies traces this legacy to the period of the Enlightenment and the pillars of individualism and mechanicalism. As with the case studies, however, the study of communication has also moved away from the transmission of ideas to the co-construction of experience.

Construction in communication is about language use and for this reason I introduced the focus on the linguistic turn in communication and specifically examined ambiguity in language. In this case, ambiguity emerges not from a designed situation where a designer chooses certain strategies to influence the openness to interpretation, but ambiguity emerges through the selection of figurative language choices and reliance on conventions for meaning-making and interpretation. In exploring how figurative language works, it became apparent that what is considered intentional ambiguity in communication is actually less open to interpretation than one might assume. Intentional ambiguity follows many of the same conventions of more literal communication. This review also indicated how studies of communication,

both of figurative and literal uses, focused on the convergence of meaning as opposed to multiple interpretations.

Yet just as this review described ambiguous language as less open than perceived, new perspectives on communication are presenting literal or everyday language as more ambiguous. This chapter introduced the work of theorists such as Shepherd, Striphas, Baxter and Peters to discuss language use and communication not as a melding of minds, nor as a convergence of meaning but a sympathetic awareness and momentary connections of otherness. Communication is not portrayed as the opposite of miscommunication, binary poles of right and wrong, correct and incorrect, but a nuanced process of hints, guesses, and muddling through. This perspective could veer too far in the direction of infinite possibilities for openness, but all of these theorists take a more pragmatic view of communication happening in a world of both possibility but also reality.

The discussion of communication as one that is always open to multiple interpretations led to a rethinking of the Clarkian model of common ground and joint salience. In this new proposal, the emphasis on 'joint' and 'common' is in the sense of being shared or sympathetic not necessarily isomorphic. Furthermore, the idea of space for interpretation was modeled as a funnel from more open to more closed (though never completely closed), but it did not correspond linearly with the amount of information or the presence of conventions. Conventions do tend to narrow the range for interpretation but they do not reduce it completely and at the same time conventions may also provide the impetus for transformation and therefore new interpretations. In other words, conventions may be the impetus for pushing from the narrow end of the funnel toward the wider end. Ultimately, the part of Clark's model that

did not require re-thinking was the formulation that all interpretations are inferences based on evidence. We can never completely equate meaning with intention as meaning is always negotiated.

The next step in the chapter was to explore how this new perspective in communication could inform thinking about the case study chapters, in particular how to study and how to evaluate multiple interpretations. Yet, in beginning this review, I discovered a disconnect between the conceptualization of communication as a process of construction and the study of communication. Most studies of communication still bear the legacy of individualism and mechanicalism. This is most evident through studies emphasizing a componentization of causal and predictable parts in the communication process. The recognition of the power of this legacy, even in light of new thinking on communication, suggests yet another link with the example of dominant design in the case studies. In the case study, a dominant design approach codified what was considered an ineffable experience. In the review of communication theory, the dominant study approach also codifies what is considered ineffable and complex. The move from conceptualization to operationalization often ends in codification.

In an effort to address this legacy, I looked for examples of alternate criteria and used Craig and Tracy's (1995) discussion of grounded practical theory as an alternative approach to scientific examinations. Grounded practical theory works to identify how practice is constituted, in particular the practice of communication. It calls for not just articulating 'what is' in a descriptive manner like an empirical study but articulating 'what ought to be'. These situated ideals or norms are not proposed as directing behavior but providing a resource or influencing behavior. The norms are as subject to

challenge as the practices. Although grounded practical theory is also descriptive, its aim is for examining how certain practices come about. It is prescriptive but not predictive. The criteria for grounded practical theory is its usefulness for reflection and practice – both for the researchers and for the participants. The exploration of grounded practical theory, alternate criteria, the benefits of empirical observations, and the difference between prediction and anticipation set the ground for returning to the evaluation of the case studies. For both case studies, I proposed how the ideas for grounded practical theory might inform a more systematic approach toward building understanding and anticipating how various attributes in the emergence of ambiguity interact. Again, the important distinction to emphasize is the goal of looking at the particularities of interactions and using these particularities to inform future design decisions, not to predict design impacts.

In addition to examining how theory became codified in the study of communication, I looked at how theories of communication influenced both directly and indirectly the practice of design. In particular I presented three alternatives when communication and design are directly linked: the blueprint, the measures into design and the affordances approach. Both the blueprint and the measures approach run the risk of reifying abstract practices into de-contextualized static representations. Whereas with theory this is something to caution against, with design the results can be more problematic because of the impact it could have on people's everyday lives. I described an alternative to the measures into design and the blueprint approach where the goal is awareness as opposed to invisible control. I also explored in more detail the idea of affordances, returning to the goal of emergent phenomenon discussed throughout the conceptualization of openness. The affordance approach

resists one to one mappings between design attributes and behaviors or design attributes and meaning. Instead, it requires thoughtful reflection on the range of interactions. Attributes of design provide constraints, but as with words they are only one form of evidence. I drew from the expanded ideas of common ground and ambiguity in order to critique a design that used as its base the idea that more information mapped to less ambiguity. Instead, I proposed how a more complex understanding of the emergence of ambiguity from a communication perspective would lead to different design heuristics. I then used these design heuristics to rethink the case studies to both inspire new directions and push on the usefulness of the heuristics themselves.

Finally, I proposed to reverse my examination from the lessons design could learn from communication to the lessons communication could draw from design. I am not alone in calling for this type of research, yet I cautioned that a narrow view of design as an instrumental problem centered process will limit the benefits. Instead, I advocate drawing from new approaches such as reflective design such as followed by each of the case studies. In this review, I highlighted four promising areas for future influences from design: refining concepts and criteria for interpretation, increasing the role of participants, the idea of 'without' in interdisciplinary work, and the growing role of the arts in social sciences. This last area captures the spirit of synergies between communication and design perhaps the best. Whereas designers may embrace the arts as inspiration for their work process, communication theorists are ahead of artists in thinking about engagement through dialogue and participation. Despite the increasing recognition of otherness, despite the ever present space for multiple interpretations, communication still works toward connection. Communication is about otherness, but not isolation.

Chapter 5. Conclusion and Future Directions

It is our differences that make us the same.
-- Roger Coleman

This work began with a personal case study questioning the limiting application of computing technology for the open and standard breaking practice of innovation in a business context. Through further exploration, I discovered this personal experience to be part of a much larger trend in the design of computing technology. In particular, the design of computing technology for rich, complex and difficult to formalize experiences typically results in an approach calling for reduction and simplification. I referred to these experiences as the 'ineffable' and the systems that result as 'interfaces with the ineffable.' It is the interfaces and their design that concerns this work. Although the ineffable provides an area of study, this is not a theory of the ineffable. Instead it is an exploration of design for a particularly relevant experience in the current emphasis toward technology that is more intimate, pervasive, and contextually responsive.

The ineffable by definition escapes formal description yet the boundaries of the ineffable are fluid. What was considered ineffable at one period of history ceases to be so in the next. As this dissertation details, the redrawing of boundaries of the ineffable is partly influenced by technology design. On the one hand, the identification of ineffable experience serves as a demarcation between humans and technology – humans being capable of functioning with and sensing the ineffable and technology failing at this. On the other hand, this boundary of the ineffable also serves as a rallying cry for new

technology agendas. In an effort to fashion computers in the image of humans, we seek to model this facility with the ineffable. Two approaches to modeling the ineffable and subsequently designing interfaces were introduced: the reductionist approach where the ineffable is turned into the effable, and the interpretation approach where the richness and complexity of the ineffable is augmented. The former approach has a longer history of development in HCI but the latter is gaining more momentum. The interpretation approach advocates an orientation of designing for openness to multiple interpretations, recognizing that the incompleteness of a design at the hands of a designer is not a weakness but an asset of the design process. Yet the charge to design for openness shifts the orientation of traditional HCI and in doing so requires re-thinking and developing new strategies for design and evaluation of such systems.

Following a reflective design practice, I explore these challenges as well as the tension between the alternate approaches of designing interfaces with the ineffable through two detailed case studies. Each study began by historically situating a formulation of a different ineffable experience: the ineffable experience of art in the first study and the ineffable experience of affect in the second. Both studies then presented the dominant approach in designing technology for such experiences and used this as a foil for articulating an alternate approach. The first case narrowed the exploration of art to the experience of art in the museum and described the dominant technology design as one of didactic one-way information transfer from expert to novice. The alternate approach in this study sought to emphasize marginal but essential aspects of the museum experience as a way of participating in and therefore connecting with art. The second case described affective

computing as designing for affect as information before introducing alternative designs for affect as interaction. Both case studies therefore followed the interpretation approach to designing interfaces with the ineffable. The first case study focused more on issues of design whereas the second case focused more on issues of evaluation. The open questions identified at the close of each study pointed to the need for further exploration into the process of designing for interpretation and engagement in interpretive acts.

The penultimate chapter picked up this charge by first examining new thinking in designing for interpretation in the field of HCI. This thinking underscores many of the same conclusions and lessons learned from the case studies, but it also extends them. One of the main conclusions in this work is the view that how open something is to interpretation can not be predetermined but it emerges in action. Yet, from a design perspective the focus is on attributes under the designer's control that constrain or enhance the interpretation space. Designers manipulate the material aspects of a situation. They build things. Despite a directive to focus on the interplay between material form, socio-cultural circumstances and practices, and attributes of people, at the end of the day what the designer controls and is therefore concerned about is the design. Therefore, in an effort to broaden the lens of interpretation, I turned to the field of communication. In the everyday practice of communication, people themselves step into the simultaneous role of users and designers. They choose the (material) form of their communication and therefore design their expressive acts. At the same time, they engage in the active process of meaning making in terms of how their contributions interact with others and the environment. By examining communication, in particular the process of interpretation and ambiguity in

language use, I proposed new insights for the field of HCI. Subsequently, I returned to the process of conducting the case studies in particular and the practice of design in HCI in general to identify how design adds to the field of communication.

The introduction of this chapter has provided a broad overview of how the work presented here has progressed. In the following sections, I will argue for the relevance or appropriateness of this approach in answering the questions motivating this research. I will then turn to the five research questions introduced in the first chapter and summarize results addressing these questions. From this specific vantage point, I will take a step back to look at broader themes that emerged across the case studies and the discussion of interpretation in chapter four. Finally, I will end with a discussion of future directions.

Relevance of Approach

This work is rooted in design and the interdisciplinary practice of HCI. As a study in reflective design it seeks to contribute new ways of thinking about, practicing, and ultimately evaluating designs for a particular context, namely for experiences of the ineffable. I present reflective design not as an instrumental problem driven approach but as a form of critical inquiry where the boundaries of existing design spaces are pushed on and the pursuit of resonant practices pursued. Reflective design is both a process of reflecting on the assumptions and values involved in design as well as a product resulting in designs that stimulate reflection on the design space and the role of technology in that formulation. Unlike critical technical practice which waits for a technical impasse to spark reflection, reflective design argues for continually examining existing design spaces to keep assumptions and values

from becoming invisible and taken for granted. Unlike participatory design and user-centered design that typically begin with known problem spaces and the articulation of user needs and requirements, reflective design also looks to provoke reflection on how the perception of needs and requirements first begin to formalize. Unlike critical design, where the audience for reflection is traditionally other designers and the idea of the design is more important than the actual implementation, reflective design works to engage designers and participants through reflection on the design process and use of an actual system. Finally, unlike conceptions of reflection that suggest a process that precedes or follows action, reflective design emphasizes reflection that happens in and through use.

Because of its focus on both designers and participants in the design process, reflective design is characterized not as an intervention but as a practice of participative inquiry. Engagement in this inquiry is toward understanding how people make meaning in their everyday lives and how they incorporate, rely on, adapt, or ignore computer technology in these everyday meaning making acts. The goal of this type of research, a broader understanding of the human condition, situates the design as research not only in advancing approaches to design but in advancing social science theories also concerned with meaning making. In particular, the work presented here is offered as an exploration of a new perspective and approach to theorizing in the field of communication.

The design approach followed in this study was ethnographically informed and ethnomethodologically inspired. From the practice of ethnography, I drew an orientation toward and relevant practices for observing designs and the process of design in action, then subsequently using these

observations as the basis for analysis. From ethnomethodology, I attempted to refrain from imposing initial categorizations on how the designs would be adopted and appropriated and instead work to elicit participants' own accounts of how the designs were used and how they would define whether a system works or not. I do not claim this as an ethnomethodological study however. I played a large role in providing categorization that would influence uptake by virtue of being both the designer as well as the evaluator in the studies. This involvement was critical for the type of research I wanted to engage in: research that was a collaboration between myself and the participants throughout the stages of design and evaluation. Finally, because of the relative newness of this area of inquiry into designing for openness, the inductive approach of developing descriptive analysis of a variety of cases is the most appropriate approach at this stage. In chapter four I discuss how this inductive case study approach may draw from systematic studies for fleshing out the design space, but the goal of this work is not the development of theorems for prediction but design exemplars for anticipation.

As a new approach to theorizing within the field of communication, this work provides a point for discussion among scholars in the field in terms of ways to structure and present research of this vein. It is rooted in design yet presented to the field of communication. I have argued for the parallels between the fields of HCI and the field of communication regarding the process of interpretation and the relevance of practices and perspectives in each respective field for the other. However, as a new approach it will be unfamiliar to many scholars in the field of communication. Many theorists in communication are very familiar with the products of technology design and the study of technology design in use, but they are less familiar with engaging

in technology design. Much of the work for this dissertation is only alluded to in this presentation. This work entailed building and deploying several working systems. Whereas most studies of computer technology in communication begin with an already working deployed system, this study first had to engage in the process of building each system.

Furthermore, because the systems were designed for environments outside the laboratory, I had less control as a researcher and had to make decisions due to the contingencies of the situation as opposed to always being driven only by the design and research questions. Although the lab also has contingencies to address, these tend to be well known ahead of time and controllable. This contingency-based work does not undermine the value of the results and I would argue that it grounds them in the contingencies of every day life. The larger point, however, is that because this is a new approach it will require further dialogue to understand how to position it most fruitfully within the field of communication. I have followed the strategy of scaffolding introduced as an important part of the designs in orienting the unfamiliar parts of this approach to research within familiar constructs but I believe more work is required.

Research Questions and Results

In this section, I will return to the original research questions outlined in the first chapter and detail how the case studies and discussion of interpretation offers evidence for answering these questions. These questions include:

> Q1: How have the boundaries of the ineffable been configured for the experience of art and for the experience of affect? What is the dominant approach of interfacing with

this configuration? What are the practical, political and personal implications?

Q2: How do we design for co-interpretation? If systems are ultimately interpreted by users, what strategies enable the designer to play a role in anticipating or contributing to this conversation?

Q3: How do we evaluate designs for co-interpretation? How do we use phenomenological approaches (and other methods) based on one particular system for more general lessons?

Q4: What insights from communication theory, particularly studies of language use, can we draw from for insights into the design, use, and evaluation of systems designed for openness to interpretation?

Q5: What insights from the process of designing and evaluating systems designed for openness can we draw on for the field of communication?

In general, these questions were approached in order through the sequence of the chapters. Question one was addressed in the historical review for each case study. Questions two and three were addressed in the design, evaluation, results and discussion sections for each case study as well as drawing additional strategies for design from the discussion in chapter four on re-thinking interpretation in HCI. Questions four and five were tackled in chapter four's examination of the parallels and cross-overs between HCI and communication. I will briefly summarize answers to these questions here.

Q1: Boundaries and Interfaces with the Ineffable

The introduction briefly identified a number of areas considered ineffable but the case studies focused on two in particular. The first case study looked at how art has historically been described as an experience of the ineffable – a transcendent experience beyond descriptions. In terms of personhood implications of the ineffable, the ability to produce and appreciate art is what separated man from beast and in later times what has motivated debates around whether it also separates man from computers. Politically, this transcendent experience has also served to demarcate a select group of elitist, those typically with an abundance of wealth, power or exposure to the arts. Although the Enlightenment ideals maintained that universality existed beyond the material, the history of art reads largely as one of exclusion. This could be seen sharply in the institutionalization of the art experience in the art museum.

In the art museum, the boundaries of the ineffable were contested and redrawn around who has access and license to participate in this experience and whether the ineffable nature of art is directed by the artist, the material form of the art itself, the critic or the viewer. Building interfaces with the ineffable in the art museum has produced ongoing debates of practice. The essentialist camp believed no amount of mediation could provide a bridge into the ineffable and encouraged the white cube mentality where the form of the art is supposed to speak for itself. Although the essentialist camp is typically associated with the powerful, artists and curators working against dominance such as the surrealists and avant-garde often show traces of essentialism where the art is still portrayed as speaking for itself and ends in dividing those who 'get it' from those who don't. The contextualist camp argues that art is

part of a larger socio-cultural history requiring an introduction and footholds for aiding interpretation and connection with the art. According to the contextualists, even surrealist art, that challenges having a 'set meaning' to decode, has a larger social commentary that requires understanding what the art is a reaction against.

The introduction of computer technology for interfacing with art into this debate tends to follow the contextualist line of argument although in doing so could be argued to continue the divide between those who get it and those who don't. The dominant application of computer technology for understanding art in the museum is designed for providing information about the art on display to the viewer. In terms of political and practical implications, the information provided is determined by museum professionals responding to the debates described above. Even in advanced systems that allow visitors to select their own tours or their own path through the available information, this information is presented with authority of a curatorial point of view for guiding the visitor's experience to a common interpretation. As was discussed with the artist who commented on his experience using the handheld tour guide at the Renwick Gallery, his concern with the amount of information provided and the rich descriptions offered by the creators of the art tended to close down the objects for him. Instead of letting the objects take on new meanings through interactions with visitors, the amount of information available tended to close this down.

The second case study also reviewed the shifting boundaries of the ineffable but in this case for the experience of affect. Like art, affect was once positioned in the realm of the spiritual, something that separated man from mere beasts. It could not be described but could descend upon or, in reverse,

elevate people to heightened experiences. Its locus was outside the body. Yet despite its original conceptions as being unpredictable, there was always a strong urge to control it evident in the earliest of philosophical writings. This need for control over emotions continued into the period of the Enlightenment with the laying of foundations for empirical science. Darwin made an early critical move in de-spiritualizing affect by demonstrating its presence in animals. Affect as a concept steadily moved inside people or other biological beings as opposed to an outside force. Also during this time period, concerted efforts were made to classify emotions – to mark off its boundaries between other constructs, such as reasoning, and between different emotions, such as happy versus sad. Finally, Dror's account of the numerization of emotions speaks to another legitimizing move in the study of affect. As science was perceived of as an 'emotion free' space, in order to study emotions they had to be de-emotionalized, contained, and abstracted away from messy uncontrollable experience. The development of technology and algorithms to track emotions numerically opened up affect for legitimate scientific pursuit. At this point then, a split could be discerned in terms of the ineffable experience of the affect. From a scientific perspective, emotion ceased to be ineffable; yet, the ineffable conception of affect still held favor for many philosophers and artists. This split could also be seen lining up implications for personhood – although Darwin's move showed emotions as a point of kinship between man and beast, unscientific emotions were regarded as savage or feminine. Today, the feminine association with emotions continues, reportedly backed by science.

The rise of affective computing, the interesting in computing technology that took into account not just reason based processes but the integral

importance of emotion in our daily work and leisure, could approach emotion as the effable construct of science or the ineffable construct of the arts. Not surprisingly, with its roots in cognitive psychology and with an interest in disassociating itself from the feminization of emotions, affective computing followed the numerization approach. In this manner, emotions were constructed as internal, discrete, and codifiable bits of information that could be transmitted to or detected by a computer. In practical terms, this meant that the experience of emotion that escaped codification, such as the felt life described by McCarthy and Wright, was left out of the equation. In political terms, the implications of computers that detect the information of emotions revolved around issues of accuracy, control, and loss of complexity.

Q2: Designing for openness to interpretation

The case studies each began with a historical positioning of art and affect respectively as experiences of the ineffable. They then illustrated how the dominant approach to designing interfaces for these experiences is to reduce the ineffability through discrete and codifiable representation. The reduction and codification of the experience of art or affect is controlled by the expert (e.g. by the scientist or the curator). In both cases, the application of technology focused on the expert identification and transference of information. Yet, both case studies also explored alternatives to this approach. In the museum case study, I presented a series of designs attempting to create both an experience of art and a tool for navigating the space of the museum. The designs largely attempted to focus on other aspects of the museum experience that visitors are the authorities on, as opposed to the curators, such as their own reactions to and interactions with the objects, people, and space of the museum. For the affect chapter, I presented a shift in

perspective of affect as information transfer to affect as interaction. This shift called for designing technologies that augmented the rich, complex, and relational experience of affect. The alternate design approaches in both case studies pursue an interpretation approach to the ineffable. In other words, instead of first defining the ineffable and then coding for it, the designs maintain that an experience of the ineffable is an experience of interpretation. Meaning is not embedded in or transferred intact through the system but constructed in interaction with the system.

In designing for interpretation, each case study experimented with different design strategies. In addition, chapter four provided a review of design strategies for openness to interpretation developed across a number of systems. These strategies are outlined quickly in Table 4.

Table 4. Summary of design strategies for designing for interpretation[58]:

Strategy	Description	Cases
Defamiliarization	A collection of strategies for augmenting and drawing attention to difference: e.g. alien presence, abstract representations, incongruent juxtapositions	I, B, A
Digital scaffolding	Providing familiar footholds to present a way into a defamiliar experience	I, B
Dynamic feedback	Presenting any information collected for the system use to the user as well, e.g. visualizations of use patterns	I, B, A
Self in collective	Allowing users to easily identify their personal influence as separate from others	I
Site-specific / context dependent	Leverage information outside the system itself; design for particularities	I, B, A
Autobiographical design	Designers as users	A
Remove internal meaning maps	System acts without a pre-coded meaning for translating input to output; meaning construction occurs outside the system	A
Access to system innards	Users can readily manipulate system code and behavior	A
Surfaces for personalization	Users leave traces of their participation; these traces become an integral part of the system	I
Framing	Altering the positioning of the system, e.g. an origin story, a genre, etc.	I, B, A
Exposing the seams	Highlighting system functioning, e.g. how information is handled between processes, how the system integrates with other systems	-
Under-designing	Providing minimal features requiring maximum meaning overlays from the users	-
Characters and extreme characters	Targeting rich, deep, identifiable people not generic stereotypes or non-existent amalgamations	-
Layering complexity	Altering system functionality over time; designing simultaneously for two different audiences (e.g. children + adults)	-

[58] [I]mprints, [B]irdscape, [A]ffector

In addition to the design strategies, one finding from the case study and review of other similar work in designing for openness to interpretation is the increased role evaluation strategies play in design. Typically, design occurs as an iterative process with a prototype or finished system introduced into a use case and an evaluation follows before returning to the design drawing board. Because the goal of these designs is to allow for openness to interpretation, the evaluation methods must document how interpretation happens in use. This resulted in a merging of design, evaluation, and use stages. For example, during the Affector case study, we used diaries to capture notes from the user and I conducted several interviews and focus group sessions throughout the design/use period. The diaries are configured into the system and as such they stand as part of the system design, no different than the access to configuring the sensors and distortions. This interweaving of evaluation methods into the system presents challenges as well as opportunities. In terms of challenges, we must consider the interaction of the evaluation methods, just as another design attribute or feature. As an opportunity however it further underscores the fluid nature of design without well defined periods of design versus evaluation versus use. In doing so, it supports the move to present the designs as a co-interpretation between designers, evaluators, and users, sometimes by the same person playing all three roles.

Finally, the design strategies listed above are not an exhaustive list nor do they represent a checklist. The purpose of developing a list of strategies is to explore their effects in a range of contexts and to create a textured description of this new design space. As will be discussed in the next section, the goal of this design approach is not prediction but anticipation. By articulating different design experiences, it is hoped that these will provide

resources for anticipating how different design decisions interact with other circumstances such as the specific environment and the number and type of people involved. As the designs are intended to open the space for interpretation, prediction is less relevant. Prediction presumes a right or wrong response as opposed to a multiplicity. Furthermore, prediction in a design context is a step away from removing control or responsibility for meaning making away from users or away from a collaborative model to one that is determined by the system's internal predictive model.

Q3: Evaluating for openness to interpretation

The challenge of evaluating systems designed for openness to interpretation materializes because if all systems are open to interpretation, then all systems could potentially be considered successful in this approach. The case studies explored how to move forward with evaluation in the face of this conundrum. One possible suggestion was to draw from metrics of creativity studies, where more ideas and the range of ideas indicate higher creativity. Yet, this quantitative approach focuses on only the product of experience and not the process. Furthermore, although the language used throughout the discussion of openness has been for multiplicity and for 'more' versus 'less' openness, the evaluation methods focused on qualitative descriptions of interpretation process. Therefore, I drew from phenomenological and qualitative inquiry studies to develop methods that were open-ended and designed to elicit reflection and rich descriptions of the systems in use. In both the museum case studies and with Affector, I avoided static tools such as surveys in favor of interviews and design sessions. The interviews during the Imprint program in the museum were designed to encourage visitors to think critically and descriptively not only about their use

of Imprints but about their visits to museums and their use of technology in general. The comment book designed for the Birdscape study was implemented as an evocative postcard attempting to look not like a research tool but something that belonged in the museum. Finally, the focus group sessions with Affector attempted to create exercises full of rich data prompts where the data was positioned as elements for crafting a story about how Affector did or did not work. Ultimately the focus for both case studies was on eliciting accounts of how the systems were appropriated – not, did the system work according to the designer's point of view, but how was it that the systems were defined as working (or not) from the users.

The chapter on interpretation in HCI and in communication also shed light on the question of evaluation. New thinking in HCI is positioning evaluation as one of eliciting multiple perspectives including the users, the designers, and a range of outside evaluators – in particular people from outside the field of HCI such as documentary film makers (Gaver, Boucher, Pennington, and Walker, 2005). Just as the designs are intended to evoke multiple interpretations, the evaluations will also likely evoke different interpretations. The exploration of studying interpretation in communication and in particular the strategy of grounded practical theory gave insights into structuring systematic studies of the different design strategies in a range of contexts. This systematic approach is for fleshing out details, in particular interactions of different attributes, but not an approach of divide and conquer. Instead, the systematic approach works toward the goal of anticipation described in the design section above. As the goal and therefore criterion of prediction is not relevant for this form of evaluation, new criteria were proposed to assess the quality of the evaluation itself. Criteria such as the

evaluation's usefulness in generating new interpretations or perspectives on the design space, its ability to evoke reflection and deep engagement with participants, its transformative or catalytic effects from virtue of participating, and finally the level of enjoyment evident from participation. All of these criteria for the evaluation reflect the same criteria of the design itself, another indication of how the design and evaluation of systems are becoming more intertwined.

Although the question of how to approach evaluation remains open, what is clear is that evaluation itself in a reflective design approach to research is a fundamentally different process than traditional notions of evaluation in HCI or in empirical communication studies. Many of the methods may be familiar but the criteria and the focus are different.

Q4: Drawing from Communication for HCI

Ultimately, the discussion of communication as a field and as a practice of study mirrored the earlier case studies of designing for the ineffable. In this case the ineffable experience is the momentary transcendence to a sympathetic awareness of the other that communication entails. The approaches explored to communication as an experience were less about specific technology designs and more about the formulation of theories and methods for approaching communication practice. The history of communication detailed a movement from communication as transmission of information and intact meaning, similar to the history of art and affect, to a process where meaning is constructed in collaboration. Although most studies of communication still focus on the construction of a single meaning, support also exists for conceptualizing interpretation not as a process of isomorphism but of multiplicity. As an exemplar of this conception, I looked in detail at

practices of ambiguity in language: language constructions designed ostensibly to be more open to multiple interpretations. In doing so, I discovered both that ambiguous language is often more clear and coordinated than we imagine it to be and that non-ambiguous language is more open to interpretations than we traditionally characterize it. This discovery led to re-thinking ambiguity in language use not as a binary construct where something is ambiguous or not, where there is common ground or not, understanding or misunderstanding. Instead, ambiguity is more fluid, and like the discussions of ambiguity in design not simply an attribute of the language itself but an emergent phenomenon.

In addition to using studies of ambiguity, I looked at how the process of interpretation and meaning making is typically conducted within communication. Despite an orientation toward construction and process, the studies tend to take more of a variable approach. Furthermore, the emphasis is more toward convergence around a single shared meaning. As an alternative methodology, I explored in detail Craig and Tracy's grounded practical theory approach to studying the reconstruction of a communication practice. Grounded practical theory differs from scientific empirical studies that describe what is (and often what will be through predictions) by instead articulating what ought to be according to the participants in the phenomenon of study. Craig and Tracy refer to this as a normative theory, but their view of the normative is a questioning of ideals not a solidification of them. The grounded practical theory explanation served as an example for future development of the case studies of weaving together examination from empirical science, action science, and critical inquiry. Finally, the grounded practical theory discussion highlighted 'usefulness' as a criterion for theories

and methods: usefulness for reflection and for new thinking. I found the orientation of this approach resonant with reflective design where the goal is not to test the accuracy of existing theories but to continue developing new fields of inquiry based on close observation of practice.

Finally, I reviewed how communication theory directly influences technology design practice and articulated three different approaches: the blueprint, measures into design, and the affordances. I discussed limitations of the first two approaches before elaborating the affordance approach which looks at potential and possibilities for interaction rather than a one to one mapping between a design attribute and an outcome. I described several examples of missteps in applying communication theory to design before describing a project where communication theories of ambiguity, applied in the affordance approach, served to identify problems in a design and propose several design heuristics. In particular, I underscored how Aoki & Woodruff's attempt to design for unresponsiveness by leaving space for stories fell foul of their objective when they equated more information with less ambiguity. The refined position on ambiguity developed through this work suggests instead that ambiguity is a question of quality of evidence, not amount. The amount of evidence is only part of the overall affordance of the situation.

The design ideas developed from this discussion (see Table 5) sit somewhere in between the objective of designing for openness and the design strategies listed above. In other words, these ideas or guidelines act as a bridge between objectives and strategies. I used these guidelines to reflect on and propose next steps for the case studies from chapter two and three.

Table 5. Design ideas inspired from communication theories of ambiguity

• Design for opposites
• Design for convention building
• Design for extremes
• Design for something else
• Design for over-interpretation.

Q5: Drawing from HCI for Communication

The last research question asked what lessons from the field of HCI could be drawn for the field of communication. To some extent, this dissertation as a whole is offered in that spirit, a study from the field of HCI of two specific design cases and reflections on how people construct meaning from open-ended experiences. In response to the charge from Poole to develop more process related approaches for a process view of communication, design theory and practice offers a strong candidate forward. However, I cautioned against using a narrow, instrumental approach to design and instead advocated the type of reflective design explored here. The new developments in reflective design and related efforts to design for openness provide an exciting area of study for conceptions of communication such as those advocated by Striphas, Shepherd, Peters, and Baxter where meaning may be multifaceted and a process of recognizing otherness as opposed to desiring sameness. Therefore, I would argue that the parallel developments in design offer at the very least refinements in conceptualizing communication as well as alternate criteria for evaluation described in response to the above questions.

I will end by summarizing three of the strongest contributions design has to offer for communication. The first is the role of participants in research.

Although communication and the social sciences in general are becoming more interested in expanding the role of participants in the research process, the field of design has a head start in experimenting with participants as designers and more recently as evaluators. Second, although both communication and HCI are interdisciplinary and to some degree overlapping fields, the former approaches interdisciplinarity more as an unfortunate legacy of its past. HCI, although not without its interdisciplinary challenges, seems more prone to embrace its multi-disciplined nature. Furthermore, the growing interest in the arts and humanities within HCI are developing very interesting advancements in terms of criteria and methods. I offered the term 'without' from Rogoff as a injunction to rely less on formalized methods, to draw on existing methods not for their reproducibility but for their ability to provide a resource or raw material for creating something new. Finally, this interest in the arts also led to the conclusion that the focus of this research is not on end results but on the process of getting to these conclusions.

Reflection on Themes

The above section roughly followed the order of the chapters looking at each research question in turn and summarizing how these questions were approached and explored. In this section, I will look across all of the chapters and identify five main themes that continued to arise throughout the discussions and mark the overall lessons learned.

Representation and Codification

This work opened with a personal case study and observation of how quickly a representation of innovation, in the form of a theory of innovation, became codified into a standard practice. The codification of this

representation became further solidified when new technology was introduced to further standardize these set routines. I quickly jumped to concern with this second order codification, from theory into design. What I overlooked in significance was the initial codification in the theorizing step.

The case studies and discussion chapter on communication and interpretation highlight how similar theory and design are in regards to representation and codification. Both employ Hayles' Platonic backhand in moving from "noisy multiplicity to reductive simplicity" (Hayles, 1999, p. 13). In design, the move is from a messy situation of innumerable choices to a narrowing of possibilities in terms of actions supported and restrained by the designed system. In theory, the move is from a complex phenomenon to a focusing on what is significant and related versus what can be ignored and considered less consequential. In both cases as well, this work demonstrates consequences of the Platonic forehand in perpetuating the representation and making change difficult. The more a design narrows possibilities of action, the more difficult it is to realize and argue for the relevance of other actions, such as in the museum space the difficulty in promoting technology that broadens the activities designed for in the experience of art. The more a theory focuses attention and amasses evidence for its perspective, the more difficult it is to look in an alternate direction. The observation of how both theory and design employ the backhand and forehand of abstraction and generation leads to two further points of reflection: the issue of control and the issue of reflection.

Just as a historical representation or theory of the past often tells us more about the historian than the history itself, so too does academic theory (or design) tell us as much about the researchers (or the designer) as the researched phenomenon. It is the storyteller, a term I do not use in the

pejorative sense, who controls the storyline and its development. In the case studies on the art museum and affect, I demonstrated approaches that sought to increase participation in controlling what an eventual design addresses. In other words, the process of representation and even codification itself is not the limiting factor, it is the level of access to this process. It is a question of control. In fact, the representation and codification process itself need not be portrayed as something to guard against but something that potentially sparks reflection. The constraints of a design or a theory offer not only a way forward in a sea of possibility that gives rise to practical designs and illuminating perspectives on phenomenon, but they also provide guides for ultimately challenging the frame itself. In other words, the frame provides a way into a phenomenon and also a way out. Again, I had an initial experience of this as the designer of the innovation platform for my clients discussed in the first chapter. It was through the process of designing the innovation system that as designers we came to know and understand the standardized practices we were using inside and out. These practices then served as a marker for perhaps overturning and looking for new practices. The point here is that representations and codifications, in the sense of normative ideals, do not need to determine or constrain behavior and perspectives to the point where change is impossible. The representations themselves can serve as a stimulus for change when awareness and agency for participation and change exists.

Awareness, Agency, and Ambiguity

The importance of awareness surfaced throughout the case studies and discussion: awareness of conventions, awareness of assumptions and values, awareness of actions supported and marginalized. All of these points of awareness direct attention toward aspects more traditionally hidden, either by

design or by nature. For instance, in the affective computing systems, one of the goals is to augment physiological symptoms such as amount of sweat on one's skin that we may not consciously attend to. As another example, in the museum automated context-aware guides, a visitor's foot traffic is calculated according to complicated Bayesian formulas in order to develop a set pattern that may or may not be discernible to the individual visitor. Yet in these examples, the awareness that is heightened is that of the system, and by extension the designer or researcher. This invisible information is brought into being as input to a system or for analysis by the researcher. As the alternate designs in the case studies argued, however, this same invisible information can be of interest to participants or users of the designed systems as well. In this manner, awareness of the invisible is the first step in designing for openness to interpretation. In order for interpretation to be engaged in, one first must be aware of the opportunity to engage in a meaning-making process.

Awareness on its own however is not enough for engagement. Another key issue arising through the case studies was the importance of agency, or as it was introduced in the studies, the license for participation. Agency suggests not only awareness of an opportunity but the wherewithal, including the desire, the skill, and the access to participate. Furthermore, agency, like the discussions of ambiguity, is an emergent property according to Suchman (2004). Agency is not located solely within the individual but is enacted relationally between people and the attributes of the environment. In the museum example, we learned that simply designing for marginal experiences in the museum, such as visitor commenting, is not enough to break out of conventional practices and expectations. Instead, strategies are needed that signal or grant this authority for appropriation.

The concept of ambiguity, or openness to interpretation, can increase both awareness (through design strategies such as defamiliarization) and agency (by signaling its openness to the active construction of meaning). Yet, designing for ambiguity can also lead to the exact opposite scenario: defamiliarization can reduce awareness and agency if it is either too strange, disorienting, or uninviting. Part of the difficulty in approaching ambiguity for design is in this tension between considering it a strategy implemented under the designer's control and a property that emerges from the interaction of design attributes, people, and the specific situation. For example, in language use, ambiguity can be considered a strategy of the communicator, such as using evasive, imprecise, or figurative language. But ambiguity can also be considered an inherent and emergent property in all language acts as both the speaker and responder actively work to coordinate meanings yet still retain a space of otherness. I have highlighted studies in everyday language use as a fertile area for further exploration as designers attempt to understand and anticipate ambiguity as an emergent phenomenon. In particular, I believe further work into the development of conventions in language use, the work required to build conventions and the use of conventions as a springboard for reopening the space of interpretation can provide a valuable resource for designers in HCI.

Digital Scaffolding and Dynamic Feedback

Two of the related concepts for awareness, agency and ambiguity that this dissertation explores include digital scaffolding and dynamic feedback. The former is a principle for design strategies and the latter outlines both a principle and a strategy. A number of design strategies for ambiguity were listed in the previous chapters but I highlight these as new contributions for

this objective of design. The concepts themselves are not new: the idea of scaffolding is borrowed from Vygotsky's theories of learning and the idea of feedback comes from studies in second-order cybernetics where the observer of the feedback becomes part of the system itself.

Digital scaffolding became an important principle in the museum case studies because we realized we had to build from people's familiar experiences. We couldn't simply introduce new experiences without accessible entry points or else we would run the risk of creating designs, like avant-garde art, where people either get it or they don't. Digital scaffolding entails working to provide footholds from the conventional to the unconventional. As a principle, digital scaffolding does not tell us as designers what to do but serves as a reminder to include strategies such as framing or leveraging familiarity as a balance to defamiliarization strategies.

Dynamic feedback on the other hand suggests both a principle and a strategy. First, it requires an orientation to research and design that values making information translucent as opposed to invisible. It is the emphasis on awareness and control described above that motivates the desire to make the information traditionally collected for a researcher's analysis or for a system's processing equally available to the people who generate this information. Second, dynamic feedback requires deliberation and experimentation with what information to track and collect. In the museum examples for instance we tracked density of people and their relative paths through the museum space. In the Affector example, we ultimately focused on changes in movement levels across time. However, in both case studies alternate indices could be experimented with and part of future explorations will try different sources. Part of what is needed to advance the use of dynamic feedback are guides for how

to choose from the variety of information sources available. The third part of dynamic feedback involves decisions over how this information is represented. As the first theme indicated, all presentations of information or indices of experience are a representation regardless of attempts to remove predetermined models of meaning. Yet, the range of possible representations will vary along dimensions such as who has access to influencing and modifying the representation and how open or closed the representation is for different situations.

Foregrounding and Backgrounding

The final theme throughout this work was initially introduced from Agre's critical technical practice conception of centers and margins. In Agre's development of an interaction approach to artificial intelligence, he swapped the traditionally dominant focus on abstract complete models in favor of the traditionally marginal aspect of context. This practice of inversion is also at the heart of reflective design and was demonstrated in both case studies as well as in the discussion of movement in the field of communication. In the histories presented for art, affect, and communication, the dominant methods for conceptualizing, studying, and designing for these concepts all shifted from an information transfer model to one of experience.

The idea of centers, something that is foregrounded, and margins, something that is backgrounded, was also discussed with regards to fields that are interdisciplinary in nature such as HCI and communication. Craig (1999), for instance, attempts to provide a coherent framework for how different approaches to the study of communication fit together, with each focusing on different aspects of the complex phenomenon of communication. As another example, when writing this dissertation, I was conscious that different parts

would appeal to different members of my committee, and corresponding parts may seem less necessary, based on each individual's own research perspective. Finally, in the museum case study, I explored how foregrounding and backgrounding played out in my interactions with artist Chen on the Birdscape implementation. Although we often understood each other's perspectives, we valued different things and therefore were driven to make different choices. The question of value is one that I am returning to over and over: whether it is the value or valence of an emotional response, the value or salience of available information, the value of an evaluation method, or the values informing what is considered a worthy design space. Values mediate the boundaries between the foreground and background of focus.

The question of values raises debates of positivist/essentialist positions versus relativist/postmodern positions. The former suggests there are right and wrong values and the latter suggests values are constructed and maintained by different communities. The accusation against the relativist approach is that it leads to paralysis or shuts down productive debate. St. John, Striphas, and Shepherd (2006) for example argue that theorists in the field of communication need to not only locate their perspective horizontally across a range of theories but also argue for their perspective vertically in terms of why their theory is better than another. This advocates on taking a step beyond foregrounding and backgrounding by articulating the implications of one lens over another. The emphasis here is on articulating the implications: the critical examination that can then lead to pronouncements of 'better' or 'worse' for various situations. The work here does not portray a paralysis of choice from relative relativism. Instead it advocates the active work of making informed decisions based on examining the foregrounding and

backgrounding of choices, the values directing this boundary work, and the implications.

Looking Ahead

This work explores the developing practice of reflective design for research in both HCI and communication. For the field of HCI, I used reflective design to inverse a dominant focus on reduction for interpretation in order to build interfaces with ineffable experiences. For the field of communication, I posited how a reflective design practice provides a useful process based method of inquiry to compliment new theories of interpretation and meaning making. Although reflective design draws on a rich history of existing theory and methods, it is a new practice and one that requires more inductive and exploratory work. This dissertation has identified many steps forward in terms of design and evaluation strategies, but it has also identified many open questions. In the spirit of Craig and Tracy's (1995) grounded practical theory, where they do not seek to test existing theories but generate new ideas, or in the spirit of Dewey's (1934) re-visionary theorizing, it is appropriate to end here with several questions before concluding.

Many of the questions for continuing this work have been posed already in the conclusions to the case studies and the chapter examining interpretation from an HCI and communication perspective. In particular, although I have presented a number of techniques for moving forward in texturing alternate ways of approaching the ineffable, what is desired is a more systematic approach. This may simply involve conducting more studies and richly describing a catalogue of results and varied attributes of interaction. However, there are two points regarding this systematic approach that I will highlight for further consideration. First, one of the criticisms of inductive case driven

research is that it lacks a sufficient level of generalizability. In the previous chapter's discussion of substituting the criteria of generalizability with transferability, I have attempted to address this criticism. In many of the design strategies and examples explored here, designing for very specific and even a-prototypical experiences often leads to designs that appeal to or apply for a range of experiences, or at least the designs are rich enough to be re-appropriated for alternate experiences. What this has to do with the question of systematic examinations is that perhaps what the systematic discovery is about is charting explored territory in order to point to unchartered territory. In other words, it is not about creating a map of the world based on a small sample that then reduces the need for further exploration. Instead, it is a guide for pointing to where new discoveries can be made.

The second point regarding systematic discovery however is a caution. Describing a design space and articulating strategies for design and evaluation is a first step toward creating tool kits, taxonomies and standardized practices. In order for a practice to advance, it needs fleshing out and acceptance by a larger community. Yet reflective design is about examining stagnation in existing practices and must continuously advance new practices as opposed to verifying a standard set. This tension between convention and invention began my investigation, first through my work with innovation practices in companies through to my interest in conventional and inventive use of language for making meaning. In returning to the model of the funnel of ambiguity, or space for interpretation, presented in chapter four, I propose in future work to examine how conventions work to both narrow the space for interpretation but how these same conventions may be used

productively to flip the funnel and move toward opening the space for invention.

One specific area where the case studies in particular and the practice of reflective design in general needs further development is in stimulating reflection on experience as well as on the technology for experience. The goal of this work has been to do both. In the art museum for instance, I wanted to cause reflection on an experience such as participating in the production of art or simply reflecting on presence as an object of art-status in the museum. At the same time, I wanted people to reflect on the role of technology in the art museum. I believe the installations were more effective for the former rather than the latter type of reflection. The latter reflection occurred mainly by peer designers and researchers whom we pitched our objective to through papers and conferences. The Affector case study was more successful in this regard but this is due to the fact that the designers were also the users and pushing on the boundaries of existing technology designs was a stated objective from the start. This raises the question of how to engender this same kind of authentic status of designer/user on a larger scale. It also raises questions of legitimacy for designers to take on this role of provocateur. I have noted the importance of granting users license to participate. What is my license as a researcher/designer to create everyday designs that could upend the familiar?

My last set of questions return to the concept of the ineffable. The goal in advancing an interpretation approach to designing for the ineffable is not to black-box or turn away from trying to understand the ineffable. It is not an attempt to call a halt to abstract theorizing or the process of formalizing practices. It is not an argument to simply keep the ineffable a mystery and not try to understand it. Instead, the work here is offered as an alternate approach

to understanding, one that prioritizes experience over explanation. This characterizes the design approaches in the case studies, but it also characterizes my call for developing new ways for doing research. In this view, the process of research is elevated over the product, both are obviously important, but the emphasis is on the former. Product driven research strives for explanatory power but process driven research focuses on experiential power. Yet this point of view requires demarcating experiences somewhere. There is still a need to point to end results but the emphasis on process makes this challenging, as does the convergence of design, evaluation and use.

This leads me to reexamining the boundaries of the ineffable. In the first chapter, I outlined several new frontiers including spirituality. A common thread uniting the frontiers described in the case studies was a connection with the spiritual, whether it was the transcendent and sublime experience of art or the mystical vapors of emotional spirits. A speculative question then is to wonder what comes next? Once information technology tackles spirituality as a whole itself, where will the borders of the ineffable be pushed? Perhaps as this work has hinted at, the ineffable is more mundane than the mysterious wonder of experiences we hold out as being out of the ordinary. Perhaps the ineffable is more closely aligned with Dewey's idea of the aesthetic experience, a heightening of experience but something possible in the everyday. Furthermore, as the ineffable may be more applicable to the everyday, the more task based easily identifiable experiences that we assume are 'effable' may push back as well. In other words, the new frontiers of the ineffable could be in a worldly as opposed to other worldly direction. This is related to Striphas's (2006) idea that translation is not a marginal and

degraded experience in communication, but all communication is a process of translation. In this spirit, all experience is an interface of the ineffable.

REFERENCES

Agre, P. (1997). Computation and the Human Experience. Cambridge, England: Cambridge University Press.

Akrich, M. (1995). User representations: Practices, methods and sociology. In A. Rip, T.J. Misa, & J. Schot, (Eds.) *Managing Technology in Society. The Approach of Constructive Technology Asssessment* (pp. 167-184). London and New York: Pinter Publishers.

Alexander, C., Ishikawa, S., Silverstein, M., Jacobson, M., Fiksdahl-King, I., & Angel, S. (1977). *A Pattern Language*. New York, NY: Oxford University Press.

Altman, I. & Low, S.M. (Eds.). (1992). *Place Attachment*. New York: Plenum Press.

American Psychological Association (2001). *Publication Manual of the American Psychological Association: 5th edition.* Washington, DC: APA.

Amirian, S. (2001). Hand-held mobile computing in the museum: A background paper. CIMI White Paper. http://www.cimi.org/whitesite/AmirianBJM.htm (last accessed January 2, 2006).

Anderson, C. & Keltner, D. (2004). The emotional convergence hypothesis: implications for individuals, relationships, and cultures. In L. Tiedens, & C. Leach (Eds.). *The Social Life of Emotions*. Cambridge: Cambridge University Press.

Anderson, M.L. (1999). Museums of the future: the impact of technology on museum practices. *Daedalus*, *128* (3), 129-162.

Aoki, P., & Woodruff, A. (2005). Making space for stories: Ambiguity in the design of personal communication systems. *Proceedings of CHI 2005*. ACM Press, 181-190.

Aoki, P., Grinter, R., Hurst, A., Szymanski, M., Thornton, J., & Woodruff, A. (2002). *Sotto Voce:* Exploring the interplay of conversation and mobile audio spaces. *Proceedings of CHI 2002*. ACM Press, 431-438.

Arendt, H. (1959). *The Human Condition*. Garden City, NJ.: Doubleday Anchor Books.

Argyris, C. (1993). *On Organizational Learning*. Cambridge, MA: Blackwell.

Armstrong, K. (1993). *History of God*. New York, New York: Ballantine Books.

Ascott, R. (2004). Planetary technoetics: Art, technology and consciousness. *Leonardo*, *37* (2), 111-116.

Austin, J.L. (1962). *How To Do Things With Words*. Oxford: Clarendon Press.

Bakhtin, M. M. (1981). *The Dialogic Imagination: Four essays by M. M. Bakhtin* (M. Holquist, Ed.; C. Emerson, & M. Holquist, Trans.). Austin: University of Texas Press.

Bannister, D., & Fransella, F. 1985. *Inquiring Man, 3rd edition*. London: Routledge.

Bannon, L., Benford, S., Bowers, J., & Heath, C. (2005). Hybrid design creates innovative museum experiences. *Communications of the ACM*, *48* (3), 62-65.

Barone, T. (2001). Science, art, and the predispositions of educational researchers. *Educational Researcher*, *7* (30), 24-28.

Bates, J. (1994). The role of emotions in believable agents. *Communications of the ACM, 37* (7), 122-125.

Batliner, A., Fischer, K., Huber, R., Spilker, J., & Nöth, E. (2003). How to find trouble in communication. *Speech Communication, 40* (1-2), 117-143.

Baudrillard, J. (1994). The Beaubourg Effect: Implosions and Deterrence. In S. Glaser (Trans.), *Simulacra and Simulation*. Ann Arbor: University of Michigan.

Bavelas, J., Black, A., Chovil, N., & Mullett, J. (1990). *Equivocal Communication*. London: Sage Publications.

Baxter, L. (2004). Relationships as dialogues. *Personal Relationships*, *11*, 1-22.

Baxter, L. (2006). Communication as dialogue. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 101-109). Thousand Oaks: Sage Publications.

Bell, G. (2002). Making sense of museums: The museum as 'cultural ecology'. *Intel White Paper.* ftp://download.intel.com/labs/about/download/museum.pdf

Bennett, T. (1995). *The Birth of the Museum: History, Theory, Politics*. London: Routledge.

Bijker, W.E. (1995). *Of Bicycles, Bakelites and Bulbs: Toward a Theory of Sociotechnical Change*. Cambridge: MIT Press.

Blythe, M. (2004). Pastiche scenario. *Interactions*, *11* (5), 51-53.

Blythe, M.A., Overbeeke, K., Monk, A.F. & Wright, P.C. (Eds.) (2003). *Funology: From Usability to Enjoyment.* Boston, MA: Kluwer Academic Publishers.

Bochner, A., & Ellis, C. (2003). An introduction to the arts and narrative research: Art as inquiry. *Qualitative Inquiry, 9* (4), 506-514.

Bochner, A., & Ellis, C. (2006). Communication as autoethnography. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 110-122). Thousand Oaks: Sage Publications.

Boehner, K. (1996). *Developing a theory of efficacy: the role of learning conversations and the use of computer mediated communication*. M.S. Thesis. Ithaca, NY: Cornell University.

Boehner, K. (2004). Ambiguity in lived experience: Design and evaluation issues for Human Computer Interaction. Qualifying Exam for Professor Jeffrey T. Hancock (unpublished).

Boehner, K., Chen, M., & Liu, Z. (2003). The Vibe Reflector: An emergent impression of collective experience. Presented at the *Providing Elegant Peripheral Awareness Workshop CHI 2003*, April 5-10, Ft. Lauderdale, FL, USA.

Boehner, K., David, S., Kaye, J., & Sengers, P. (2005). Critical Technical Practice as a methodology for Values in Design. Presented at the *Quality, Value(s), and Choice: Exploring Deeper Outcomes for HCI Products Workshop CHI 2005*, April 2-7, Portland OR, USA.

Boehner, K., DePaula, R., Dourish, P., & Sengers, P. (2005). Affect: From information to interaction. *Proceedings of the Critical Computing Fourth Decennial Aarhus Conference.* ACM Press, 59-68.

Boehner, K., Gay, G., & Hembrooke, H. (2005). Designing for a sense of place: Imprints of presence. *Proceedings of HCII2005*, Lawrence Erlbaum Associates Press.

Boehner, K., Gay, G., & Larkin, C. (2005). Drawing evaluation into design for mobile computing: A case study of the Renwick Gallery's handheld education project. *Journal of Digital Libraries Special Issue: Museums*, *5* (3), 219-230.

Boehner, K., & Hancock, J.T. (2006). Advancing ambiguity. *Proceedings of CHI 2006*, ACM Press (in press).

Boehner, K., Sengers, P., Gay, G. (2004). Affective presence in museums: Ambient systems for creative expression. *Journal of Digital Creativity*, *16* (2), 79-89.

Boehner, K., Thom-Santelli, J., Zoss, A., Gay, G., Hall, J., & T. Barrett. (2005). Imprints of place: Creative expressions of the museum experience. *Proceedings of CHI 2005*. ACM Press, 1220-1223.

Böhlen, M., & Mateas, M. (1998). Office Plant #1: Intimate space and contemplative entertainment. *Leonardo: Journal of the International Society for Arts, Sciences, and Technology*, *31* (5), 345-348.

Boniface, P., & Fowler, P. (1993). *Heritage and Tourism in the 'Global Village.'* London: Routledge.

Bourdieu, P. (1984). *Distinction: A Social Critique of the Judgment of Taste.* Cambridge, MA: Harvard University Press.

Boxer, S. (2005). Critic's notebook: Art that puts you in the picture, like it or not. *New York Times*, April 27, 2005, E7.

Bradley, M. M., & Lang, P. J. (1999). International affective digitized sounds (IADS): Stimuli, instruction manual and affective ratings (Tech. Rep. No. B-2). Gainesville, FL: The Center for Research in Psychophysiology, University of Florida.

Brand, S. (1994). *How Buildings Learn: What Happens After They're Built*. New York: Penguin Books.

Breazeal, C. (2000). Sociable machines: Expressive social exchange between humans and robots. Sc.D. dissertation, Department of Electrical Engineering and Computer Science, MIT.

Brennan, T. (2004). *The Transmission of Affect*. Ithaca, NY: Cornell University Press.

Brown, B. (2005). Hedonic computing: the computer science of leisure and enjoyment. Presented at the Cornell University SIGCHI lecture series. April 11, 2005.

Burrell, J., Gay, G., Kubo, K., & Farina, N. (2002). Context-aware computing: a test case. Presented at the 2002 Conference on Ubiquitous Computing. Gothenburg, Sweden.

Button, G., & Dourish, P. (1996). Technomethodology: paradoxes and possibilities. *Proceedings of CHI 1996*, ACM Press, 19-26.

Cadiz, J.J., Venolia, G., Jancke, G., & Gupta, A. (2002). All ways aware: Designing and deploying an information awareness interface. *Proceedings of CSCW 2002,* ACM Press, 314-323.

Chalmers, M., Dieberger, A., Höök, K., & Rudström, Å. (2004). Social navigation and seamful design. *Cognitive Studies: Bulletin of the Japanese Cognitive Science Society*, *11* (3), 171-181.

Chalmers, M. & Galani, A. (2004). Seamful interweaving: heterogeneity in the theory and design of interactive systems. *Proceedings of DIS 2004*, ACM Press, 243-252.

Clark, H. (1993). *Using Language*. Cambridge, England: Cambridge University Press.

Condit, C. (2006). Communication as relationality. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 3-12). Thousand Oaks: Sage Publications.

Cooke, P. (2005). Things and technology: museums as hybrid institutions of the 21st century. Keynote address at Re-thinking Technology in Museums Workshop. Limerick, Ireland. 29-30 June 2005.

Craig, R. (1989). Communication as a practical discipline. In B. Dervin, L. Grossberg, B. O'Keefe, & E. Wartella (Eds.), *Rethinking Communication Theory*, *Vol. 1* (pp. 40-52). Newbury Park, CA: Sage,

Craig, R. (1999). Communication theory as a field. *Communication Theory*, *9*, 119-161.

Craig, R. (2006). Communication as a practice. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 38-48). Thousand Oaks: Sage Publications.

Craig, R. & Tracy, K. (1995). Grounded practical theory: The case of intellectual discussion. *Communication Theory*, *5* (3), 248-272.

Damasio, A. (1995). *Descartes' Error*. New York: GP Putnam.

De Guzman, E., Yau, M., Gagliano, A., Park, A., Dey, A. (2004). Exploring the design and use of peripheral displays of awareness information. *Proceedings of CHI 2004.* ACM Press, 1247-1250.

De Sousa, R. 2003. Emotion. In E. Zalta (ed.), *The Stanford Encyclopedia of Philosophy (Spring 2003 Edition).* http://plato.stanford.edu/archives/spr2003/entries/emotion/

Deetz, S. A. (1994). Future of the discipline: The challenges, the research, and the social contribution. *Communication Yearbook, 17*, 565-600.

Deetz, S.A. (2003). Reclaiming the legacy of the linguistic turn. *Organization*, *10* (3), 421–429.

Denzin, N. & Lincoln, Y. (2000). *Handbook of Qualitative Research*. Thousand Oaks, CA: Sage Publications.

Dewey, J. (1934). *Art as Experience.* New York: Minton, Balch & Co..

DePaula, R. & Dourish, P. (2005). Cognitive and cultural views of emotions. *Proceedings of the Human Computer Interaction Consortium Winter Meeting* (Douglas, CO).

Diamond, S. (2005). Participation, flow and the redistribution of authorship: The challenges of collaborative exchange and new media curatorial practice. In J. Trant, & D. Bearman (eds.). *Proceedings of Museums and the Web 2005*, Archives & Museum Informatics. http://www.archimuse.com/mw2005/papers/diamond/diamond.html

Djajadiningrat, J.P., Gaver, W. W., & Frens, J.W. (2000). Interaction, relabeling and extreme characters: Methods for exploring aesthetic interactions. *Proceedings of DIS 2000*, ACM Press, 66-71.

Dobrzynski, J. (1999). Art museum attendance keeps rising in the U.S.. *New York Times*, 1 February 1999, B1-3.

Domike, S., Mateas, M., & Vanouse, P. (2003). The recombinant history apparatus presents 'Terminal Time'. In M. Mateas and P. Sengers (eds.), *Narrative Intelligence* (pp. 155-173). Amsterdam: John Benjamins Publishing.

Dourish, P. (2001). *Where the Action Is: The Foundations of Embodied Interaction*. Cambridge, MA: MIT Press.

Dourish, P. (2004). What we talk about when we talk about context. *Personal and Ubiquitous Computing*, *8* (1), 19-30.

Dror, O. (1999). Scientific image of emotion: Experience and technologies of inscription. *Configurations, 7*, 355-401.

Dror, O. (2001). Counting the affects: Discoursing in numbers. *Social Research 68* (2), 357-378.

Dunne, A. & Raby, F. (2001). *Design Noir: The Secret Life of Electronic Objects*. London, England: August/Birkhäuser.

Ekman, P. (1973). Darwin and cross cultural studies of facial expression. In P. Ekman (ed.), *Darwin and Facial Expression: A Century of Research in Review.* New York: Academic Press.

Ekman, P. (1992). An argument for basic emotions. *Cognition and Emotion, 6,* 169-200.

Ekman, P., Friesen, W.V., & Ellsworth, P. (1972). *Emotion in the Human Face: Guidelines for Research and an Integration of Findings*. New York: Pergamon Press.

Falk, J., & Dierking, L. (2000). *Learning from Museums: Visitor Experience and the Making of Meaning.* Walnut Creek, CA: AltaMira Press.

Falk, J. (1999). Museums as institutions for personal learning, *Daedalus, 128* (3), 259-277.

Fallman, D. (2005) Integrating User Experience into the Design Process with the Repertory Grid Technique: Some Preliminary Notes, *WP9 Workshop on Innovative Approaches for Evaluating Affective Systems*, Stockholm, Sweden, Jan 9-11.

Finley, S. (2003). Arts-based inquiry in QI: Seven years from crisis to guerrilla warfare. *Qualitative Inquiry*, *9* (2), 281-296.

Flavell, J., Miller, P., & Miller, S. (2002). *Cognitive Development, 4th edition*. Upper Saddle River, New Jersey: Prentice-Hall Books.

Friedman, B., Kahn, P., & Borning, A. (in press). Value Sensitive Design and Information Systems. To appear in P. Zhang & D. Galletta, eds., *Human-Computer Interaction in Management Information Systems Foundations*. New York: M.E. Sharpe.

Fridlund, A.J. (1994). *Human Facial Expression: An Evolutionary View*. San Diego, CA: Academic Press.

Galani, A., & Chalmers, M. (2004). Production of pace as a collaborative activity. *Proceedings of CHI*. ACM Press, 1417 – 1420.

Galloway, A. (2004). Panel: Design for hackability. *Proceedings of DIS 2004*, ACM Press, 363-366.

Garrett, J.J. (2002). *The Elements of User Experience: User-centered Design for the Web.* New York: New Riders.

Gaver, W. (1996). Affordances for interaction: The social is material for design. *Ecological Psychology*, *8* (2), 111-129.

Gaver, W. (2001) Designing for ludic aspects of everyday life. *ERCIM News*, *47*, 20-21.

Gaver, W., Boucher, A., Pennington, S., Walker, B. (2005). Evaluating technologies for ludic engagement. *CHI 2005 Workshop on Innovative Approaches to Evaluating Affective Systems*.

Gaver, W., Bowers, J., Boucher, A., Gellerson, H., Pennington, S., Schmidt, A., Steed, A., Villars, N., & Walker, B. (2004). The Drift Table: designing for ludic engagement. Proceedings of CHI 2004 Design Expo, ACM Press, 885-900.

Gaver, W., & Dunne, A. (1999). Projected realities: conceptual design for cultural effect. *Proceedings of CHI 1999*. ACM Press, 600-607.

Gaver, W., & Martin, H. (2002). Alternatives: Exploring information appliances through conceptual design proposals. *Proceedings of CHI 2002*, ACM Press, 209-216.

Gay, G. & Hembrooke, H. (2004). *Activity-Centered Design*. Cambridge, MA: MIT Press.

Geertz, C. (1973). *Interpretation of Cultures*. New York, NY: Basic Books

Gere, C. (2002). *Digital Culture*. London: Reaktion Books.

Gere, C. (2004). New media art and the gallery in the digital age. *The Tate Papers*, Autumn 2004.

Gibson, J.J. (1979). *The Ecological Approach to Visual Perception.* Boston: Houghton Mifflin.

Gillespie, T. (2006). Designed to effectively frustrate: Copyright, technology, and the agency of users. *New Media and Society*, 8(4), (in press).

Gillespie, T. (2007, forthcoming) *Technology Rules: Copyright and the Re-alignment of Digital Culture.* Cambridge: MIT Press.

Goren-bar, D., Graziola, I., Rocchi, C., Pianesi, F., Stock, O., & Massimo Z. (2005). Designing and redesigning an affective interface for an adaptive museum guide. In J. Tao, T. Tan and R.W. Picard (Eds.) *Proceedings of ACII 2005*. Berlin: Springer-Verlag, 939-946.

Graham, B. (2005). Taxonomies of new media art: Real world namings. In J. Trant, & D. Bearman (Eds.), *Proceedings of Museums and the Web 2005*. Toronto: Archives & Museum Informatics.

Green, N. (2004). *Byrdcliffe: An American arts and crafts colony*. Ithaca, NY: Herbert F. Johnson Museum of Art, Cornell University.

Greenbaum, J., & Kyng, M. (1991). *Design at work: Cooperative Design of Computing Systems.* Hillsdale, NJ: Lawrence Erlbaum.

Grice, H.P. (1975). Logic and conversation. In P. Cole & J.L. Morgan (Eds.), *Syntax and semantics 3: Speech acts* (pp. 41-58). New York: Seminar Press.

Griffiths, P.E. 2001. Emotions and expression. In N. Smelser, & P. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences, vol 21* (pp. 4433-4437). Oxford: Elsevier Science.

Hall, S. (1992). Cultural studies and its theoretical legacies. In L. Grossberg, C. Nelson, & P. Treichler (Eds.), *Cultural studies* (pp. 277-294). New York: Routledge.

Hamel, G. (1996). Strategy as Revolution. *Harvard Business Review*, 74 (4), 69-81.

Hamel, G. (2000). *Leading the Revolution*. Boston, MA: Harvard Business School Press.

Hamel, G. & Prahalad, C.K. (1994). *Competing for the Future*. Boston, MA: Havard Business School Press.

Hancock, J. (2004). Verbal irony use in face-to-face and computer-mediated conversations. *Journal of Language and Social Psychology*, *23* (4), 447-463.

Harrison, S. & Dourish, P. (1996). Re-place-ing space: the roles of place and space in collaborative systems. *Proceedings of CSCW 1996*, ACM Press, 67-76.

Hassenzahl, M., Beu, A. & Burmester, M. (2001). Engineering joy. *IEEE Software*, *18* (1), 70-76.

Hatfield, E. & Rapson, R. (2004). Emotional contagion: religious and ethnic hatreds and global terrorism. In Tiedens, L. and Leach, C. (Eds). *The Social Life of Emotions*. Cambridge: Cambridge University Press.

Hayles, K. (1999). *How We Became Posthuman: Virtual Bodies in Cybernetics, Literature and Informatics*. Chicago, IL: University of Chicago Press.

Heidegger, M. (1934/1971) Origin of the Work of Art. In A. Hofstadter (Trans.), *Poetry, Language, Thought.* New York: Harper & Row.

Hevner, A., March, S., & Park, J. (2004). Design science in information systems research. *MIS Quarterly*, *28* (1), 75-105.

Höök, K., Sengers, P., & Andersson, G. (2003). Sense and Sensibility: Evaluation and Interactive Art. *Proceedings of CHI 2003,* ACM Press, 241-248.

Höök, K., & Svensson, M. (1999) Evaluating adaptive navigation support. In A. Munro, K. Höök, & D. Benyon (Eds.)*, Footsteps in the snow: personal and social navigation in information space*. London: Springer.

Hubbard, P., Kitchin, R., & Valentine, G. (Eds). (2004). *Key thinkers on space and place*. London: Sage Publications.

Jaén, J., Bosch, V., Esteve, J., & Mocholi, J. (2005). MoMo: A hybrid museum infrastructure. In J. Trant and D. Bearman (Eds), Proceedings of Museums and the Web 2005. Toronto: Archives & Museum Informatics.

Jeremijenko, N. (2006). Structures of Participation and Information Exchange around Tangible Computational Interfaces: an empirical study of sociotechnical interaction, information distribution and micropolitical structure. School of Information Technology and Electrical Engineering. Brisbane, The University of Queensland. Doctor of Philosophy.

Kaplan, A. (1964). *The Conduct of Inquiry: Methodology for Behavioral Science*. San Francisco: Chandler.

Kaye, J.J., Levitt, M., Nevins, J., Golden, J., & Schmidt, V. (2005). Communicating intimacy one bit at a time. *Proceedings of CHI 2005*, ACM Press, 1529-1532.

Kelly, G. (1955). *The Psychology of Personal Constructs, vol 1 and 2*. London: Routledge.

Kelshaw, T. (2006). Communication as political participation. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 155-163). Thousand Oaks: Sage Publications.

Kester, Grant. (2004). Conversation Pieces: Community and Communication in Modern Art. Berkeley, CA: University of California Berkeley Press.

Kiesler, S., Siegler, J., & McGuire, T.W. (1984). Social psychological aspects of computer mediated communication. *American Psychologist*, *39*, 1123-1134.

Krakauer, Tom H. (1999). Yes, Kids are Having Fun, But . . . Are They Learning Science? *Scientific American Explorations, 2* (1), 7.

Kurzweil, R. (1999). *The Age of Spiritual Machines*. New York, NY: Penguin Books.

Lakoff, G., & Johnson, M. (1980). *Metaphors We Live By.* Chicago: University of Chicago Press.

Lang, P.J., Bradley, M.M., & Cuthbert, B.N. (2005). International affective picture system (IAPS): Digitized photographs, instruction manual and affective ratings. Technical Report A-6. University of Florida, Gainesville, FL.

Latour, B. & Woolgar, S. (1979) *Laboratory Life: The Social Construction of Scientific Facts*. Beverley Hills, CA: Sage Publications.

Laurel, B. (1991). *Computers as Theatre.* Boston, MA: Addison-Wesley.

Lave, J. & Wenger, E. (1991). *Situated Learning: Legitimate Peripheral Participation*. Cambridge, England: Cambridge University Press.

Le Doux, J. (1996). *The Emotional Brain*. New York: Simon and Schuster.

Lincoln, Y.S. (1995). Emerging criteria for quality in qualitative and interpretive research. *Qualitative Inquiry*, *1* (3), 275-289.

Lively, K. (2004). Sociological realms of emotional experience. *American Journal of Sociology, 109* (5), 1109-1136.

Lutz, C. (1988). *Unnatural Emotions.* Chicago: University of Chicago Press.

Lynch, K. (1960). *Image of the City*. Cambridge, MY: Technology Press.

Mandler, G. (2001). Emotion: History of the Concept. In Smelser, N. and Baltes, P. (Eds), *International Encyclopedia of the Social and Behavioral Sciences, vol 21* (pp. 4437-4440), Oxford: Elsevier Science.

Mandryk, R., Atkins, M.S. & Inkpen, K (2006). A continuous and objective evaluation of emotional experience with interactive play environments. *Proceedings of CHI 2006*, ACM Press.

Mateas, M. (2001). Expressive AI: A hybrid art and science practice. *Leonardo: Journal of the International Society for Arts, Sciences, and Technology, 34* (2), 147-153.

Mateas, M., & Romero, M. (2005). Alien Presence. *Proceedings of HCII2005*, Lawrence Erlbaum Associates Press.

McCarthy, J. & Wright, P. (2004). *Technology as Experience*. Cambridge, MA: MIT Press.

McCarthy, J., Wright, P. Wallace, J., & Dearden, A. (2005). The experience of enchantment in human-computer interaction. *Personal and Ubiquitous Computing,* (in press).

McCarthy, J., & Monk, A. (1994). Channels, conversation, cooperation and relevance: all you wanted to know about communication but were afraid to ask. *Collaborative Computing*, *1*, 35-60.

McClellan, A. (2003). A brief history of the art museum public. In A. McClellan (Ed.), *Art and Its Publics: Museum Studies at the Millennium* (pp.1-49). Malden, MA: Blackwell Publishing.

McCullogh, M. (2004). *Digital Ground*. Cambridge, MA: MIT Press.

Miller, G. A. (1983). The background to modern psychology. In J. Miller (Ed.), *States of Mind*. New York, NY: Pantheon.

Mitchell, W., Inouye, A., Blumenthal, M. (2001). *Beyond Productivity: information Technology, Innovation, and Creativity*. Washington, D.C.: the National Academies Press.

Mullen, C. (2003). A self-fashioned gallery of aesthetic practice. *Qualitative Inquiry*, *9* (2),165-181.

Muller, M., Christiansen, E., Nardi, B., & Dray, S. (2001). Spiritual life and information technology. *Communications of the ACM*, *44* (3), 82-83.

Myers, D. (2001). A pox on all compromises: Reply to Craig (1999). *Communication Theory*, *11* (2), 218-230.

Nass, C., Steuer, J., & Tauber, E. (1994). Computers are social actors. *Proceedings of CHI 1994*, ACM Press, 72-78.

Negroponte, N. (1995). *Being Digital*. New York City, NY: Alfred A. Knopf.

Nickerson, M. (2005). 1-800-FOR-TOUR: Delivering automated audio Information through patron's cell phones. In J. Trant, & D. Bearman (Eds.). *Proceedings of Museums and the Web 2005.* Toronto: Archives & Museum Informatics.

Norman, D. (1988). *The Design of Everyday Things*. New York: Doubleday.

Norman, D. (2003). *Emotional Design: Why We Love (Or Hate) Everyday Things.* New York, NY: Basic Books.

Nunberg, G. (2003, November 12). [Digital audio recording of radio program], On Fresh Air. National Public Radio. Available online at http://freshair.npr.org/day_fa.jhtml?display=day&todayDate=11/12/2003 .]

Oatley, K. (2001). Emotion in cognition. In N. Smelser, & P. Baltes (Eds.), *International Encyclopedia of the Social and Behavioral Sciences, vol 21* (pp. 4440-4444), Oxford: Elsevier Science.

Oatley, K. (2004). *Emotions: A Brief History*. Malden, MA: Blackwell Publishing.

Orr, J. (1996). *Talking About Machines: An Ethnography of a Modern Job*. Ithaca, NY: Cornell University Press.

Osgood, C., Suci, G., & Tannenbaum, P. (1975). *The Measurement of Meaning.* Urbana, IL: University of Illinois Press.

Oudshoorn, N., & Pinch, T. (2003). *How Users Matter: The Co-Construction of Users and Technology*. Cambridge: MIT Press.

Pearce, W.B. (1989). *Communication and the Human Condition*. Carbondale: Southern Illinois University Press.

Pennebaker, J. (2002). What our words can say about us: Toward a broader language psychology. *Psychological Science Agenda*, January/February 2002, 8-9.

Penny, S., Smith, J., & Bernhardt, A. (1999). Traces: Wireless full body tracking in the CAVE. *Proceedings of the ICAT Virtual Reality Conference*. The Virtual Reality Society of Japan.

Peters, J. D. (1986). Institutional sources of intellectual poverty in communication research. *Communication Research*, *13* (4), 527-559.

Peters, J.D. (1999). *Speaking into the Air*. Chicago: University of Chicago Press.

Phelan, P. & Rogoff, I. (2001). "Without": A conversation. *Art Journal*, *60* (3), 34-41.

Picard, R. (1997) *Affective Computing*. Cambridge, MA: MIT Press.

Pinch, T. & Bijker, W.E. (1995). *Of Bicycles, Bakelites, and Bulbs*. Cambridge, MA: MIT Press.

Pitman, B. (1999). Muses, museums, and memories. *Daedalus, 128* (3), 1-31.

Polanyi, M. (1983). *The Tacit Dimension*. Gloucester, MA: P. Smith.

Popper, F. (1975). *Art: Action and Participation*. London: Studio Vista.

Prior, N. (2003) Having one's Tate and eating It: Transformations of the museum in a hypermodern era. In A. McClellan (Ed.), *Art and Its Publics: Museum Studies at the Millennium* (pp. 51-74). Malden, MA: Blackwell Publishing.

Proctor, N., & Tellis, C. (2003). The state of the art in museum handhelds in 2003. In J. Trant, & D. Bearman (Eds.), *Proceedings of Museums and the Web 2003: Proceedings*, Toronto: Archives & Museum.

Radford, G. (1994). Overcoming Dewey's 'False Psychology:' Reclaiming communication for communication studies. Paper presented at the *80th Annual Meeting of the Speech Communication Association,* New Orleans, Louisiana, November 19-22, 1994.

Reddy, M. (1993). The conduit metaphor: A case of frame conflict in our language about language. In A. Ortony (Ed.), *Metaphor and Thought* (pp. 164-201). Cambridge: Cambridge University Press.

Reeves, S., Benford, S., O'Malley, C., & Fraser, M.. (2005). Designing the spectator experience. *Proceedings of CHI 2005*. ACM Press, 741-750.

Reeves, B., & Nass, C. (1996). *The Media Equation: How People Treat Computers, Television, and New Media Like Real People and Places.* Stanford, CA: CSLI Publications/Cambridge University Press.

Rice, D. (2003). Museums: theory, practice, and illusion. In A. McClellan (Ed.), *Art and Its Publics: Museum Studies at the Millennium* (pp. 77-95). Malden, MA: Blackwell Publishing.

Roberts, G.L., & Bavelas, J.B. (1996). The communicative dictionary: A collaborative theory of meaning. In J. Steward (Ed.), *Beyond the Symbol Model: Reflections on the Nature of Language.* Albany: SUNY Press.

Robinson, M., & Bannon , L. (1991) Questioning representations. In L. Bannon, M. Robinson, & K. Schmidt (Eds.), *Proceedings of ECSCW 1991*, ACM Press, 219-233.

Rorty, A. (2003). Enough already with theories of emotion. In R. Solomon (Ed.), *Thinking About Feelings: Philosophers on Emotions*. Oxford; New York: Oxford University Press.

Rudström, Å., Höök, K., & Svensson, M. (2005). Social positioning: Designing the seams between social, physical and digital Space. In *Proceedings of HCII2005*, Lawrence Erlbaum Associates Press.

Russell, J.A. (1980). A circumplex model of affect. *Journal of Personality and Social Psychology, 39* (6), 1161-1178.

Sawyer, R. K. (1991). The emergence of creativity. *Philosophical Psychology, 12* (4), 447-469.

Schacter, S., & Singer, J. (1962). Cognitive, social and physiological determinants of emotional states. *Psychological Review*, *69*, 379-99.

Scherer, K. (2005). What are emotions? And how can they be measured? *Social Science Information, 44* (4), 695-729.

Scherer, K., & Ceschi, G. (2000). Criteria for emotion recognition from verbal and nonverbal expression: Studying baggage loss in the airport. *Personality and Social Psychology Bulletin, 26,* 327–339.

Schneiderman, B. (2002). *Leonardo's Laptop: Human Needs and the New Computing Technologies*. Cambridge, MA: MIT Press.

Schön, D. (1983). *The Reflective Practitioner.* New York, NY: Basic Books.

Seale, C. (1999). Quality in qualitative research. *Qualitative Inquiry*, *5* (4), 465-478.

Searle, J. R. (1969). *Speech Acts*. Cambridge: Cambridge University Press.

Sengers, P. (2006). Autonomous Agency: Boundary Crossings Between STS and Artificial Intelligence. Submitted to *Social Studies of Science*.

Sengers, P. (2006). Autobiographical Design. *CHI06 Workshop on Theory and Method for Experience Design.* Montreal, Canada.

Sengers, P., Boehner, K., David, S., & Kaye, J. (2005). Reflective Design. *Proceedings of the 4th Decennial Critical Computing Conference*, 49-58.

Sengers, P., Boehner, K., Gay, G., Kaye, J., Mateas, M., Gaver, B., & K. Höök. (2004). Experience as Interpretation. *CHI04 Workshop on Cross-Dressing and Border Crossing: Exploring Experience Methods Across Disciplines*, Vienna, Austria.

Sengers, P., Boehner, K., Warner, S., & Jenkins, T. (2005). Evaluating Affector: Co-interpreting what works. *Evaluating Affective Technology Workshop CHI 2005*. Portland OR, USA.

Sengers, P. & Gaver, B. (2005). Designing for Interpretation. *Proceedings of HCII2005*, Lawrence Erlbaum Associates Press.

Sengers, P. & Gaver, W. (2006). Staying open to multiple interpretation: Engaging multiple meanings in design and evaluation. *Proceedings of DIS 2006*, ACM Press. (in press).

Sengers, P., & Mateas, M. (2005). Closing the Affective Gap. A Proposal submitted to the National Science Foundation's directorate on Information and Intelligent Systems, accepted October 2005.

Sengers, P., Liesendahl, R., Magar, W., Seibert, C., Müller, B., Joachims, T., Geng, W., Mårtensson, P., & Höök, K. (2002). The enigmatics of affect. *Proceedings of DIS 2002,* ACM Press.

Shapiro, D. (1994). The limits of ethnography: Combining social sciences for CSCW. *Proceedings of CSCW 1994*, ACM Press, 417-428.

Shellmann, J. (1977). *Joseph Beuys: The Multiples.* Cambridge, MA, Minneapolis, MN, and Munich/New York: Busch-Reisinger Museum, Walker Arts Center, and Edition Schellmann.

Shepherd, G. (1999). Advances in communication theory: A critical review. *Journal of Communication*, Summer, 156-164.

Shepherd, G., St. John, J., and Striphas, T. (Eds.) (2006). *Communication As…Perspectives on Theory*. Thousand Oaks: Sage Publications.

Simon, H. (1967). Motivational and emotional controls of cognition. *Psychological Review, 74*, 29-39.

Slack, J. (2006). Communication as articulation. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 223-231). Thousand Oaks: Sage Publications.

Smith, M., Davenport, D., & Hwa, H. (2003). AURA: A Mobile Platform for Object and Location Annotation. Demonstration session at Ubicomp 2003.

Sparacino, F. (2002). The Museum Wearable *Museums and the Web 2002: Proceedings*. Toronto: Archives and Museum Informatics.

Springgay, S., & Irwin, R. (2005). A/r/tography as living inquiry through art and text. *Qualitative Inquiry*, *11* (6), 897-912.

St. John, J., Striphas, T., & Shepherd, G. (2006). Introduction: Taking a stand on theory. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. xi-xx). Thousand Oaks: Sage Publications.

Staske, S. (1996). Talking feelings: The collaborative construction of emotion in talk between close relational partners. *Symbolic Interaction*, *19*, 111-135.

Striphas, T. (2006). Communication as translation. In G. Shepherd, J. St. John, & T. Striphas (Eds.), *Communication As…Perspectives on Theory* (pp. 232-241). Thousand Oaks: Sage Publications.

Strong, R., & Gaver, B. (1996). Feather, Scent and Shaker: Supporting simple intimacy. *Proceedings of CSCW 1996*, ACM Press.

Suchman, L. (1987). *Plans and Situated Actions.* Cambridge, England: University of Cambridge Press.

Suchman, L. (1993). Do categories have politics? The language/action perspective reconsidered. *Proceedings of the ECSCW 1993,* Kluwer Press.

Suchman, L. (1997). Do categories have politics? The language/action perspective reconsidered. In B. Friedman, (Ed.), *Human values and the design of computer technology* (pp. 91-105). Oxford, UK: Cambridge University Press.

Suchman, L. (2004). Figuring Personhood in Sciences of the Artificial. Published by the Department of Sociology, Lancaster University, Lancaster LA1 4YL, UK at http://www.comp.lancs.ac.uk/sociology/papers/suchman-figuring-personhood.pdf

Sundstrom, P. (2006). A wild evaluation of users' emotional engagement. Innovative Approaches to Affective Evaluation Workshop. HUMAINE conference. Stockholm, Sweden.

Sundström, P., Ståhl, A., & K. Höök. (2005). eMoto – affectively involving both body and mind. *Proceedings of CHI 2005*, ACM Press, 2005-2008.

Tiedens, L., & Leach, C. (2004). *The Social Life of Emotions*. Cambridge: Cambridge University Press.

Tuan, Y.F. (1977). *Space and Place: The Perspective of Experience.* Minneapolis: University of Minnesota Press.

Turkle, S. (1984). *The Second Self: Computers and the Human Spirit.* New York, NY: Simon and Schuster.

Vom Lehn, D., & Heath, C. (2005). Accounting for new technology in museum exhibitions. *International Journal of Arts Management, 7* (3).

Vom Lehn, D,, Heath, C., & Hindmarsh, J. (2005). Re-thinking interactivity: design for participation in museums and galleries. In L. Ciolfi, M. Cooke, T. Hall, L. Bannon, and S. Oliva (Eds.), *Proceedings of Re-thinking Technology in Museums Workshop.* Convivio, 131-136.

Walker, B. (2003). *Taxonomy of Thrill*. London, England: AERiAL publishing.

Wallach, A. (2003). Norman Rockwell at the Guggenheim. In A. McClellan (Ed.), *Art and Its Publics: Museum Studies at the Millennium* (pp. 97-116). Malden, MA: Blackwell Publishing.

Watzlawick, P., Bavelas, J.B., & Jackson, D. (1967). *Pragmatics of Human Communication: A Study of Interactional Patterns, Pathologies, and Paradoxes*. New York: WW Norton and Company

White, C., & Burgoon, J. (2001). Adaptation and communicative design: patterns of interaction in truthful and deceptive conversations. *Human Communication Research*, *27* (1), 9-37.

Wilson, G. (2004). Multimedia tour programme at Tate Modern. In D. Bearman and J. Trant (Eds). *Proceedings of Museums and the Web 2004.* Toronto: Archives and Museum Informatics.

Wilson, S. (2002) *Information Arts: Intersections of Art, Science, and Technology.* Cambridge, MA: MIT Press.

Winograd, T. (1996). *Bringing Design to Software.* Reading, MA: Addison-Wesley.

Wittgenstein, L. (1958). *Philosophical Investigations*. Oxford: Blackwell.

Wright, P., & McCarthy, J. (2005). The value of the novel in designing for experience. In A. Pirhonen, H. Isomaki, C. Roast. & P. Saariluoma (Eds.), *Future Interaction Design*. London: Springer-Verlag.