Dispelling Design as the 'Black Art' of CHI

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ABSTRACT
We discuss the legacy and processes of creative design, and differentiate it from the type of user-centered design commonly found in CHI. We provide an example of this process, and discuss how design practice constitutes an essential mode of inquiry. We argue the complementary nature of creative design and user-centered design practices. Syncretic disciplines shift and drift from their original practice. A key issue is how CHI is to respond to changes in acceptable design practice. A key contribution of this work is an illustrative example showing how designers can communicate their intellectual rigor to the CHI community.

Author Keywords
Design, Theory, Method, Sketching, Prototyping, Process, User Centered Design, Creative Design.

ACM Classification Keywords
H.5.2 [Information interfaces and presentation (e.g., HCI)}: User Interfaces---User Centered Design

INTRODUCTION

Formative research has long been considered a vital part of the user-centered design process. Participatory design techniques, contextual inquiry, and ethnography are all means to understanding what needs to be built. Yet one important means for deciding what needs to be created and how to go about it still remains on the fringes of CHI — creative design. Design has been considered part of HCI since its early days as part of cognitive science, but we argue that typical HCI usage of design is at best limiting and at worst flawed. This may be inevitable, since the disciplinary practices of the design community are not static; nevertheless, as design practice changes we in the CHI community need to be responsive.

We begin by differentiating our use of the term design from its many uses in CHI. Simon [quoted in19] defines design as acts that convert "existing to preferred situations." Like Schöen [19], we distinguish our use of design by leveraging a more specific definition based on Löwgren's critical distinction between *engineering design* and *creative design* [16, p77]. Engineering design

> "assumes that the 'problem' to be solved is comprehensively and precisely described, preferably in the form of a requirements specification. The mission … is to find a solution. Engineering design work is … seen as a chain of transformations from the abstract" [16, p87].

On the other hand, creative design

> "is about understanding the problem as much as the resulting artifact. Creative design work is seen as a tight interplay between problem setting and problem solving. In this interplay, the design space is explored through the creation of many parallel ideas and concepts. The given assumptions regarding the problem are questioned on all levels. Creative design work is inherently unpredictable. Hence, the designer plays a personal role in the process" [16, p87].

Löwgren's distinction is an extreme characterization that describes different approaches to problem solving, perhaps more than the inherent nature of a problem. Engineering design certainly can involve creativity, and creative design, while focusing on exploring the problem space, also seeks solutions. Nonetheless, the distinction is useful to bear in mind as we contrast practices in HCI, which often reflect engineering approaches, to the processes of creative design.

While user-centered design practices in HCI have recognized the interplay between designer and setting, they have tended to overlook differences between creative and engineering design. The exact positioning of user-centered design between these two extremes can be controversial, and dependent on the situation and the skills of the design team. In communities like DIS and DUX, one is more likely to see creative design approaches, whereas in the CHI community there is a tendency towards the engineering approach. Regardless, it is clear that there is a creative design extreme whose processes we wish to more closely examine. By 'design' we include creative design as well as the practices of graphic design, product design and other design disciplines immersed in the culture of design. As Button [2] criticizes the use of ethnography in CHI for losing its analytic component, being reduced to "scenic fieldwork" painting broad pictures of the environment

CHI 2006, April 22–27, 2006, Montréal, Québec, Canada.

studied, we argue that design practices in CHI have suffered a similar fate. In order to legitimate design processes in a community oriented towards the quantitative, design has adopted a process of iterative refinement, which we call *formal iteration*. The formality of this practice is not commonplace in creative design, but is an accommodation to the cultures of engineering and user-centered design. Formal iteration allows designers to prove or at least account for the evolution of their design in a manner acceptable to the CHI community. In this way designers reduce the need to justify design decisions, because they have empirical evidence that their decisions are 'correct.' In contrast, we describe the process of creative design and show how it has its own form of rigor, by which we mean not formalization, but 'rigor' as a repeatable process, of a consensual standard of quality, in use by a professional community of practice. In this sense, design rigor is analogous to scientific rigor.

Another difference between creative design and user-centered design practice is the role of prototyping. Fallman [8] argues that HCI is a *research-oriented field* where the prototype serves as a "proof-of-concept" whose design just seems to "happen," and is "design[ed] by necessity." He argues that the "design process tends to remain implicit as researchers are embarrassed by not being able to show evidence of the same kind of control, structure, predictability and rigorousness in doing design as they are able to show in other parts of their research" [8, p230]. Design is thus viewed by many in CHI as a 'black art.'

In what follows, we attempt to not only describe the creative design process but to articulate its value to the CHI community. To anticipate the argument, it provides a means of documenting the creation of artifacts as well as an evaluative vocabulary that is rigorous, if not formal. We review attempts to systematically model design, and discuss how these are ill-suited to design practice. We describe how design rigor comprises judgment and interpretation, the making of artifacts, and a means of communication and evaluation particular to design culture. To aid discussion, we provide an example from our own work on a conference calling system called Rendezvous. This is accompanied by a process timeline of significant *design artifacts* and *judgments*. The presentation of Rendezvous is meant to suggest how designers might communicate their intellectual rigor to the CHI community. Finally, we discuss how to create a thriving design culture.

HISTORICAL CHI PERSPECTIVES ON DESIGN

Some in the CHI community came to reject the "waterfall" approach to development,[1] witnessing its mismatch to real design and development processes. Carroll [4] recalls the evolution of his thinking, beginning with studies of design that he and colleagues carried out in the late 1970's through the emergence of iterative development with its key idea of user testing and improvement. At the time, the ideas that

> "useful and usable systems [could not] be specified first-time final, that the real needs and practices of users must be understood as design requirements, and that the extent to which the designed system meets these needs must be directly and continuously evaluated through the development process"

were a radical departure from existing engineering practice typified by the waterfall model. But as iterative development came to be more widely accepted, Carroll raised a core question, writing: "What [is] the guarantee that iterative design [will] not merely produce local optimizations and thrashing?" At the time, it wasn't clear what *could* provide a sure escape from the dangers of local optimizations and non-convergent or incoherent designs. The tension between engineering design and more qualitative and creative design-oriented approaches continued to play out in the 1980's and early 1990's as CHI as a field struggled to figure out how to provide real help and guidance to application developers [23]. Usability engineering, based on formal iterative user design and testing was formulated, refined, and promulgated [13, 14]. Others worked to provide a "science base" for grounding decisions about interface design, for example developing 'engineering models' of human users meant to help evaluate interface designs [3]. These efforts are an important reflection of CHI's engineering legacy.

Those who rejected a deductive approach to design followed other paths. Whiteside and colleagues at DEC developed and advocated what they called "contextual" or "action" research – an approach to interactive system design inspired by hermeneutics that eschewed the formulation of hypotheses or abstraction from observations – a tradition that today survives in methods such as contextual inquiry and connects with traditions from other fields, such as ethnomethodology [13,21,22]. Conklin [6] and others argued that design problems were "wicked" as defined by Rittel [18], and required the assessment of multiple possible solutions and the integration of multiple facets, beginning streams of work on design rationale and reflective design [6,9]. Carroll and colleagues developed and argued for the use of design principles (such as minimalism) and semi-structured techniques (such as psychological design rationale and scenario-based design) that were meant to help application designers identify and reason about real contexts of use and the tradeoffs inherent in design decisions [5].

More recently, some researchers have explicitly adopted an approach based on the traditions of "artist-designers" [11]. Emphasizing "aesthetic control," the "cultural implications" of designs, and "ways to open new spaces for design," these designer-researchers have developed new methods, such as cultural probes, whose purpose is not to collect or analyze data about users, but to inspire the creation of appropriate, pleasurable, even provocative designs [11, p25]. Gaver and colleagues characterize their work as "functional

[1] The waterfall model is a sequential process wherein each stage of development is completed before the next starts.

aesthetics," and state that they "believe aesthetics to be an integral part of functionality, with pleasure a criterion for design equal to efficiency or usability." In a plenary address at the DIS 2000 conference [10], Gaver distinguished the kinds of accountability that "design" vs. "science" demand of practitioners. Design demands 'aesthetic accountability,' he argued, where the foundational question is "does it work"? Science demands 'epistemological accountability,' where the foundational question is "how do you know that what you claim is true?"

There is an inherent tension in these questions, reflected in the distinctive practices and disciplinary orientations of engineering and creative design. Yet it is not an insurmountable conflict: creative designers in HCI do not work in a vacuum, devoid of user input or knowledge of situations of use; nor do practitioners of usability engineering test every design decision, or have a deductive method for determining what to change when user testing reveals problems. In fact, it may not matter much which is framed in terms of the other; both perspectives are valid. User-centered design practitioners may prefer to view empirically-based iterative design as the framework with design effectively a sub-process; designers may take the creative design process as framework with knowledge of users as input. In the discussion of Rendezvous that follows, we will take creative design as the framework, as this stance is less familiar to the CHI community. In doing so, we do not put creative design above engineering design. Rather, we hope to demonstrate how a skilled designer executes a rigorous creative design process in the context of a multidisciplinary team with multiple user, technological, and organizational constraints. It is this kind of design rigor that guarantees that interface designs will not be merely the product of local optimizations and thrashing, and that they will converge and cohere with the myriad requirements to which they must be responsive.

DESIGN RESEARCH

Despite the recognition within parts of the CHI community of the "wicked" nature of design problems, incorporating creative design practice and design research into HCI and usability engineering has been difficult. First, early attempts to incorporate design by formal modeling have proved problematic. Second, the role of prototyping and iteration is sufficiently different in the two fields to have resulted in confusion. Third, professional communications within the CHI research community tend to present and discuss problems in a way that is contrary to the nature of design.

Design Methods

Perhaps in an effort to make design processes more understandable and accessible, many attempts have been made to capture design as a method. Löwgren [16] writes that modeling design was in vogue in the design community 1962-82. Most models were based on practitioner theory rather than systematic observations of the design process [15]. Gedenryd discusses the lack of success of such methods:

> "...Jones (1970) acknowledged the problems with these methods, and the lack of success stories. This he did already in the original edition; even in the same paragraph as where he stated the *need* for these methods: 'However, it is not obvious that the new methods that are reviewed in this book are any better. *There is not much evidence that they have been used with success even by their inventors*. ... The usual difficulty is that of losing control of the design situation once one is committed to a systematic procedure which seems to fit the problem less and less as designing proceeds.'" [12, pg. 59, original italics].

Gedenryd argues that such modeling fails due to a classic mistake that can be traced back to Pappus, a mathematician who attempted to define a process for solving geometry problems. Pappus argued that accounting for solutions in a logical way after the fact distorted the structure of the genuine process (Lakatos in "Proofs and Refutations" makes a similar point). Like geometry proofs, accounting for design as a logical sequence of steps is not effective:

> "In actuality, this path is never followed […] Hence it is a mistake to see this as plan following, or to think of the proof as a plan. It cannot even be known until at the very end of the process, when you also have the answer. ... Instead there is just one process, where the functions of analysis and synthesis are two aspects of the same activity, not two different activities, stages or processes." [12, p63][2]

Methods thus have been unsuccessful in taming the design process.

Löwgren [16] characterizes the design method movement in three phases which closely parallel CHI's view of design. The first generation of design methods was characterized by "analysis, synthesis and evaluation." The second generation focused on user participation, with the designer's role being to "liberate the user's needs and requirements." The third generation emphasized "the specific competence of the designer; design was seen as a distinctive kind of thinking, as fundamental to man's intellectual ability, as, e.g., language." He argues that the first and second generations of design practices have been integrated into successive waves of HCI. The first mirrors engineering design, the second provided the basis for participatory design techniques like cooperative inquiry. The third generation, however, remains outside of mainstream HCI. This raises the question of how the CHI community adopts new practices in related disciplines, particularly where a new practice is seemingly at odds with core values of the community. While we are not able to address the larger issue of disciplinary drift, we do endorse the need for a third wave of design practice in HCI that recognizes the role of the designer in a creative design practice.

Role of Prototyping and Iteration in Design

In HCI there is a tendency to use prototyping, iteration, and evaluation throughout the design process to give it scientific

[2] This line of argument is reminiscent of Suchman's [20] discussion of plans vs. situated action.

rigor, but as Fallman [8] writes "Fieldwork, theory and evaluation data provide systematic input to this process, but do not by themselves provide the necessary whole. For the latter, there is only design." He argues that design is not a midpoint on a continuum between science and art and that its role is "unfolding a coherent whole – a previously nonexistent artifact – from the various bits and pieces gathered in the process of research, but which simply put together do not by themselves form the whole." This is where design comes into play.

Prototyping is used differently in formal iterative practice than in creative design practice. Fallman [8] explains the role of iteration in creative design practice:

> "Traditionally, the concept of iteration is also used as an add-on, an extension, to overcome some of the recognized problems of the structured design methods, which basically allows the designer freedom to move between the stages of analysis, synthesis, and evaluation. It is a response to the recognition that understanding and describing the problem, finding a resolution, and implementing a solution do not occur straightforwardly or by applying a set of processes in a linear manner as suggested by the conservative account."

Iteration in creative design practice is not about punctuating the design process with the rigor of evaluation, but rather about presenting the designer with opportunities to analyze her work. Analysis here refers not to user studies or formal evaluation, but to the collaborative and introspective processes of designers. The deliberation about a design artifact thus can be as important as the artifact itself. As Fallman [8] notes:

> "In reviewing prototyping in HCI, Houde and Hill come to the telling conclusion that a limitation of the ordinary way of conceiving and talking about prototyping (i.e., sketching) is the tendency to focus on attributes of the prototype itself (i.e., the sketch), highlighting for instance which tools were used to produce it and if it is of high or low fidelity. In doing so, the vital dialogue becomes concealed under the sketch itself."

Communicating the Results of CHI Research

The design and CHI communities have absorbed Rittel's [18] distinction between tame and wicked problems. Tame problems understood well enough can be approached with a logical, systematic plan. But as many have noted, creative design is better suited for wicked problems [12,17,18]. CHI has recognized this in much technical work. Nevertheless, when it comes to reporting work in CHI, there is a tendency to present it only in its final state, losing the complexity of the creative design or iterative process and effectively treating wicked problems as if they were tame. Nelson and Stolterman argue against this practice:

> "Wisdom – specifically what we call design wisdom-- is a much richer concept than problem solving, because it shifts one's thoughts from focusing only on avoiding undesirable states, to focusing on intentional actions that lead to states of reality which are desirable and appropriate" [17].

This suggests that discussion of how we develop artifacts is central for understanding and communicating about the wicked problems that CHI professionals encounter.

DESIGN RIGOR; DESIGN PRAXIS

Having described what design is not, we now turn to an explanation of what design *is*. We consider how creative design practices construct knowledge that is different from knowledge that commonly results from scientific practice. Creative design constitutes a 'praxis' (i.e., rational action and reflection on decisions within the context of design activity) in pursuit of what we have called design rigor. We explain design praxis and outline four professional qualities inherent in it.

Design praxis is comprised of the following professional qualities, which overlap with each other and are necessarily entwined, contributing to an overall design culture: 1) a **non-linear process** of intent and discovery, 2) **design judgment**, which is informed by a combination of knowledge, reflection, practice and action, 3) the **making of artifacts**, and 4) the **design critique ('crit')**. The shared reflection of the first three qualities combined with an insightful and forward-looking attitude creates a design culture, embodied in the practice of the design crit. The design crit is a designer's reflective, evaluative and communicative explanation of her design judgments and the activities in which she has engaged.

Each of these qualities was present in Rendezvous. The project aimed to improve the conference call user experience by coordinating and connecting telephony and information technology. IBM's previous social computing research was core to our approach and provided a context within which to start. However, it was clear from the start that Rendezvous was going to be a 'wicked problem' to solve. We were embarking on a project that would essentially marry a disparate combination of end user experiences (phone calls from a variety of locations including cars, offices, and homes, only some of which included the use of a computer) with disparate technologies (VoIP and traditional enterprise IT). Each had unique challenges, but potential solutions in one domain strongly impacted the other.

1. Design Praxis: Design as a Non-Linear Process

Figures 1-3 show a relative timeline of the design artifacts developed during the Rendezvous project. The picture is somewhat misleading because it is linearized even though the process was not. Over time, many interdependent activities and decisions were made. The figures have six horizontal lines running in tandem, representing different design considerations that informed and motivated further design activity. These design considerations culminated in a series of design judgments that were integral to the design process. Design considerations tend to be multifaceted and complex; the design activity in our example is necessarily highly simplified for the sake of exposition. What is critical to note is that activities and decisions happen

simultaneously and tend to affect each other – they are not necessarily a result of linear reasoning nor do they follow a prescribed, premeditated path. Hence an important design competence is mediating the various considerations that we will describe effectively. Certain activities and judgments do tend to lead to particular kinds of design activities, but not in a deterministic manner.

2. Design Praxis: Design Judgment

Traditional HCI techniques use qualitative and quantitative means to obtain an understanding of the problem at hand and its context. They assume that interpretations of valid data can serve as a basis for design. But as with Gaver's epistemological accountability, design decisions that cannot be grounded empirically may have little credibility.

Creative design also revolves around the user but does not try to establish scientific validity. Its practices take account of the user in a different way: "Design is about *service on behalf of the other*" [17]. This means that the designer practices the design process on behalf of the user in order to bring about purposeful change and meaning.

Nelson and Stolterman state that the role of interpretation in the design process is comparable to evidence and proof in science. In Rendezvous, design artifacts were not made arbitrarily, but to validate design judgments and gain acceptance of a solution. The practice of creating artifacts is integral to design interpretation, judgment and discovery. We must clarify that the term judgment here does not mean criticism. Instead, design judgment means the ability to assess, appreciate and make appropriate decisions regarding the object and its context. In this context, judgment does not provide a criticism that blocks further inquiry, but rather is a vehicle to inspire an informed decision.

To describe the informed design decision-making process, we draw on Nelson and Stolterman's explanation of design judgments [17]. For the sake of succinctness, we do not include their entire taxonomy, but instead provide definitions and examples of the six forms of design judgment most relevant to our discussion. These forms comprise two sets: *unconscious* and *conscious* judgments.

Unconscious Design Judgments

Two kinds of unconscious judgment are *service judgments* and *deliberated offhand judgments* (see the top two lines of Figures 1-3). Service judgments identify whom the design is meant to serve; this judgment results in an undercurrent of criteria and objectives throughout design activity consistent with the target audience. *Deliberated offhand judgments* are deliberated because they are honed through practice and reflection and then internalized as a design strategy or understanding that can be more broadly applicable as a design rationale. The resulting design rationale becomes expertise that is ingrained and automatic every time a similar set of conditions presents itself.

These judgments provided a foundational rationale for Rendezvous that would be drawn upon for the entirety of the project, providing early and continuing guidance. Prior to the project, the theoretical foundation for IBM's approach to social computing had been laid (Figure 1, letter A). This work gives primacy to social cues via social proxies, and designates the end-user as a guiding force. "We do not try to imitate the real world (e.g., via virtual reality or video); instead, we use 'social proxies,' minimalist graphical representations of the online presence and activities of people" [7]. In depicting social activity in Rendezvous, we sought to provide presence, awareness and accountability (i.e., social translucence). Subsequent work on social translucence provided further examples of making collective activity visible via social proxies, including the online lines proxy, the lecture proxy, and the auction proxy [7]. A conference call proxy was conceived in 2001, which served as a precursor to the Rendezvous project.

These early social computing projects laid the academic groundwork essential for graceful and productive interactions in computer-mediated technical systems. The relevance of this work is twofold; it established that the design of these interactive technologies was to service end users above all – an audience to remain accountable to – and it clarified the social computing philosophies that were carried throughout all design activities and unconscious judgments in the Rendezvous design process.

Conscious Design Judgments

Conscious design judgments are judgments that require a more cognizant and active relationship with the activity at hand. These include navigational, framing, compositional and appearance judgments.

Navigational judgment does not refer to the familiar sense of navigation via interface elements on web pages. Instead it is akin to the navigation of a ship, adjusting course based on weather and obstacles as they become apparent. Nelson and Stolterman define it as "the ability to formulate essential situational knowledge that is applicable to the conditions of the moment [...] At a basic level, this is survival" [17, p198]. It is typical for this type of judgment to be used in political or tactical situations, neither of which is commonly discussed in the reports of research projects. Undeniably though, these issues have very real and tangible impacts on how a project will be situated and how design intention is formulated and understood.

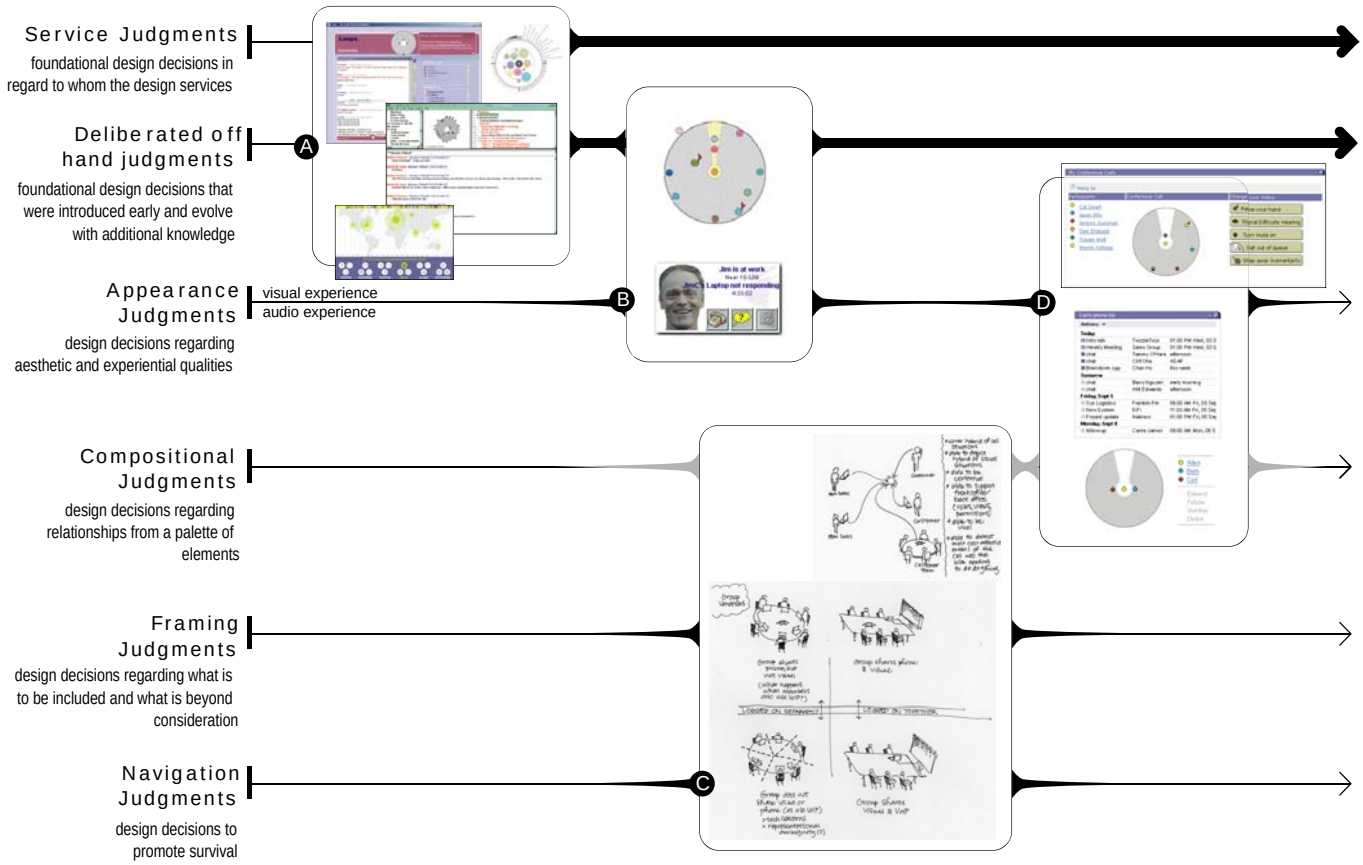

FIGURE 1: DESIGN P ROCESS TIMELINE

Navigational judgment set the stage for Rendezvous, when the business climate offered support for a collaborative solution that integrated telephony and the PC (Figure 1, letter C). How it would work and what it would look like were not specified; the design intention at this early stage was to create something to make conference calls easier and more cost effective. A few research projects served as starting points (see Figure 1, letter B): Grapevine, a solution that provided ways of contacting others through currently available channels, including the telephone; and the conference call proxy, a solution for displaying people and their activity during a conference call.

Framing judgments are used for "defining and embracing the space of potential outcomes" and serve as a sort of crucible that contains design activity [17, p199]. This judgment determines the scope of the design activity. Framing judgments suggest questions to be explored and answered rather than pre-specified tasks to be completed. Given a context and a set of questions, a design inquiry is launched. The annotated sketches (Figure 1, letter C) served as a quest to frame the problem; they articulated what we already knew and sought to reveal what we did not. Here we explored how we might coordinate two previously disparate technologies (telephony and computers) into a reasonable end user experience and the kinds of new experiences that might be available to our users given the integration of VoIP and IT. We considered issues and opportunities and how previous work might (or might not) apply to the variety of usage situations our users might face.

The navigational judgment was motivated by external circumstances, but it required some design activities to 'unpack' and define the fuzzy situation (Figure 1, letter C). Annotated sketches are a mode of design activity well-suited to clarifying starting points and exploring issues. We entertained several hypothetical possibilities and quickly established a set of criteria we thought most appropriate at the time. This design activity was not explicitly engaged in to satisfy navigational judgment; other considerations drove its progress. We find that navigational judgments often give way to framing and compositional judgments, and this was certainly true of the first phase of Rendezvous. These annotated sketches, based on the current circumstances , constituted a newly formed whole – a new composition.

The judgment most central to the design process is the *compositional judgment*. Here aesthetic, ethical and rational considerations all come into play, allowing the designer to create relationships "among a palette of elements, with an eye towards calling forth a compositional whole" [17, p200]. 'Composition' in this case does not refer to the designed layout of visual elements on a plane, but the way the parts of the solution combine in a greater whole.

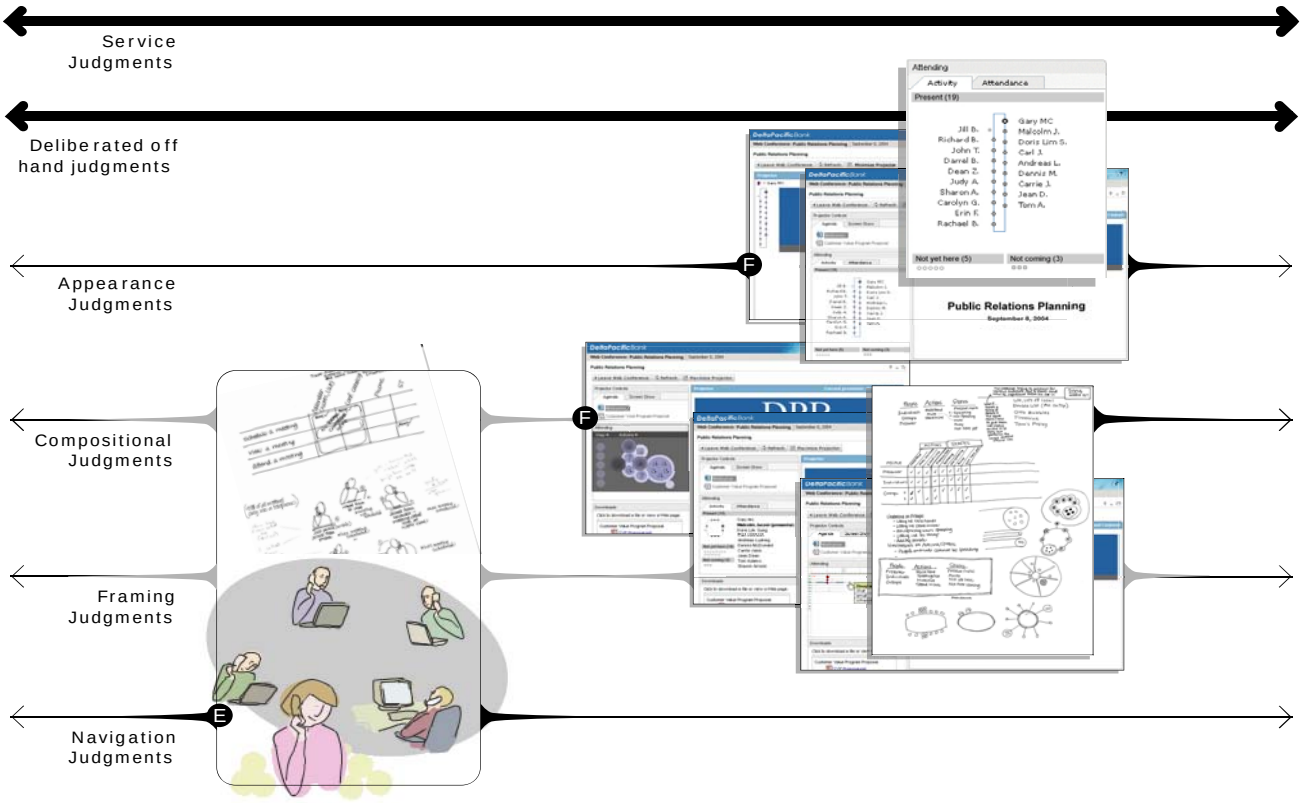

FIGURE 2: DESIGN P ROCESS TIMELINE

Note that multiple design activities occurred along the compositional judgment continuum in Figure 1 (letters C and D). The annotated sketches were based on earlier work, accounting for it and exploring its applicability to the current design situation. Meanwhile, an implementation of the early conference call proxy design (Figure 1, letter D) was created to see if the concept could be concretized and how it would work in a web portal environment. For Rendezvous to exist in this environment, we needed to be sure that it could be implemented, and that it would fit in and be symbiotic with other likely portlets (e.g., a web meeting or a calendar of meetings).

The combination of the annotated sketches and the early working prototype gave us a better idea about what we would strive to create and what we would need to prioritize. Equipped with a better understanding of the issues and the quirks of our prototype, we set about composing a practical and effective solution.

Appearance judgment is probably the easiest to appreciate and the quickest to evaluate, however it is complex and multi-layered. "It includes determinations of style, nature and character. … Considerations about character concern qualities such as form, essence and excellence" [17, p196]. Good appearance judgments usually accompany good design training and allow the design rationale to be based in part on the accompanying functionality.

We created many variations in the appearance and interactivity of the meeting visualization (Figure 2, letter F). We can delineate five specific design results of this activity: 1) Names would appear next to the icons to more easily identify people and their activities; 2) No analog temporal representation of attendance would be provided since we could safely assume synchronous presence (removing the benefit of an analog representation); 3) No queue would be depicted, since we learned this might be seen as creating too much social pressure due to disclosure of a user's online activity; 4) An improved visual appeal; 5) The realization that certain features worked well in the portal environment, in particular collapsible visualizations, and a mechanism/UI for tracking attendance.

The culmination of this series of design judgments was a shared understanding of the kind of meeting experience from which our users would benefit: one where they did not have to have a computer available to benefit from Rendezvous; where they could manage their meeting materials before, during and after the meeting without extra steps in an additional application; and where they could schedule meetings just as they already did but get access to extra meeting functionality on-the-fly.

Work on Rendezvous is ongoing. It is clear, in hindsight, that we were able to fulfill the initial intention. Each step along the way pulled along with it previous decisions and influences in an attempt to give holistic consideration to the

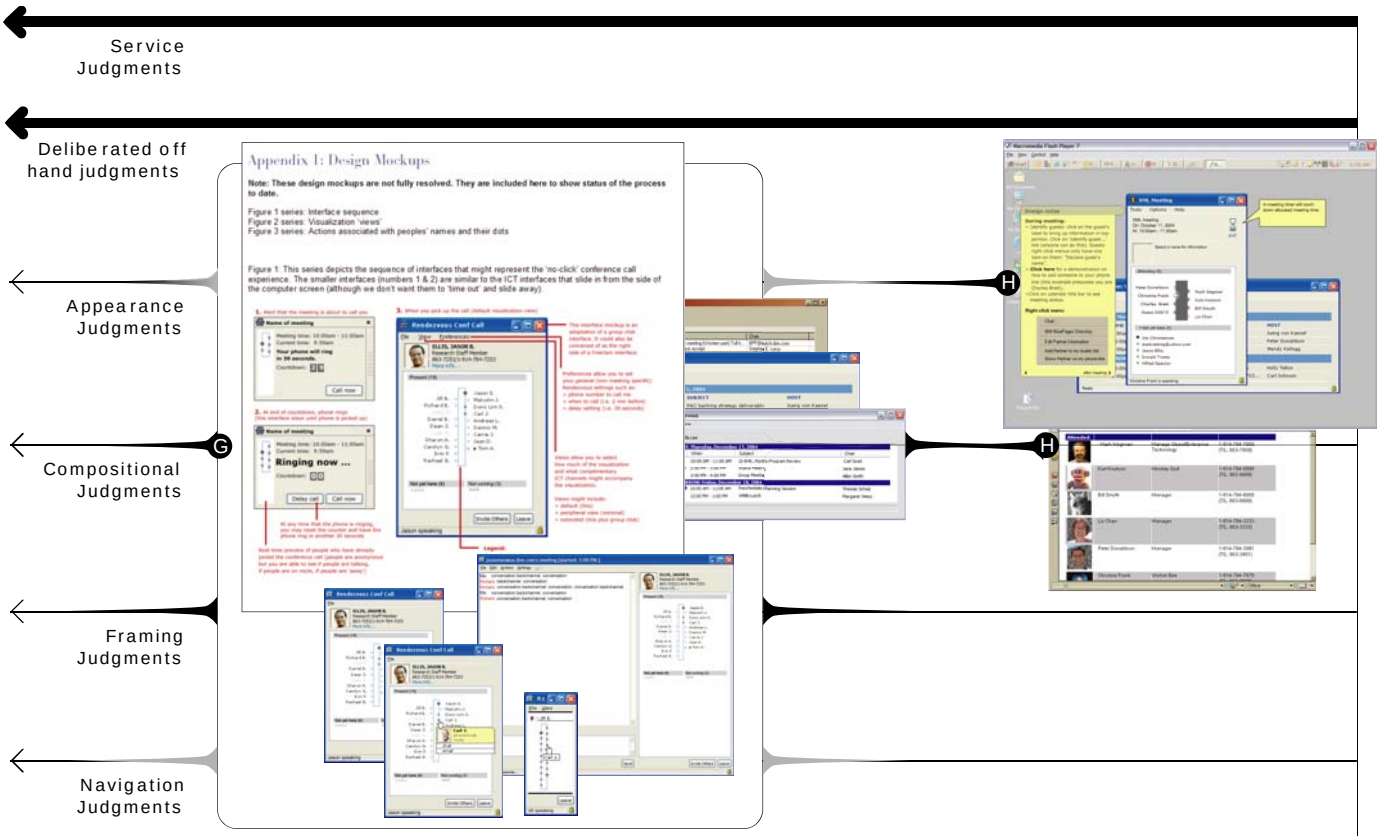

FIGURE 3: DESIGN P ROCESS TIMELINE

designed solution. It would have been impossible to predict or expedite our current solution.

3. Design Praxis: The Making of Design Artifacts

Throughout the design process there is an important practice of creating design artifacts. These artifacts are an essential part of design rigor and come in many forms, including sketches, collages, digital mockups, interactive simulations, overlays or almost anything that provides a visual and spatial forum for design ideas. There is a wealth of design artifacts that serve these purposes and go largely unrecognized for their facilitation of problem-finding and problem-solving. It is from these artifacts that ideas surface and mature. Design artifacts can serve two basic purposes: to promote further design activity (design discourse agent, an agent of investigation and discovery) and secondly, to communicate ideas (knowledge artifact). These design artifacts are rarely seen in CHI because they are part of the process rather than the end product.

A *design discourse agent* is a design artifact whose production creates a suggestive state that the designer in turn reacts to and is able to push forward. It is a tool for perpetuating alternatives, suggesting different ways of looking at something, and attempting to clarify a situation. The designer in his act of creation works along three dimensions: "the domain of language in which he describes and appreciates the consequences of his moves, the implications he discovers and follows, and his changing stance towards the situation with which he converses" [19, p95]. It is this third practice that Schöen calls reflection in action – a conversation between the designer and situation. Any of the sketches in Figures 1-3 are examples of a design discourse agent. For example, the sketch in Figure 2, letter F was created because we needed a visualization that allowed users to be aware that more than one person at a location was sharing a phone. Note the extensive annotation that accompanies the sketches; the design dialog manifests as a written-visual discourse that accounts for the organization of the information represented.

Communication or knowledge artifacts visually articulate design thinking to capture it in a way from which others might draw insight or build upon. The communication artifact enables people to engage in discourse about the usefulness or applicability of a concept or set of design decisions by referring to a common concept. Knowledge artifacts can be shared to establish a common language with which to talk about fuzzy situations and to provide a platform for shared creativity [19].

We discussed navigation judgments earlier; artifacts that aid navigation judgments may seem necessarily reactionary. However, Figure 2, letter E presents a design artifact that was a preemptive navigation attempt. It represents a design for how multiple applications could be coordinated for an efficient and pleasing meeting experience with Rendezvous

as an integral component. This strategic scenario explored ways to coordinate meeting applications and described how our solution could effectively knit the experience together. The scenario was embodied in an interactive Macromedia Flash™ movie that showed how five different attendees might join the same conference call using different means – some existing and some invented – along with the UIs that would be used. This interactive design artifact helped communicate our ideas to a wider organizational audience and has persevered as a knowledge artifact that can be referred to over time. It has become a valuable resource to revisit when designing for similar situations.

All of the design artifacts in Figure 3 are communication artifacts that serve the end result but are not themselves end results. Figure 3 represents a phase where we shifted away from the web portal platform. This meant developing a mini-application (a "plug-in") and losing some contextual apparatus that we had been using. For instance, the portal environment supported tracking meetings – a UI that listed the meetings and launched the meeting visualization. The new platform lacked this, so we needed to create a meeting calendar that extracted meetings from the user's primary calendar. We decided to assemble them in a two-day window so that any were selectable. Earlier concepts that had been thrown away once again became possible. The set of design artifacts helped to sort out how the new platform would change our designed experience.

Figure 3, letter H is another form of communication artifact: an interactive design simulation used as a design document for implementation. This kind of design document aggregates team decisions about which features will be included, how they will be included and how it all works together. The team can verify that important ideas are represented as expected in the simulation; the engineer can mimic the simulation without inferring what is meant by a textual description; and the tester can verify the adherence of the implementation to the design.

4. Design Praxis: Design Crits, Design Discourse

Designers have a tradition of design critique (crits) that serves as their form of reflection, evaluation, reuse of knowledge, accountability, etc. Crits are often two-way communications: explanations about design judgments and the framing of the problem are presented, and the qualities of subsequent decisions are considered by experts and discussed with the designer(s). The conversation unveils the effectiveness of the process and the design rationale used to reach its ends. Crit panels are comprised of experts in the field, potentially supplemented by users and stakeholders. It is critical that the panel represent an adequate level of design competence in order for insights and feedback to have credibility (e.g., the design crit is not a forum for uninformed taste and preferences). Designers benefit because the crit provides insight that can make them better designers. During a crit, it is common for a very specific design language to be used and perpetuated –as 'technical' jargon is often used in professional settings. This language is important to the profession and should be honed as a matter of professional practice.

At one point in the Rendezvous project, we were fortunate to collaborate with product designers. We initially engaged with them over an interactive conceptual design artifact (Figure 2, letter E) which prompted a flurry of design artifacts, remote design sessions and design critiques. Their input resulted in some key changes to the meeting visualization. However, the real strength in this relationship was the extent to which a design culture was promoted and reinforced. When designers get together for design collaboration and critique, their culture is strengthened. While this may seem purely social and somewhat trivial in terms of progress, it is in fact essential. Our correspondence with the product designers was part of a reflective process that makes us better designers. We not only learned aspects of the project they had discovered before us, but gained a better understanding of their design process and judgments. Such insights strengthen the act of designing and the quality of design from that time on for all the designers involved.

CREATING A DESIGN CULTURE THAT THRIVES

To create a thriving professional practice of design within the CHI community, we need to address a number of factors. First, when discussing design, we must account for the strong relationship between intention, activity as inquiry, and judgment. Second, ensuring design rigor requires organizational support. Projects must be set up with design as a core competency with trained designers on hand to fulfill that role. Design culture must be accepted within the context of research and technology development, meaning that an organization must acknowledge and support design activities as a professional practice and that projects must explicitly account for design activity. Third, we need to develop more innovative practices to facilitate shared understanding among members of multidisciplinary teams. This paper is a start at such a development. We need to value the diversity of design process artifacts, not just the end product; these artifacts can be worked into social science practices, creating a symbiotic relationship. Fourth, the trend of CHI training its own 'interaction designers' fluent in HCI design methods runs the risk of removing HCI design from the design community's core values and creative design practice. Interaction designers need to be formally trained in creative design practices, so that they can be masters of process and design judgment. Finally, by accepting different forms of knowledge, we can better understand how to complement skills and work together, or as Biggs [1] writes:

> "Have we somehow conspired to arrange matters so that knowledge is always what we say about something rather than what we show about it? If so, it would account for the difficulty of using objects as constituting or communicating knowledge. Is the problem that the whole concept of knowledge and research arises out of words rather than actions, or do we simply have too narrow a range of examples, i.e., only lexical examples?"

CONCLUSION

The CHI community has a history of embracing new approaches. We embraced participatory design techniques as a complement to user-centered design methods. Qualitative research methods in ethnography have gained acceptance as a way of evaluating an application's success. We wish to build on this attitude and legacy of mutual respect and position creative design as a valuable alternative to the engineering design-oriented approaches.

Creative design is not arbitrary or illusive; designers adhere to a design process that enforces design rigor. Design evolves by applying design judgment and engaging in a variety of practices. Sketching provides an alternative to prototyping and iteration. Discussion with clients and briefs allow for requirements elicitation. Design critiques allow a structured means for determining whether a design adheres to good practice and confirming that design judgment was carefully rendered throughout all aspects of the design. We believe that discussion about rigor, key to the design critique, can be presented in written form and have provided an example appropriate for the CHI community.

User-centered design embodies aspects of both creative and engineering design. For problems that can be treated as "tame" problems, the engineering approach of prototyping and iterative testing is effective. However, creative design practices must be employed for wicked problems. Löwgren's work suggests that the evolution of design practice in HCI will mirror the phases of design practice: the first phase roughly similar to user-centered design practice, the second similar to participatory design, and the third based on design judgment and creative design.

There is a place in CHI for iterative development, with its prototypes and testing. There is also a place for creative design and an opportunity for a symbiotic relationship. Creative design should be acknowledged as the professional practice it is. Only then will we as a community be able to overcome the caricatures of the designer's unbounded leaps of creative fancy and the engineer's painstaking over-reliance on logic and empirical validation.

ACKNOWLEDGMENTS

We thank Jim Christensen, Tom Erickson, Jason Ellis, Paul Dourish, Juerg von Kaenel, and the CHI reviewers for their comments. We would like to credit conversation with the late Henrik Gedenryd as partial inspiration for this work and encourage others to read his fine dissertation.

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