The Three Paradigms of HCI

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ABSTRACT
There are three *paradigms* of HCI: Human-Factors, Classical Cognitivism/Information Processing Based and the Third/Phenomenologically-Situated Paradigm. Each of these paradigms represents a world-view and encompasses a set of practices and expectations for the value and contribution of research. Each contributes to HCI, but in different ways. The first two are not particularly controversial in terms of their contributions to larger enterprises of HCI. Human-Factors focuses on optimizing man-machine fit. Classical Cognitivism/Information Processing emphasizes (ideally predictive) models and theories and the relationship between what is in the computer and in the human mind. The third paradigm, with its base in Phenomenology, is less reified, but no less real. It focuses on the experiential quality of interaction, primarily the situated nature of meaning and meaning creation. All three paradigms drive design, but in different ways. All three have their own forms of knowledge creation and criteria for what constitutes knowledge. Identifying these approaches as paradigms allows us to value work more clearly.

INTRODUCTION: An Example
We will argue that it is useful in understanding what is happening in contemporary HCI to look at the field as a whole in terms of three paradigms, allowing us to understand why differences arise between intellectual approaches contributing to the field. To start the discussion, we will cartoon the nature of each of the paradigms, through a simple and well-known interface example.

In the 1960's, the United States Air Force developed automated cockpit warning systems to alert pilots to hazardous conditions. The systems used recorded voices to tell pilots to turn, climb, or dive to avoid head-on collisions, among other things. Each of the three paradigms contributes a different kind of thinking to the formulation of the problem and the range of solutions:

1. The situations that drove the initial system design were classic examples of "critical incidents" (Flanagan, 1954). The Air Force realized they needed to quickly gain the pilots' attention. At the time, all pilots and flight controllers were male, so someone had the bright idea of using a woman's voice so that it would be immediately identified as the "emergency voice". This was clever and worked well to reduce pilot errors. It also corresponds, as we will discuss below, to the *human factors* paradigm.

2. Women's voices are a particular design solution. However, they work because they effectively differentiated signal and noise in the system interface's interaction with the pilot. Efficient transmission of information turns out to be a factor in modeling the entire system of machine, interface and the actual user. This model suggests other design solutions. For example, there could be a taxonomy of voice types created, based on cognitive load and response times. Experimentation using this approach revealed that familiar (i.e. wives, girlfriends) further improved pilot performance. This optimization of communication and pilot mental work load corresponds to the *classical cognitivism/information processing paradigm*.

3. A pilot's wife's voice might be most familiar, but might lead to unpredictable pilot response when the couple was on the verge of divorce. When we include the social and emotional construction of meaning in our description of the situation, we see different implications and aspects than those that emerge in the design solutions of the other two approaches. In fact, the original female voice was reputed to have been selected for its sultry and seductive tone[1]. This quality reinforced the idea of the space of the cockpit being "male," echoed in movies like *Top Gun*, and became increasingly inappropriate as women became pilots and flight controllers. We call this the *third/phenomenologically-situated paradigm*.

While different paradigms focus on different problems, we can see that all three of these perspectives can peacefully exist – that whatever the solution, pilots should be warned of peril in a timely fashion, that measurable improvement in this context is better, and that the larger issues of the construction of problematic meaning also matter.

The paper lays out what structures and phenomena constitute these paradigms and reviews each with an eye towards understanding each in contrast to the others. Our example shows that the paradigms are not independent of one another in that we cannot talk about one without implications for the others. However, each paradigm takes a different metaphor of interaction as central to the enterprise of HCI. As a consequence, each has a different goal for interaction, leading to differences in the typical questions that each paradigm finds important to answer and to the utilization of different methods and criteria for knowledge creation.

Understanding Paradigms

To make this argument, we first need to explain what the term *paradigm* means in the context of HCI. Although the fundamental idea comes from Thomas Kuhn (1970), it has been refined and reformulated by Agre (1997), to apply more clearly and cleanly to systems that are not only discovered, but also designed.

Kuhn (1970) first used the term "paradigm" as a way to describe waves of research in a scientific field. The theory of scientific revolutions says that science progresses not only from a gradual accumulation of facts, but also by successive and overlapping waves which fundamentally re-frame ideas. These ideas may fundamentally alter the nature of what we take to be facts. Canonical examples of such paradigm shifts include the acceptance of continental drift by earth scientists and the shift from a mechanically elegant Newtonian physics to the messy and, at times, counter-intuitive relativistic physics.

Kuhn argued that a particular paradigm can be characterized by a common understanding of what phenomenon is being studied, the kinds of questions that are useful to ask about the phenomenon, how we should structure our approach to answering those questions, and how the results should be interpreted. Kuhn tracks changing paradigms in physics by noting shifts in the 'paradigmatic examples' (i.e. classic experiments) used in schools to teach the field.

Kuhn's model of scientific paradigms does not fully characterize thought in HCI, because of its focus on design as well analysis, and owing to our interdisciplinary breadth and the dearth of classical reproducible experiments and demonstrations in our field. We suggest, following Agre (1997, pp. 33-48), that paradigm shifts can be traced in HCI by tracing shifts in the underlying metaphor of interaction used in discussion.

Agre's theory of generative metaphors in technical work (1997, pp. 33-48) suggests that technical fields are structured around *metaphors* that guide the questions that are interesting to ask and methods for arriving at answers to them. So, for example, the metaphor underlying cognitive science – that human minds are like information processors – suggests questions such as: how do humans process their input, how do they represent information internally, how do they access memory, and so forth. It also suggests

[1] One interesting side effect was to gender popular media representations of flight control automata as female. Particularly notable is the original StarTrek computer.

methods for finding answers to those questions, for example that we can effectively model human mental activity using computational code and validate these models by comparing computational and human input and output. An important attribute of these metaphors is that while they by no means strictly dictate what is done in a field, they do bring certain phenomena into the center of investigation, while marginalizing others. In cognitive science, for example, it is relatively straightforward to analyze intellectual, abstract skills, but it has been more difficult for the field to model embodied skills.

An important difference between Kuhn's focus on scientific inquiry and Agre's emphasis on metaphor in discourse is that the notion of scientific inquiry implies an absolutist metric, in which one paradigm has to be right and the others wrong. Thus, Kuhn argues that Newtonian physics is wrong, though convenient. In contrast, Agre's approach allows metaphors to exist side-by-side without the necessity of reconciling all contradictions.

Following Agre, we argue that central to each paradigm in HCI is a different metaphor of interaction. Each such metaphor introduces 'centers' and 'margins' that drive choices about what *phenomena* constitute important descriptive qualities of interactions, what *questions* are interesting to ask about interaction, what *methods* are appropriate for studying and designing interaction and what *validation procedures* are required to establish knowledge claims about interaction. A paradigm shift, then, could be said to occur when a new generative metaphor is driving new choices of what to research and how, and can be identified when problems and issues that used to be marginalized have moved to the center.

Recognizing a set of ideas as a paradigm is important because it allows us to perceive and discuss the organization of thought at the level of a system rather than just as component pieces. Components take their relevance and meaning from within the operating paradigm. Paradigms provide broad perspectives that are useful for sorting out what problems are interesting and likely to be solved, to suggest success criteria for finding their solution, and to guide evaluation and acceptance of work in the field.

Scoping "Paradigms" – Paradigm or Framework?

Our use of "paradigm" is meant to be about big differences in world-views rather than particular methodological differences. The distinction between paradigms and frameworks is that, from within a paradigm, the reasons for a particular framework are basically comprehensible for investigators, whereas the issues involved in frameworks are considerably more complex across paradigms. Thus, ethnographic investigations and Activity Theoretic investigations are different enterprises that speak to one another. Likewise, those who use GOMS and cognitive walk-throughs can relate each others' work to their own. Based on the paradigms we'll outline below, other frameworks can be understood from within their encompassing paradigms and their contribution to HCI appreciated.

The Human Factors and Classical Cognitivism/Information Processing Paradigms

Using this model of paradigms, we can now characterize the first two paradigms of HCI. Looking back over the history of HCI publications, we can see how our community has broadened intellectually from its original roots in engineering research and, later, cognitive science. The official title of the central conference in HCI is "Conference on *Human Factors* in Computing Systems" even though we usually call it "CHI". Grudin (2005) provides a detailed history of the development of these two paradigms and their subdivisions.

HUMAN FACTORS

In origin, human factors is an a-theoretic and pragmatic approach to identifying problems in industrial systems and ergonomics. When applied to HCI, human factors conceptualizes interaction as *a form of man-machine coupling*. The goal of work in this paradigm, then, is to optimize the fit between humans and machines; the questions to be answered focus on identifying problems in coupling and developing pragmatic solutions to them. Occupying the center of the first paradigm are concrete problems that arise in interaction and cause disruption; at the margin are phenomena that underlie interaction but do not di-

rectly lead to noticeable trouble. The CHI conference and field still reflects these roots not only in its name but also in the use of simple performance metrics.

Classical Cognitivism/Information Processing

As Grudin (2005) documents, CHI is more dominated by the classical cognitivism[2]/information processing paradigm in which the central metaphor is that of the mind and computer as *coupled information processors*. Card, Moran & Newell (1983) start from the premise that human information processing is deeply analogous to computational signal processing, and that the primary computer-human interaction task is enabling communication between the machine and the person. Operations performed by one in pursuit of a goal affect the state of the other. By modeling the state of the person as well of the computer, we can predict and optimize the relationship. Like human factors, work starts by identifying a phenomenon or problem in the real world. What distinguishes this paradigm from human factors is that the phenomenon or problem is then abstracted to the form of a model, the more general the better. One power of this approach comes from the fact that the terms of the information-processing models hold within the computer, between the computer and the person, and within the person. Since the model is one of rational actors, operations can be measured in terms of the accomplishment of goals. Therefore, designs can be systematically evaluated against one another.

This cognitive-revolution-influenced approach to humans and technology is what we usually think of when we refer to the HCI field. At the center is a set of information processing phenomena or issues in computers and users such as 'how does information get in', 'what transformations does it undergo', 'how does it go out again,' 'how can it be communicated efficiently' and so forth. To appropriate Flyvbjerg's characterization of the state of modern social sciences, it places "rationality and rational analysis [as] the most important mode of operation for human activity" (2001, p. 23).

Experiments in human-computer interaction that take a task, such as "notification" or "awareness," and test two or more designs against one another follow in this tradition at least implicitly by postulating an underlying psychological state for the user that can be modeled and optimized.

This description of the two paradigms that have been dominant in HCI is not intended to imply that all research projects or researchers fit neatly into one of these two categories. Neither do the paradigms necessarily contradict one another. Work may be done that cuts across paradigms or that exists outside of them entirely.

What's Missing

The value of the space opened up by these two paradigms is undeniable. Yet one consequence of the dominance of these two paradigms is the difficulty of addressing phenomena that these paradigms mark as marginal. And paradigms do mark phenomena as marginal in consequential ways. A senior colleague recently commented during a research review on emotional computing "Everything is cognitive." She legitimately saw her task and the task of HCI in general as using the traction we have over the cognitive to maximize cognitive accounts. Less legitimately, she rejected the idea that not all phenomena of interest may be accounted for perspicuously with a cognitive lens. From this point of view, the meaning of the warning-signal voice to the pilot after a fight with his wife is not an HCI problem because it is noise with respect to the model.

Yet over the last twenty-five years a wide variety of approaches have emerged that appear to fit poorly the models and methods emerging from either human factors or classical cognitivism. These include participatory design, activity theory, user experience design, ethnomethodology, interaction analysis, and critical design. These approaches are often frustrating to cognitivist researchers who ask "what would we do dif-

[2] We first saw the term "classical cognitivism" used by Marco Iacoboni (????) to distinguish a "rational" model of cognition from more recently identified forms of cognitive activity such as mirror neurons. While the *rationality* of classical cognitivism applies to models of computation and formulations of artificial intelligence, we limited our use to models of human cognition in HCI. Much later in this paper, we will revisit cognition to speculate on how recent developments of neuroscience can reconcile some paradigmatic conflicts.

ferently because of the observations or findings that come out of these approaches?" They are asking a second paradigm, cognitivist/information processing question about we will call a third paradigm, phenomenologically-based, exploration. The third paradigm researcher would, in general, not seek a single, simple design implication that justified the exploration, but would instead use the thick description to instigate a design process whose outcomes were indeterminate, yet satisfactory (Dourish, 2006).

A THIRD PARADIGM---PHENOMENOLOGICALLY-SITUATED

Issues at the Boundaries

A paradigm shift can be tracked by noticing attempts to bring marginal issues into the center of attention. To show that a different paradigm is present we describe some of the contemporary strands of research that are currently marginal to HCI, but that suggest patterns at the edge of the information-processing metaphor and the need to grapple with alternative perspectives.

Dynamic Use Context

First, current work in ubiquitous and pervasive computing brings the *dynamic use context* of computing into central focus. Some methods of dealing with the importance of this context follow directly from the first and second paradigms, notably ones that attempt to identify and optimize information flow between mobile and ubiquitous devices and their context. These approaches model use-context as yet another source of information that can be formalized and transmitted to machines. But approaches to ubicomp that derive from disciplines such as ethnography, design, and the arts are based on the idea that use-context is, in the end, fundamentally innumerable, unspecifiable and must be dealt with by other means, e.g. (Dourish, 2004). From this perspective, describing identified factors and conditions is a crucial contribution. This kind of contribution does occur, but around the edges. Pervasive gaming takes changing context as a central focus for investigation (Benford, 2004a; Benford, 2004b; Benford, *et al.*, 2005; Benford, *et al.*, 2006), and often publishes changes in context as a central finding. However, context is not widely accepted as a centrally important notion. The notion of seamfulness (Chalmers & Galani, 2004) and the elaboration of where seams occur has been published in ToCHI and DIS, but is usually hidden in the rhetoric of a new form of activity.

Socially Situated

A related but distinct set of issues arises out of workplace studies, which focus on the *social situation of interaction*. These perspectives have often been hard to reconcile with HCI, leading to their parallel exploration in CSCW and PD. In particular, the centrality of social, situated actions in explaining the meaning of interaction is at odds with the information-theoretic view of social interaction that is at the core of the second paradigm (Aoki & Woodruff, 2005; Suchman, 1987). Activity theory, for example, is often incorporated into HCI work to the extent that it is used to create accounts of an existing situation, but its relevance is seen as limited. It is, for example, by-and-large not involved in discussions of design or evaluation.

Indirect and Multiple Goals

Dynamic use contexts and social situations lead to *indirect and multiple goals*. Consider the shifting goals of interactive learning technology: ultimately K-12 student learning goals are relatively specified, but the relationship between student experience and learning outcomes is speculative. Furthermore, student use of technology is mediated by a teacher who is also a user and whose goals and concerns must also be met by the design of the program. Tutorial programs that supplant the classroom are quite consistent with the second paradigm, tying learning tightly to information transfer, but 'information transfer' is a limited understanding both of what teachers mean by 'learning' and of what it takes to help learning happen in a sustained way. Classroom level interventions that utilize sophisticated, interdependent claims about fit entail complex reasoning about means and ends. The benefits of the technology have to do with its relationship to this complex setting rather than its prima facie novelty or unique contribution to learning.

Non-Task Oriented Computing

A fourth set of issues arises out of the domain of *non-task-oriented computing*, such as ambient interfaces and experience-centered design. These approaches tend to be bad fits to the first and second paradigms, whose methods tend to require problems to be formalized and expressed in terms of tasks, goals and efficiency - precisely what non-task-oriented approaches are intended to question. It is difficult, for example, to apply usability studies to ambient interfaces, since standard evaluation techniques are 'task-focused' in the sense of asking users to pay attention to and evaluate the interface, precisely what the system is devised to avoid. Alternative methods require discussion and thought and may involve values.

Handling Emotions

Yet another set of issues arise out of the marginalization of *emotion* in classic cognitive work. A wide range of approaches to emotion, notably those of Picard (1997) and Norman (2004), has been inspired by recent cognitive psychology, which argues that emotion plays a central role in cognition and models emotional exchange as a type of information flow. But other approaches to affective computing reject the equation of emotion with information and focus instead on the interpretation and co-construction of emotion in action in ways analogous to situated action approaches in workplace studies, e.g. (Begiun & Clot, 2004).

The Problem of Phronesis

In *Making Social Science Matte*r, Bent Flyvbjerg (2005) claims that social science, in general, brings a third form of knowing to intellectual debate. He points out that while we have cognates in many modern, Western languages deriving from two of Aristotle's components of knowledge, *techne* (technology with its entailments of skill, craft or engineering) and *episteme* (epistemology with its entailments of generalized knowledge or science), we have none for the third component, phronesis. *Phronesis* translates, roughly, to wisdom about ethical matters, and describes the idea of knowing about "things that are good or bad for man" (p. 57) or:

> It focuses on what is variable, on that which cannot be encapsulated by universal rules, on specific cases. *Phronesis* requires an interaction between the general and the concrete; it requires consideration, judgment, choice. More than anything else, *phronesis* requires *experience*. (p. 57)

The first paradigm marginalizes the idea that there may be generality to what is good or bad for humans. By promoting cognition as the fundamental metric, the second paradigm marginalizes the idea that there is knowledge in thinking more broadly about what is good or bad for humans (and the world).

A principal argument in this paper is that the apparent proliferation of alternatives to the two commonly identified paradigms in HCI---human factors and classical cognitivism/information processing---can be conceptually unified. There is at least one specific, additional, coherent paradigm with its own methodologies and legitimation that puts these issues in the center rather than the periphery of investigation.

The Third Paradigm, Defined

We are now in a position to define the third paradigm more precisely, following the framework developed in the first part of this paper. The third paradigm treats interaction not as analogous to information processing and transmission but as a form of meaning making in which the artifact and its context are mutually defining and subject to multiple interpretations. Such meaning making represents the creation of candidate culture.

The third paradigm contains a variety of perspectives and approaches whose central metaphor is *interaction as phenomenologically situated*. The goal for interaction is to support situated action and meaning-making in specific contexts, and the questions that arise revolve around how to complement formalized, computational representations and actions with the rich, complex, and messy situations at hand around them. Thus the three interlocking elements of the *phenomenologically situated paradigm* are a (1) focus on meaning and meaning creation, (2) based on human experience, and (3) therefore represented through multiple perspectives, and the relationship amongst those perspectives. We repeat that we are *not* saying

that human factors or cognitive/information-processing omit these altogether, but rather that these are the central focus within the third paradigm.

Because of its emphasis on multiple perspectives, the third paradigm does not espouse a single, correct set of methods or approaches to answer these questions. Instead, we see a variety of approaches that are embedded in a similar epistemological substrate. This substrate is analogous to a biological matrix, a compatible environment that supports the emergence of a heterogeneous variety of specific structures and connects them to one another. The third paradigm thereby fulfills Kurt Lewin's (1951, p. 240) demand that we "draw on the totality of coexisting facts which are conceived of as mutually interdependent" to explain, predict, and influence human behavior and experience. In a curious way, the third paradigm resembles the first in its ability to recognize issues phenomenologically. However, rather than eschewing theory, it adopts multiple theories or stances and considers them non-exclusively. The motivating differences between these paradigms are summarized in Table 1.

The description of the third paradigm should not sound new – many researchers in HCI are already working from this world view, although it has not been systematically recognized as such. One goal of this paper is simply to bring what already appears to be happening to the surface for conscious consideration. Indeed, an informal survey of the 151 long and short papers at CHI 2006 shows that 30 could be thought of as developed from the situated perspectives paradigm.

Intellectual Commitments

Intellectual commitments advanced by a number of different thinkers take on central importance in the worldview of the third paradigm.

1. The construction of meaning

The first paradigm tends to take a pragmatic approach to meaning, ignoring it unless it causes a problem, while the second interprets meaning in terms of information flows. The third paradigm, in contrast, sees meaning and meaning construction as a central focus. It adopts the stance that meaning is constructed on the fly, often collaboratively, by people in specific contexts and situations, and therefore that interaction itself is an essential element in meaning construction. Meaning derives from information, of course, but in this perspective cannot be summed up by mapping information flow; it is, instead, irreducibly connected to the viewpoints, interactions, histories, and local resources available to those making sense of the interface and therefore to some extent beyond the reach of formalization. This notion is at the heart of Suchman's *Plans and Situated Actions* (1987) and has been very important in understanding the limitations of systems designed to support interdependent groups; in other areas we see, for example, research on the value of ambiguity, notably the heavily cited work of Gaver, Beaver, & Benford (2003).

2. Seeing Users in Their Settings

If meaning is in some ways irreducibly local, then user knowledge is strongly situated as well. Following Haraway's definition (1988), the term *situated knowledges* refers to the idea that people's understanding of the world, themselves, and, in the case of HCI, interaction is strongly informed by their varying physical and social situations. Designing interaction, then, moves from attempting to establish one correct understanding and set of metrics of interaction to studying the local, situated practices of users, taking into account but not adjudicating the varying and perhaps conflicting perspectives of users. Aoki & Woodruff (2005), for example, argue for the value of CMC systems accommodating multiple understandings of what is happening in a relationship.

3. Putting interfaces in their place

McCullough's *Digital Ground* (2004), which treats ubicomp from an environmental design perspective, analyzes the significance of technologies becoming designed for or designed to adapt to specific locations, times, social situations, and surrounding systems. Broadly, 'putting interfaces in their place' is grounded in the recognition that the specifics of particular contexts greatly define the meaning and the nature of an interaction. Since all possibilities cannot necessarily be designed for, one design strategy is to design the computation and the interface as embodied. By designing the interface to fit into its intended

physical and social setting, much in the way that robotics has embraced the idea (Horswill, nd; Brooks, 1990; Steele & Brooks, 1995), and by drawing on the notion of the embodied human mind, the device or system does not have to model every contingency. Other strategies include location awareness or situation awareness, for example cell phones knowing if they are in a movie theater or if their owner is in the middle of non-phone conversation.

The first and second paradigms acknowledge context primarily as those non-technological factors that affect the use of the technology. They tend to notice those aspects of context that are salient with respect to what the designer has control over. We can describe these as primarily first order effects. The second paradigm may search for deeper explanations in response to a perceived problem, but its relevance is determined by how it relates to the interaction.

Under the third paradigm, the context ideally includes the totality of experience, including aspects that may be irrelevant to the immediate goal of the interaction. Researchers tend to ask not only "how does context give our design meaning?", but also "how does our design accommodate the context?" This latter question includes what researchers do *not* put into their design, their restraint, or "zensign" (diGiano et al., 2007; Tatar et al., 2007). It also encompasses the possibility that the technological system is reported not because, taken alone, it is particularly unique or attractive, but because of how it fits into the particulars of a complex situation. A consequence of this is that context is a central component not only to the problem (if any) but also to design and evaluation.

By framing this set of concerns in terms of a third paradigm, we can interpret the nodes and connections in activity theory as a particular set of structures that encourage or demand the researcher to take a broad view of context, especially second-order interactions. Thus, while activity theory researchers may have a profound commitment to those particular structures, they may also accept findings and descriptions from other researchers who similarly struggle to describe and utilize context broadly.

4. Putting researchers in their place

If users' knowledge is situated, so is that of the researchers studying them. Compared to the second paradigm, at least, the range of disciplines and perspectives constituting the third paradigm is remarkably catholic, ranging from the arts to sociology to policy. The goal does not appear to be to establish one of these disciplines as the gold standard. Indeed, one characteristic of the third paradigm is a preference for multiple interpretations that give a rich sense of the site of interaction over a single, objective description of it (Sengers & Gaver, 2006).

5. Explicit focus on values in design

Given that the phenomenological perspective highlights the variety of potentially valid viewpoints, evaluation of what makes a system a success can no longer be rooted *a priori* in measures said to be universally valid. Instead, we must ask questions about what it means for a system to be 'good' in a particular context – a question that quickly brings us to issues of values. Value-based approaches to HCI such as participatory design and value-sensitive design have come into use to establish new criteria of success - and therefore of decision-making - in system design and evaluation (Friedman, 1997). All HCI paradigms call for some form of explication and explicit negotiation of standards of success; however, values are usually background by the time design is under way.

Instead of being marginalized as a confounding factor, the context of design is seen as central, leading to questions such as "Who is making the design decision?", "Who is paying for it?", "What is this saying about the user?" and so on. Likewise, in aesthetic evaluation of interfaces, "elegance" is no longer exclusively premiated; it is just as likely that "appropriate" or "appropriable" are central aesthetic requirements.

6. The necessity, but inadequacy, of theory

In comparison to the first paradigm, the third paradigm has a much greater emphasis on theory as a resource for making sense of what is happening at the site of interaction. Nevertheless, because context is

seen as an equally essential ingredient for knowledge-making, the third paradigm recognizes that theory in the abstract has necessary limitations. In contrast to the second paradigm, which often sees theory as primary and design and evaluation as ways of instantiating, testing, and developing theories, third-paradigm approaches tend to focus on theory more as heuristics to be drawn on, with full understanding emerging from the combination of theoretical lenses and what happens practically at the scene of action – what Gaver calls "humble theory" (2006). So ethnographic and particularly ethnomethodological approaches, for example, tend to eschew *a priori* categories of interest in favor of discovering what emerges from interaction (Emerson, et. al., 1995). Similarly, cultural probes are purposefully constructed to avoid asking direct questions that would limit discovery to what is suggested by researchers' theoretical interests (Gaver, et. al, 2004; Boehner, et. al., 2007).

7. The underlying role of embodiment

Both the first and second paradigms recognize the human body and discuss some entailments of the fact that we live within bodies. In human factors, attention is paid to such qualities as the fit of a mouse to the human hand or the amenability of particular font sizes to be easily read. Cognitively based work in HCI has laid out physical constraints that usefully inform interface design such as the speed at which humans are able to react in various situations.

Embodiment in the third paradigm is more than optional. *Where the Action Is* (2001) argues for embodied interaction as a theme uniting tangible interaction, ethnographic and ethnomethodological approaches. Dourish emphasizes that embodied interaction does not involve primarily a shift in what we build but a more fundamental shift in the way we understand the nature of interaction: "*Embodiment is not a property of systems, technologies, or artifacts; it is a property of interaction…. In contrast to Cartesian approaches that separate mind from body and thought from action, embodied interaction emphasizes their duality*" (p. 189).

Klemmer, Hartmann, & Takayama (2006) go further than this. In a review of the literature on embodiment, they highlight five central implications an embodied stance has for the way we think about interfaces. A focus on embodied interaction moves from the second paradigm idea that thinking is cognitive, abstract, and information-based to one where thinking is also achieved through doing things in the world, for example expression through gestures, learning through manipulation, or thinking through building prototypes. It suggests that our GUI interfaces place too little emphasis on the differential abilities of the human body, overemphasizing seeing, hearing, and motor control of our hands, while under-supporting other senses and our physical abilities such as action-centered skills and motor memory. It refocuses attention from the single-user / single-computer paradigm that has dominated the first and second paradigms towards collaboration and communication through physically shared objects. It highlights the importance of risk as a positive aspect of embodied practice; there is no undo button in the real world. Finally, it reminds us that, while under the first and second paradigms we have tended to focus on aspects of activity that are easily automated, real-world practice is complex and rich, interleaving physical activity and awareness with abstract thoughts, rituals, and social interaction in ways that defy a purely informational approach.

Dourish's proposition and Klemmer *et al*.'s implications are indeed radical. From these points of view, embodied interaction is not only a shared intellectual commitment, but also a crosscutting perspective at the heart of other commitments in the third paradigm. Not only do they put physical embodiment – i.e. having a body - into a central, defining role, but they argue for the centrality of a linked viewpoint, in which all action, interaction, and knowledge is seen as embodied in situated human actors. At base, this rejects a simple view of the mind as an information processor, putting a non-information processing viewpoint in the center of understanding.

Furthermore, Dourish and Klemmer *et al*., argue that the embodied perspective is by itself a shift to recognizing a plurality of perspectives and appreciating the value of accommodating those differences rather than trying to reduce them to one single perspective. The commitments that we identify in a range of literatures in HCI to meaning, plurality, location, context and an ongoing search for necessarily inadequate

theories are a consequence of the human, embodied experience of partial, fragmented knowledge. The approach does not rule out global knowledge, but it focuses on the ways in which global claims must be rooted in the local.

Thus, a perspective drawing on embodied interaction is not simply a different topic for standard HCI methods, nor only a different understanding of what is salient about interaction. Rather, this perspective is grounded in substantially altered epistemological commitments to first- and second-paradigm HCI. These commitments systematically lead to changed research questions, methodologies, and forms of design and evaluation – in other words, a third paradigm.

8. The Term "Situated"

As identified by Béguin & Clot (2004), there are at least three widespread definitions of the term "situated": the interactionist, the ecological, and the cultural. In the first, the situation is an account of the "full range of resources that the actor has available to convey the significance of his or her own actions, and interpret the actions of others" (Suchman, 1987, p. 118). This definition focuses on the genesis of action in the relationship between the action and the material and social circumstances of that action. It asks how society is produced by behavior (Goffman, 1959). A second definition stems from ecological psychology (Gibson, 1979). In this, the situation is that part of the organization of action that is taken care of by the environment, whether designed or pre-existing. This definition often leads to questions about how we arrange the world. Hutchins (1995) builds on this to attain a third approach in which (1) the connection of cognitive and cultural artifacts is emphasized and (2) the individual acts in a way situated by the presence of others in the distributed system of the group in which the individual is operating. This approach is often associated with questions about the relationship between individuals and the movement of information between systems elements.

All of these are systems approaches in that they seek to explain or account for the relationship between system elements and activities. In this sense, all of these definitions are encompassed by the third paradigm (although the Gibsonian term "affordance" is frequently utilized in second paradigm work not as a specific claim about the match between properties of a system and properties of the human(s) using the system, but rather as a general term of praise).

Intelligent and important discussions may be held about the relationship between these definitions of "situation." However, all of them stand in contrast to cognitive approaches that use the same term. For example, modern, scientific social psychology is hugely influenced by the power of cognitive explanations. One of its underpinnings is actor-observer theory, the idea that people have a systematic cognitive bias in which they err by attributing another person's behavior to personal disposition (e.g. to the person) rather than to the setting (e.g. any relevant aspect of the person or environment other than stable personality dispositions) (Ross and Nisbett, 1991). The conclusion of actor-observer theory is that the situation has undue influence on the observer's belief about the actor. This is a (triumph of) second paradigm understanding, but it does not address the social system. Although the word "situation" is used to produce this generalizable rule, situation in the third paradigm sense is background rather than foreground.

	Paradigm 1: Human Factors	Paradigm 2: Classical Cognitivism/ Information Processing	Paradigm 3: Phenomenologically Situated
Metaphor of interaction	Interaction as man-machine coupling	Interaction as information communication	Interaction as phenomenologically situated
Central goal for interaction	Optimizing fit between man and machine	Optimizing accuracy and efficiency of information transfer	Support for situated action in the world
Typical questions of interest	How can we fix specific problems that arise in interaction?	What mismatches come up in communication between computers and people? How can we accurately model what people do? How can we improve the efficiency of computer use?	What existing situated activities in the world should we support? How do users appropriate technologies, and how can we support those appropriations? How can we support interaction without constraining it too strongly by what a computer can do or understand? What are the politics and values at the site of interaction, and how can we support those in design?

Table 1: Paradigms compared

Different Ways of Knowing

Each of the paradigms described in this paper involves a different central phenomenon of interest, different sets of questions that are considered interesting or useful to ask, and different kinds of methods considered appropriate for answering those questions. Uniting these different aspects for each paradigm are differing conceptions of what it means to know something is true. Our goal in this section is to outline the contrasting epistemological commitments of the different paradigms, summarized in Table 2. Because the first-paradigm is less oriented to systematic knowledge production than the second or third, we will primarily discuss contrasts between second- and third-paradigm epistemologies.

1. Objective vs. subjective knowledge

The first and second paradigms emphasize the importance of knowledge that stands alone. Such knowledge is considered to be objective. Its merit is that it may be applied without regard to the specifics of the situation. The third paradigm, in contrast, treats knowledge as intrinsically tied to the situation. In some frameworks within the paradigm this is reflected in a focus on multiple viewpoints. In others, general patterns exist, which may be considered objective, such as the notion that people tend to delay saying "no" in an utterance responding to a request while they premiate "yes" (Pomerantz, 1984). Thus, there will be a longer pause before someone starts a request denial and the actual bad news will appear later in the sentence than the good news in an affirmative reply. However, as much importance is placed on the occasions in which people behave differently as on those in which they follow the rule, because the behavioral rule is seen as part of the construction of meaning. As Emmanuel Schgloff said in a talk long ago, a fraction consists of a numerator and a denominator. From an ethnomethodological point of view, the denominator must always be subject to consideration and challenge. If we are seeking an account of phone answering and we discover that people answer the phone 99 times out of 100 by saying "hello" but on the 100th time, someone says "Joe's pizza," our account of phone answering must include the unusual case, because it is not a statistical aberration, but, under some circumstances, a perfectly reasonable way to answer the phone for the participants (Schegloff, 1989).

	Paradigm 1: Human Factors	Paradigm 2: Classical Cognitivism/ Information Processing	Paradigm 3: Phenomenologically Situated
Appropriate disciplines for interaction	Engineering, programming, ergonomics	Laboratory and theoretical behavioral sciences	Ethnography, ethnomethodology, ethology, action research, practice-based research, interaction analysis
Kind of methods strived for	Cool hacks	Verified design and evaluation methods that can be applied regardless of context	A palette of situated design and evaluation strategies
Legitimate kinds of knowledge	Pragmatic, objective details	Objective statements with general applicability	Thick description, stakeholder "care-abouts"
How you know something is true	You tried it out and it worked.	You refute the idea that the difference between experimental conditions is due to chance	You argue about the relationship between your data and what you seek to understand.
Values	Reduce errors Ad hoc is OK Cool hacks desired	Optimization Generalizability wherever possible Principled evaluation is *a priori* better than ad hoc, since design can be structured to reflect paradigm Structured design better than unstructured Reduction of ambiguity Top-down view of knowledge	Construction of meaning is intrinsic to interaction activity What goes on around systems is more interesting than what's happening at the interface "Zensign" – what you don't build is as important as what you do build Goal is to grapple with the full complexity around the system

Table 2: Epistemological distinctions between the paradigms

From a second paradigm point of view, the status of knowledge in the third paradigm is by definition subjective, in part because there may always be another case. The implications of the model are hard to interpret. Furthermore, situated viewpoints represent more than breaking the mirror of objectivity into fragments, instead recognizing the subjectivity of the researcher and the relationship between the researcher and the researched (Chalmers & Galani, 2004; McCarthy & Wright, 2004). Indeed, this recognition is essential to participatory design. Yet where issues of intersubjectivity are common in anthropology and education, they are remote and difficult to address in the second paradigm. At the same time, the third paradigm often sees the dominant focus on models and objective knowledge as suspect in riding roughshod over the complexities of multiple perspectives at the scene of action.

2. Generalized vs. situated knowledge

The second paradigm starts from observation of real behaviors or think aloud protocols, but values generalized models, as exemplified by GOMS ("Goals, Operators, Methods and Selections") in Card, Moran, and Newell (1983) and Keiras (1983). But because the third paradigm sees knowledge as arising and becoming meaningful in specific situations, it has a greater appreciation for detailed, rich descriptions of specific situations. In part, this refers back to the arguments around situated action, which argued that while abstract knowledge and formalisms are certainly useful, they do not directly drive or explain our activity in the world. To better understand what people are doing, we need to track the situated contingencies and strategies people use to apply this abstract knowledge in real situations. Where the second paradigm down-played whether an office had books in it or that a computer sitting under a desk produced

lots of heat when analyzing mouse performance, that the third paradigm recognizes that "externalities" are often central figures in the understanding of interaction.

3. Information vs. interpretation

The second paradigm arises out of a combination of computer science and laboratory behavioral sciences that emphasizes analytic means such as statistical analysis, classification and corroboration in making sense of what is going on at the site of interaction, often under controlled conditions. As Sengers & Gaver argue, however, new approaches to HCI see interaction as stimulating multiple interpretations in concrete, real-world situations, and the job of the evaluator as identifying and tracking those interpretations, often in collaboration with their 'subjects' (Sengers & Gaver, 2006). The epistemological stance brought to this site is generally hermeneutic, not analytic, and focuses on developing wholistic, reflective understanding while staying open to the possibility of simultaneous, conflicting interpretation. As Bannon writes, "Our critique relied on the centrality of interpretation in the conduct of work, and also on the fact that the development of computer-based applications requires the collaboration or involvement of a variety of distinct communities.... [characterized by an] essential incommensurability of their world views and languages" (Bannon, 1995).

4. "Clean" vs. "messy" formalisms

The second paradigm, reacting to the a-theoretical orientation of the first paradigm, values clean, principled, well-defined forms of knowledge. The third paradigm, in contrast, sees the practical trade-offs in design as more often "messy" rather than principled. Paradigmatic for the second paradigm, for example, are design spaces, which are, as Tatar argues (2007), clean, mathematical representations of what is at stake in design and suggest that design decisions can be made independently of each other and with little regard for context. Tatar contrasts design spaces with 'design tensions', a series of (non-orthogonal) axes laying out conflicting design opportunities that come out in practice, the contextual issues that they impinge upon, and the ways in which they may be practically negotiated. The difference between these ways of thinking is rooted in whether researchers place the cleanliness and certitude of formal models at the center of their thinking or whether they instead place an appreciation for the complexity of real-world, messy behavior and activity at the center.

Clarification: The Role of Design

HCI encompasses both analytic and design components. However, each of the paradigms has differing goals with respect to design. As Wright, Blythe, and McCarthy (2006) discuss, the notion of what design is and how to approach it looks different in different paradigms. The underlying metrics of evaluation of each are reflected in differing aesthetics of "good design." For the sake of contrast, we cartoon the different relationships design and analysis have in each paradigm:

1. Human Factors

In valuing "usability", the human factors paradigm adopts the idea of variance reduction from engineering. To put this in the context of process, designing in the first paradigm is integral with, but post-facto to the human factors enterprise. Designs are constituted as problems and solutions. Initial designs are solutions to problems understood in previous designs. Since critical incidents (the "coin of the realm" of human factors) are most often failures during use, new design knowledge is primarily created in use or use-like testing.

2. The Classical Cognitivism/Information Processing

Design in the second paradigm is principled. Although in practice it relies upon heuristics and conventions for much of its basic knowledge, there is a fundamental difference from the first paradigm in when, how, and by what means evaluation is carried out. User testing looks for process improvement along the lines of information theory that therefore can be validated without full-deployment or simulation of the final conditions. This means that evaluation is often tightly coupled with creation – in fact, design is often constructed as hypothesis-testing, rather than problem-solving. It is for this reason that the scientific (or

perhaps quasi-scientific) aspects of HCI can seem to make design appear secondary[3]. One structural consequence of being built on a single set of principles is that design can be more clearly organized in top-down and goal-directed structures. This orderliness can be seen, famously, as constituting a *science of design* (Simon, 1996).

3. The third, Phenomenologically-Situated paradigm

In the third paradigm, design is an element of enquiry. Since interaction is seen as an element of situated action in the world, the understanding or construction of the situation is the core of the design. In this, the intellectual questions that form the analytic frame are intrinsic elements of the design process. Thus, problems, hypotheses and solutions are not the primary construction of design moves.

Design schools teach semiotics, or meaning construction, because semiotic thinking provides a way of encouraging students to explore the evocative potential of their designs. This focus on phenomenology in design pedagogy can be confusing from the outside, because it may seem to equate semiotic approaches and design. However, this is not accurate. In fact, designers have many other techniques for evaluation, and may use semiotic approaches in relationship to other paradigms.

Nonetheless, different constructions and approaches to design are better fits for different paradigms. So, for example, Fallman describes a 'conservative' account of design that sees it as a problem-solving activity. In this account, once a problem is analyzed and defined, a solution can be achieved through a succession of design decisions that are based entirely on the problem definition and the project's constraints (Fallman, 2003); such an approach aligns well with the first and second paradigms. Other approaches to design highlight a more situated approach to design and a more provisional relationship to theory or construction of truth (Gaver, 2006); critical design, for example, which highlights design as an opportunity to spur reflection on political, social, and cultural dimensions of technology, is a natural fit for the third paradigm (Dunne & Raby, 2001).

In sum, design is not at home in a single paradigm; instead, each paradigm takes a different stance towards design. Particular design practices may be a better or worse fit for the paradigm depending on what constitutes a contribution and what counts as success.

Getting the Best out of Multiple Paradigms

Because HCI is an interdisciplinary field, it would be easy to argue that issues around validity and evaluation are already too confusing. What added value is there to HCI from an explicitly identified third paradigm? Here, we outline three major advantages to the field of fully embracing at least one additional paradigm:

(1) we will develop a better understanding of interaction;

(2) we will recognize good work when it occurs; and

(3) we will increase the validity of our methods and knowledge.

Better understanding of interaction

Each paradigm takes as central a different metaphor of interaction. Based on this metaphor, each paradigm is able to centrally focus on and address different kinds of phenomena, and to leave different phenomena at the margin. Different paradigms therefore lead to different kinds of questions which are seen as important to answer. Thus, the first advantage of recognizing additional paradigms arises from the realization that, whatever our personal stance to research, **multiple paradigms allow the field as a whole to develop a more complete overall understanding of the nature of interaction and good practices around design and evaluation**.

[3] This may be one fundamental source of the tension between design and analysis in HCI.

Indeed, if we wish the field to be consequential, we must explain important questions. However, many questions which have clear social, cultural, and economic importance for present-day interfaces are difficult to address within first- and second paradigm frameworks. For example, in these paradigms, it is difficult to explain why people play games or why there are more Windows machines than Macintoshes. The advantages of aesthetics are challenging to understand, since the value of a nice looking interface must be expressed in functional terms. For example, instead of talking about emotional design as significant in its own right, Don Norman (2004) cites studies showing that good-looking interfaces produce more efficient outcomes. Isn't engendering a rich emotional experience enough of a reason to be interested? If ugly interfaces were more efficient, would that close the discussion down? Furthermore, there are legitimate questions about equivalency of designs rather than differences between them that cannot be well explored using statistical methods.

Multiple perspectives allow us to approach interaction more broadly. This insight is to some extent acknowledged in HCI practice; the enthusiastic proliferation of alternative practices is itself a sign that HCI researchers and reviewers recognize the need for wide lenses on interaction. The recent addition of "community" structure to the CHI conference, for example, may be seen as a reflection of the notion that some new perspectives ought to be acknowledged.

Recognition of Solid Contribution

While the recognition of multiple paradigms allows us to deal with a broader array of questions in the field, it is equally important to recognize that there are substantial differences in the way that different paradigms structure their approaches to answering these questions. As a consequence, the nature of validity necessarily undergoes substantial alteration as we move from one paradigm to another. Notions of validity drawn from one paradigm fail to accurately characterize a solid contribution of work in another paradigm. Therefore, the second advantage of recognizing an additional paradigm is the realization that **we must develop differing standards of validity for work in different paradigms in order to be confident of recognizing good work in each paradigm**.

While the value of multiple perspectives is likely broadly accepted in HCI, the insight that different perspectives require more nuanced and contextual understandings of validity appears a poor fit to HCI practice on the ground. The primary challenge, then, for the third paradigm to fully bloom is to break out of the standards that have been set up by incompatible paradigms. Doing so is not easy; the results so far have been, in part, a series of misappropriations, misunderstandings, and rejections of work resulting from the third paradigm because it poorly fits ideas of method and validity arising from previous paradigms. There are numerous kinds of problematic mismatches.

External Legitimization Needed to be Acceptable

Dourish (2006) argues that 20 years after the introduction of ethnography into the HCI canon, it is still systematically misunderstood as a method for extracting user requirements rather than a discipline that analyzes the entire site of human-computer interaction. Thus, currently, an ethnography, by itself, does not, for example, constitute a legitimate CHI publication without an additional instrumental component such as user requirements or an evaluation of the interface using information-processing criteria.

Legitimate Approaches Which Are Not Accepted

Of course, when paradigms clash, problems may arise. An example of such a clash is the 'Damaged Merchandise' controversy in the mid-'90's, in which Gray and Salzman argued not only that specific pragmatically-oriented approaches to usability evaluation are invalid, but also that usability can be validated only through the scientifically and theoretically grounded methods of the second paradigm (Gibson, 1979; Gray & Salzman, 1998; also see Friedman, 1997). Similar clashes, we would argue, are appearing now.

Measuring Success, Measuring Contribution

In the second paradigm, measuring contribution is equated with measuring success of the system; this is convenient because both paradigms measures of success by measuring the comparative effectiveness and efficiency of information transfer. User self-reported satisfaction might suffice, but is seen as a poor

cousin to efficiency. Measures of success from the third paradigm incur a variety of fates when reviewed from this perspective. Some criteria, such as delight, are not seen as legitimate criteria at all. Other criteria, such as provoking ideas or causing the reader to consider new possibilities, are not considered sufficient criteria of success. Furthermore, balancing the concerns of different stakeholders in a clever way, or enabling activity that would otherwise simply not be possible are not by-and-large sufficient measures of success.

As Grudin (2005) has documented, we see the rise of specialty research communities such as ICLS ("International Conference on the Learning Sciences") or ECSCW ("European Conference on Computer Supported Cooperative Work"). These do not, as they might, form new sub-disciplines with a more particular set of methods, values and aesthetics, but rather *adopt independent standards*. When we fail to recognize good work and drive it out of our community, the result is a loss to the HCI field.

Valid methods and knowledge

Lack of recognition of the differences among the paradigms can lead to acceptance of invalid methods and knowledge as part of the canon of HCI. Inappropriate expectations for third paradigm work, impatience with classical cognitivism/information processing approaches and confusion about the sources of validity in the third paradigm contribute to this.

In particular, in order to be represented in central HCI venues, third-paradigm work is often required to conform to inappropriate standards in addition to or instead of its inherent forms of validity. For example, Boehner et al. (2007) have explored the adaptation of cultural probes in HCI from its original intention as a situated, dialogic, open-ended method to a standardized recipe for extracting user requirements. These changes are sometimes invisible to the researchers involved – apparently deriving from a conviction that a method *must* be intended in first- or second-paradigm modes and a systematic blindness to other possibilities – or are described by researchers as improvements that put the third-paradigm work on more solid scientific footing. In the process, the forms of validity embodied in the original probes, which rest on personal engagement between designer and those designed for, rich and situated interpretation of the probes, and recognition of their fundamental ambiguity, are lost. At the same time, the probes have not been subjected to the development and testing process associated with "stimuli" in classical cognitivism/information processing. Equally often, second-paradigm trappings such as graphs and statistics are applied superficially and fail to adequately support the generalizations researchers make from probes. The results end up looking valid from *neither* second- *nor* third-paradigm perspectives.

Although we believe that third paradigm work is the primary casualty of methodological friction, we have also sometimes observed a narrowness in the review and evaluation of the products of classical cognitivism/information processing. Sometimes reviewers reject out of hand clever operationalizations and the philosophy of replication and extension of experiments that (ideally) extends from paper to paper in the second paradigm. They do not seem to have patience with the need to build second paradigm generalizations through predictions that may require deliberate, controlled distortion of the "real world." When the existence of different kinds of contributions is not recognized, people may ask all contributions to be the kind that they themselves favor.

Confusion about the sources of validity in the third paradigm can also lead to a diminution of quality. The *thick description* (Geertz, 1973) and associated argumentation is key to the presentation of phenomena, but recognition of thick descriptions and interesting arguments itself requires expertise in the domain. Inadequate evaluation or the hope of encouraging junior researchers can lead to tolerance for thin thick descriptions, especially if the lack of depth in the descriptions is difficult to pinpoint.

The purposes of the third paradigm include perceiving first, second and higher order effects of systematicity, and striving to see the structures at all levels that have not previously been perceived. The act of being able to write well about structure, meaning, and experience is the meta-method associated with quality in this area. Hallmarks of this are precision in the use of words and descriptions, framing the observations to speak to extant and enduring themes in the observation of how humans accomplish the work

of creating the social and artifactual worlds around them, and the presence of meaning creation as a theme.

Hybrid-work may be of crucial importance. Indeed, our impetus to write this paper springs in part from the efforts of some of the authors to conduct hybrid-work. However, despite the recipes given in such primers as *Research Design: Qualitative, Quantitative and Mixed-Methods Approaches* (Creswell, 2003), these cannot be easily conducted. We cannot build on approaches that simply ignore the epistemological foundations of the paradigm that they implement. Such work must either attempt to live up to the standards of all the paradigms it draws upon, or must explain the rationale and reasoning behind the choices and arguments and qualify the findings appropriately.

Methods Alone Are Not Enough

As Boehner *et al*. (2007) argue, inappropriate alterations to third-paradigm methods appear to derive, in part, from a naïve conception that methods alone can guarantee the validity of research results, without reference to their underlying methodology, or the underlying principles which organize a particular approach to research and substantiate resulting knowledge claims. Because techniques arising from the third paradigm are not seen as inherently valid, methods and insights from alternative perspectives are often simply amalgamated to informational or engineering perspectives, without recognizing or dealing with the very real incompatibilities between these perspectives. While discussion of methods is extremely common in HCI literature, there is relatively little discussion of methodology or even, apparently, understanding that methods need methodology in order to make sense. As a consequence, we see the adoption of a small number of recipe-like methods as rigid standards for truth.

As represented in accepted papers, the CHI conference holds controlled experimentation with a few kinds of quantifiable outcomes in extraordinarily high esteem[4]. The canon of acceptable methods is even more confined than that in modern scientific psychology, as many of the most famous psychological studies involve quasi-experimental or demonstration designs (Gerrig & Zimbardo, 2002). Furthermore, even experiment-based theories that grapple with highly contextual content may be seen as insufficient in HCI, because they are difficult to apply without training and thought. Monk, for example, concludes his discussion of Clark's theory of language as follows:

> "In an ideal world, a theory should be encapsulated as a set of guidelines or rules that could be used by a designer with very little background in human factors of human communication. Falling this, the theory should be formalized as principles…. the theory is only really usable by researchers…." (Monk, 2001, p. 288).

Insofar as HCI claims to be a scientific discipline, this is a surprising declaration. Insofar as it is an engineering discipline, we note that civil engineers are required to have a considerable understanding of basic physics, followed by considerable instruction in how that physics relates to real materials and conditions before they are certified to build bridges. It is not the theory's job to be simpler than the phenomena it describes. In any case, such limited guidelines or rules run counter to understandings of the complexity of interaction that arise from the third paradigm.

Divorcing method and methodology, and replacing nuanced discussion of how methods relate to methodology with rigid methods said to guarantee truth is a substantial problem for any paradigm, not just the third. In order to create valid knowledge in any paradigm, researchers must adapt methods to particular problems and invent appropriate new methods. To do this correctly, they must understand the frame within which they are working. This is as true for good experimental laboratory research as it is for good contextual fieldwork.

[4] By rough count, at least 90 of the 151 long and short papers in CHI 2006 reported quantified results. We cannot, of course, know how well the accepted papers represent the rejection criteria.

Differentiating Quality in the Third Paradigm

It appears that evaluators are uncomfortable with their ability to differentiate high-quality from low-quality work in the third paradigm with the result that methods are often inappropriately altered. There is no simple rule. Intelligent, well-meaning people may differ.

Therefore, reviewing third-paradigm papers cannot be handed to graduate students with little oversight. Papers must be judged by critical theory methods, including their resonance with prior literature with respect to complex recurring themes in human behavior. Specialized language and (worse) specialized usage may be involved. For example, for many years, CSCW papers would have phrases drawn from ethnographic usage such as "doing being a student" or "doing being a secretary" to acknowledge and emphasize the idea that roles are not static but must be continually achieved, and defined through interactive activity. This was a manifestation in a pragmatic, engineering context of an important finding in a number of fields (ethnography, ethnomethodology, sociology) that fed the third paradigm, but was not easily evaluated or understood from the outside.

Within paradigms, there are differences between and within each of the constituative frameworks. For example, at the CHI 2009 conference, "Ethnography Considered Harmful" (Crabtree *et al*., 2009), argued that only ethnomethodolgically-informed ethnography is useful and valid for HCI. The issue was hotly debated in a panel with subsequent publication expected to document the various responses.[5] This "my method is the one true method" or "my phenomenology can beat up your phenomenology" disagreement provides an example of the difficulty even within a paradigm to agree on quality. However, the points of overlap between sub-disciplines can give a starting point for general assessment. Some examples of basic cross-cutting third paradigm metrics might be:

- *How well is the work grounded in a particular situation and how well is that communicated?* That communication might be assessed in either a publication or a designed artifact.
- *Do we know who the actors are and precisely what their actions were?*
- *Does the framing fit?* In many situations, it might also be, *how well does the framing generalize?*
- *Are the particular stances of the parties understood? How do we know?*
- *Is the system of meaning-creation in the situation of study explicated? If the work includes design what is the relation of the analytic system to the system of meaning-making of the designers?*

These are not the sort of assessments that would be foremost amongst either the first or second paradigm. The third advantage, then, of recognizing that there are at least 3 paradigms in HCI is **that we are able to recognize the differences in methodology between paradigms and therefore increase the likelihood of valid methods and knowledge in each paradigm, as well as in hybrid work**.

Discussion: "Third" Things

We have used the term "third paradigm" quite often so far without acknowledging either its obtuseness as a term or that some others have organized HCI into three paradigmatic elements which might cause confusion. We will very briefly distinguish our three paradigms from the complex historical structure that Jonathon Grudin identified in "Three Faces of Human-Computer Interaction" (2005) and the structures that Suzanne Bødker used in "When second wave HCI meets third wave challenges" (2006) – and we will also revisit the significance of "thirdness" in the context of a phenomenological realm to explain why "third paradigm" is a useful and appropriate shorthand as well as "phenomenologically-situated".

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[5] In this case, the paper argues that ethnomethodogically-informed ethnography is the only ethnographic method that produces results that the authors can use to inform design. This seems a case of not understanding that different designers want to inform design using different data and experience. It also does not acknowledge the observation made by Horst Rittle that wicked problems can have multiple formulations each of which would result in a different design solution. That is, the argument of the paper is that the sorts of design problems as defined by the paper's authors can best be addressed by ethnomethodolologically-informed ethnography, and not at all by any other kind of ethnography.

Two Other Three-Part Organizations of HCI

We have previously referred readers to Jonathon Grudin's extensive history of HCI (Grudin, 2005). He identifies the evolution of HCI from three research foci: computer operation, information systems and management, and discretionary use. These foci map to various user communities: Human Factors and Ergonomics (operation and data entry), HCI for MIS (managerial use), and Computer-Human Interaction (discretionary hands-on). His Figure 1, a timeline, shows the diverging and overlapping elements of the three research foci[6] (Grudin, p 8, 2005). Grudin uses the term "faces" rather than "paradigms" to categorize these groups. We consider this appropriate. While the various "faces" address slightly different and temporally shifting core questions, the methods and values Grudin describes often substantially overlap.

Suzanne Bødker also organizes HCI into three technology and analytic "waves" with some overlap with our paradigm structure. The first wave is not discussed, but we assume it to be batch-processing interaction with computers and therefore aligning with the early years of Grudin's first face. The second wave is personal computing which would very loosely align with Grudin's third face. The main purpose of the paper is to raise the challenge that single user frames do not work well when confronted by context, multiple and unknowable applications, places of use, new modalities of interaction, etc. This is done with an eye towards reconceptualizing participatory design and exploring new methods necessitated by shifting technological capabilities.

Neither of these publications addresses the pervasiveness of intellectual frameworks issue head-on. For example, Grudin argues that legitimate knowledge for one community would be found in a journal article while another would find it at a conference like CHI rather than there being a paradigmatic disconnect about the sorts of knowledge that are legitimate. Bødker argues from a user-world view shift rather than the expansion of legitimacies we are advocating. However, Bødker does imply that an expansion of legitimacies would be the inevitable result of this shift in world view and therefore, we encourage careful reading of that paper as an example of how the third paradigm might free second wave researchers stuck in third wave dilemmas.

What's in a Name?

This now brings us to a final digression about the name we have been using for the third paradigm. In fact, as our thinking about the paradigm has evolved, we have tried many different names. Our first name for it was "*phenomenological matrix*" trying to suggest the multiplicity of phenomenologies and more specifically, how, like a biological matrix in a Petri dish, understandings would grow on them; this term never always seemed to need explanation and the authors had trouble using it in easy conversation. "*Situated understandings*" was a nod towards the significance of Lucy Suchman's work challenging the classical cognitivism of the second paradigm and positivist tendencies of technology research, in general; it was discarded as being too limited in scope. "*Embodied and situated*" was another – quickly discarded – attempt to use more-or-less familiar terminology in a direct and accessible fashion; ironically, direct and accessible seemed to miss the point of the third paradigm – trying to contain it with second paradigm acoutrements. A few other problematic names were "*meaning-making*", "*post-cognitive*", "*semiotic enterprise*", "*HCI - the next generation*", and "*Curly*" (after the third of the Three Stooges).

On "Thirdness"

At the time of this writing, the authors have settled on *phenomenologically-situated*, but find ourselves using "third paradigm" more often. Beyond its value as shorthand nomenclature, the term has coincidentally relevant roots. The American philosopher, Charles Sanders Pierce, developed a structure of meaning relations divided into three elements[7]: *representamen* (the sign itself), *object* (the thing that is represented), and *interpretant* (the sign in the mind that results from one's signification encounter). This tripartite structure derives from a more fundamental observation of Pierce's on the nature of categories:

[6] We strongly encourage thorough study for verification of the various communities visibility and invisibility to one another.

[7] This is in contrast to Saussure's more familiar structure of a sign being composed of the signifier and signified. Most design school semiotics begin and end with Saussure's self-contained dyad.

Pierce had seen that there were three universal categories (meta-categories) of category formation[8]: *firstness*: quality of feeling, a reference to a ground, experienced as ideas; *secondness*: reaction or resistance, reference to correlate, experienced as brute facts; *thirdness*: representation, reference to an interpretant, experienced as a representation. While it is tempting to immediately map the three paradigms presented here to Pierce's structure, it does not work. (They are, of course, meta-structures appropriate to categories within each of the three paradigms.) We do, however, take Pierce's three elements that form the robust model of categories as a talisman of the need for robustness in describing the HCI enterprise and use the overloading of "*third*" (both Pierce's form and the HCI paradigm) as a gateway to making it work. It is this association that legitimizes the experiences of life as elements of HCI and suggests ways of giving them form.

Discussion: Where's the Science?

From a second paradigm point of view, the contribution of HCI may be thought to rest on empirical, generalizable, scientific results. The third paradigm does not promise to address these contributions. Yet a careful look at the state of the second paradigm identifies several kinds of needs for third paradigm thinking.

First, many fields that feature empirical investigation such as that advocated by the second paradigm also build on a substantial tradition of systematic observation of phenomena similar to that advocated by the third paradigm. For example, the Linnean classification of organisms was a major empirical contribution to biology though not, in origin, experimental.

Second, the empirical status of second paradigm thinking is itself subject to question. Critics raise the question of whether true scientific theory is possible in the social sciences on which much second paradigm epistemology is based. Flyvbjerg, for example, argues that "the problem for social studies is that the background conditions change without the researcher being able to state in advance which aspects one should hold constant in order for predictions to continue to operate" (Flyvbjerg, 2001, p. 45).

Of course, criticizing the nature of science as conducted in the second paradigm does not make the third paradigm more scientific. What it does is raise the question of what science is in HCI and whether scientific criteria are the best and most apt ones for the field.

Discussion: Science or Substantiation?

Even under the second paradigm, we in HCI are not pursuing abstract truth in general, but rather in more particular, technologically defined ways. We are interested in generalizability, but generalizability of meaningful design decisions or meaningful distinctions. For example, we no longer do research on emacs keystrokes because the emacs text-editor is no longer widely used. Our questions are almost always local and provisional.

Perhaps rather than searching for science, part of the field tacitly is searching for *substantiation*: reasons that I can understand and believe what you say. All paradigms represent ways of coming to know about the world, and all require continual reflection about goals, purposes, assumptions and legitimacy. In many areas of HCI, particularly those centered in the second paradigm, the forms and paraphernalia of science are used to accomplish this. But they may not be primary.

A further extension of the importance of substantiation (as opposed to science), is that we are, as a field, engaged in the creation of a culture of use rather than the creation of knowledge about use. However, if the creation of HCI culture is the central enterprise, then as computing becomes more pervasive---that is, more central to everyday life---a multiplicity of values and viewpoints must be brought to be its construction.

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[8] From a lecture "On a New List of Categories" *Proceedings of the American Academy of Arts and Sciences* 7 (1868), pp. 287-298. Presented May 14, 1867.

Conclusion

In the opening chapter to *HCI: Models, Theories and Frameworks*, Jack Carroll (2003) describes HCI as a multi-disciplinary science. By calling out the disciplines in terms of three paradigms, it is our desire to bring some missing clarity to the field, and to point out that the third paradigm deserves attention. We may have used some radical language to clarify the breaks we see between the first, second and third paradigms, but we also trust that the reader recognizes the elements of their own work that are in each.

We are not arguing that the third paradigm is right, while the first and second paradigms are wrong. Indeed, one of the authors of this paper is a primarily a second paradigm researcher. Rather, we argue that paradigms highlight different kinds of questions that are interesting and methods for answering them. Even so, we believe it would be wise to recognize the differences and incompatibilities between paradigms that make them amenable to different sorts of problems.

We also believe it is important for HCI to understand that, sometimes, paradigms do clash; those clashes may appear in the form of debates in the field about proper methodology, validity of results, etc. Work in one paradigm can easily look invalid to someone working in another paradigm, because it is based on quite different notions of what knowledge is and how it is to be generated. Or may seem valid but beside the point, since the driving questions are different.

When paradigms clash, the overlap of ways of seeing taken with conflicting epistemologies results in a miasma of legitimacies. HCI has always been a hybrid discipline and therefore has used either the intersection or union of legitimate practices from its constituents. Thus the first paradigm defines legitimacy as measurable utility, the second paradigm as contrastive, and these are the standards to which third paradigm work tends to be held. But that is not *a priori* the definition of legitimacy; to allow the third paradigm to bear full fruit, we need to recognize and accommodate its notions of validity. And one cost of work in the third paradigm is precisely the need to explicate what is legitimate in the third paradigm enterprise. We would expect that any submission in the third paradigm would explain how it places itself within the matrix of situated perspectives and explain (rather than argue for) its measures of success.

The claim that there are three paradigms in HCI, and that the third one frequently goes unrecognized is not meant to disregard the importance of different approaches within any of the paradigms. Activity theory, with its roots in Marxism and dialectics, differs considerably from ethnography, with its roots in anthropology. Fitts Law is not studied the same way that GOMS is. However, there are important commonalities; to repeat, people within a paradigm can, broadly speaking, understand the motivations and mechanisms of other work within that paradigm. It is much more difficult to understand the rationales across paradigms.

In the future, we hope that calling out the underlying paradigm will become a standard part of every publishing and reviewing. Thus, we will not be forced into the sort of *pro forma* corners that Paul Dourish (2006) warned us about at CHI 2006. Further, it is also reasonable to expect that evaluation of research and new interface ideas will become more nuanced and situated, and that richer descriptions (no matter what the paradigm) will become the standard. In this way, we hope that the third paradigm, just as the first and second, can be allowed to make a permanent contribution to the field.

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