Concept-Context-Design:
A Creative Model for the Development of Interactivity

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ABSTRACT

Existing CHI interaction models are focused on understanding the needs of users. They begin with user tasks and user feedback. While the involvement of users is critical for human computer interaction development, so is the imagination the artist-scientist-designer-developer. We constitute a legitimate source of impetus in the definition and development of interactive artifacts, as well as functioning as interpreters, measurers, and respondents. The development of interactivity is a fundamentally creative process. This paper distills a creative model for the development of interactivity as a residue of the *CollageMachine* development experience. Both the model and the artifact are components that contribute to the integrated approach of interface ecology.

BACKGROUND

CollageMachine

CollageMachine [6-10] is a creative web visualization tool that learns while you surf. Instead of waiting for you to click a hyperlink, the program proactively crawls the web, seeking content of interest. *CM* parses websites, modeling the web as collections of linked documents and their constituent media elements - images and chunks of text. These media elements continuously stream into a collage.

You can use collage design tools to create your own look and feel. By engaging in visual design, you also express dis/interest in media elements. *CollageMachine* learns about what you like from these interactions, and annotates its model to represent your interests. Decisions about what content to pursue and how to build the collage are made according to the model. The Collage Visualization Grid allocates screen real estate and history-enriches collage elements as a representation of your intentions. Unlike typical information visualization systems, perceptible structure develops bottom up. Navigational trajectories and combinatorial concepts emerge. The user experience blurs boundaries between web browsing and art-making.

Meshwork

An aggregate is an association of diverse elements, all of which are on the same level [2, 8]. Some structure, process, or mechanism sustains their association. The relationships between the elements are multifarious. Even though they are part of a common aggregate structure, the components

retain their distinct identities. Processes within aggregates develop bottom up. They are heterogeneous structures that foster diversity. A meshwork is a self-organizing aggregate in which there is significant exchange of energy among the constituents. The binding association is a strong one, based on ongoing, active feedback loops. Dynamic circulation in meshworks pushes them toward boundary conditions, and the emergence of new forms. Meshworks contrast with hierarchies, in which structurally uniform elements dominate one another recursively in static formations.

Interface Ecology

Interface ecology [10] brings the perspectives of diverse disciplines to bear on what interfaces are, how they work, and how they can work. Disciplines, and the media, cultural, and epistemological forms to which they apply, are free to relate in meshworks, opening inquiry. No system of representation dominates; none are considered subordinate. Rather, they are interdependent elements, connected by referential flows of interaction. The interface ecology approach enables the development of interactive artifacts, like *CollageMachine*, that support open-ended processes.

The ecosystems approach investigates the levels of function and context that influence the effects of interfaces. The exploration and operation of interface ecology unearths fundamental issues about the structure of meanings, knowledge, disciplines, media, cultures, and interfaces themselves. It engages history, politics, ethnography, economics, and semiotics, as well as computer science, cognitive science, composition, design and art.

An interface ecosystem involves:
- the dynamic interactions of media, cultures, and disciplines, the border zones through which these

911 Streaming Collage #315, shot 6

interactions occur, the voices represented, and the hybrid forms that emerge;

- the roles of human beings and cyborg components -- such as corporations, markets, information artifacts, semiotic codes, telecommunications networks, computers, and presentation media -- and the flows which connect them;

- the technological, socio-cultural, political, and economic processes, which define, circulate, transform and accumulate sign values, and the concomitant significant behaviors through which people manipulate and are manipulated by signs.

The interface ecology framework encompasses both the analysis of interfaces in action, and the actual development of interfaces. It establishes fundamental connections between these analytic and generative modes of practice. It dwells in the interstices between systems of representation. Interface ecology substantiates and territorializes these borders as zones of interconnection, so as to avert the marginalization they otherwise afford.

911 Streaming Collage #315, shot 8

INTRODUCTION

The triangular concept – context – design loop is a new model for interactive artifact development. Prior iterative design models [13, 19, 21] are driven by the tasks or activities of real users in actual usage scenarios. As compared to waterfall development models, which are linear, and don't take into account the need to get feedback and, potentially, to alter any aspect of a design, those iterative models are flexible and fluid. They adapt design to real world conditions. Part of what makes those iterative models effective is that, when executed fully, they conduct ethnographic investigation into the situations of users. The circumstances and resulting perspective of the user, in her/his role as "the other", can be inherently difficult for developers to comprehend. Steps toward bridging this cultural gap serve to align developers' understanding of the users' actual experience. Gulfs of experience and execution are bridged. The better they understand users' actual experiences, the more able developers are to meet their
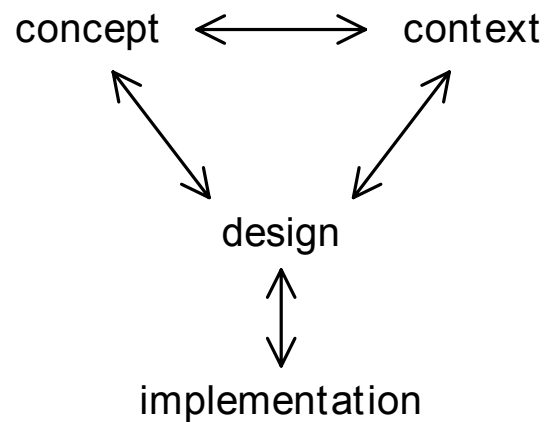
Figure 1. Concept – context – design, a model for the development of interactivity.

needs. These iterative design practices work well when the goals for an artifact, and the underlying values, are clear. They are sufficient for incremental advances in interaction design.

However, a process of iterative design based on the present activities of a user population does not, in itself, offer a method for the creation of interactive artifacts that are more fundamentally transformative. What are the processes that create new paradigms? How can we conceive new activities with interactive artifacts? The generative mode of interface ecology practice requires a broader, conceptually based approach. Such an approach can support the creation of work that redefines the nature of how people think about interactive artifacts, and how we express ourselves through interaction. It can transform the roles of and relationships between people and artifacts, and the processes we engage in. A goal is to transcend the stasis of task-centered iterative design methods that replicate the status quo.

Prior iterative design models have taken initial steps to add dimension to the process of human computer interaction development; however, user-centered design is still limited. While arriving at one or more well-defined usage scenarios will always enrich a development process, such scenarios are not always a good starting point. Beginning with such scenarios assumes that the activities of a certain set of users are entrenched, and that the way of life that these activities represent is sufficient. In the cases when we accept these assumptions, thorough understanding of what users are doing provides a basis for how technology – in the form of interactive artifacts – can make their jobs easier.

FUNDAMENTAL INNOVATIONS

In fact, fundamental innovations in interactivity have emanated from a different process. For example, consider hypermedia. Hypermedia is perhaps the most significant media technology in the history of civilization to be introduced since the printing press. The basic concept of hypermedia was conceived by Vanevar Bush as The Memex during the 1940's [1]. Ted Nelson [17] refined the concept and concretized details during the eighties. Tim Berners-Lee defined HTML. Marc Andreessen built the

first browsers that were sufficiently powerful and usable to attract a mass of users. This coincided with the availability of sufficiently powerful personal computers and network bandwidth at a sufficiently low price point to entice the market. Usability studies did not play an essential role in any of these steps. They emanated from imagination.

Another example, the personal computer, has mixed origins with regard to task analysis and usability studies. The Xerox Star was the progenitor of the modern PC. The role of iterative design and usability testing in the development of the Star "desktop" is well chronicled and much celebrated [15]. The resulting system of overlapping windows, with the "desktop metaphor", forms the basis of the graphical user interface for modern PCs. In fact, the Star desktop project was *initiated* not in response to users, but as a result of Alan Kay's "personal computing" concept [5]. The development of the first PC at Xerox is an instance of the proposed concept-context-design model for the development of interactivity: it began with a concept, and later was refined through usability-oriented iterative design. Indeed, the failure of the Star and the Alto, can be linked to the failure of the developers to respond sufficiently to aspects of context that extend beyond usability. The commercial failure of those products was a matter of poor performance and high price. Microprocessors were not available at that time that could execute the Smalltalk language fast enough. Despite its conceptual elegance, if the developers had abandoned Smalltalk and recoded their implementation in C – that is, if they had done more to take their broader context into account – Xerox's role in the history of the industry might be quite different.

CONCEPT – CONTEXT – DESIGN

The concept – context – design loop is a model for fundamental research into human computer interaction, and for interactive art. The model's meshwork blending of scientific and artistic methods illustrates the critical need for the ecosystem approach to interface development. Because *people* use computational artifacts, technological advance hinges on creative and cultural factors. Computer science is connected to the unboundedness of "what goes on outside the computer," the Pandora's box that Newell and Simon opened out of necessity [18].

The primary components in the triangular model are threefold. They are connected symmetrically. And yet, they are not all equal. The triangle starts in the upper left-hand corner. The development process begins with concept.

Concept

Rational judgments repeat rational judgments.

Illogical judgments lead to new experience…

Irrational thoughts should be followed absolutely and logically…

The concept … implies a general direction…

Ideas alone can be works of art; they are in a chain of development that may eventually find form. All ideas need not be made physical…

The concept of a work of art may involve the matter of the piece or the process in which it is made.

– Sol LeWitt, in "Sentences on Conceptual Art" [14]

Concept is the underlying basis for creative work. Concept specifies what one wants to accomplish, and how it will be accomplished, that is, a sense of desired results, and enabling processes. Applied in practice, concept focuses processes, methods, and goals. Concept substantiates what the artist wants to express, communicate, convey, demonstrate, and/or provoke through a work. Concept may include a sense of desired effect. This sense of effect may be partially concrete and well defined, partially a feeling, an impression, a sensation. It can be a clear picture or a fleeting vision. "I want the user to be amused by the irony of this juxtaposition," and, "I want the *CollageMachine* user's interaction with this media element to result in retrieval of similar media," are two contrasting conceptual sensibilities. Concept may be set in advance and maintained as a project develops; it may evolve. Together with context, it frames the development process. As a project develops context, a well-articulated concept turns into a tattered map that can guide ongoing decisions. When my sense of concept is clear, it informs ongoing decisions on many levels about design and implementation.

Concept extends far deeper than responding to requirements specifications and task analyses. The horizon of interfaces needs to be open. The structures of inquiry and the structures of results are meshwork forms by nature. Where do specifications come from? What determines scope? Concept is the font for goals, micro and macro.

Concept is fundamentally artistic and political. Some scientists and engineers may consider giving primacy to the arts and getting involved in politics to be an affront. It may be scary to move from a mode where everything is rationally justifiable and provable, to one based on more than reason. In fact, creative and political decisions about what to build, and why, are made in all processes of hci development. When they are buried as unexplored, implicit ecosystem factors (and this is standard), an incomplete map becomes the basis for inquiry. Making concept explicit strengthens the depth and diversity of what is undertaken. Advancement in our understanding and development of interfaces is maximized when constituent disciplines form a dynamic meshwork.

In the case of *CollageMachine*, concept began with a musical impetus: desire to compose for the medium of the web. I wanted to visually express a sense of West African *cross-rhythm* -- the simultaneous use of contrasting patterns within a single time scheme [12]. Like Cage, Lucier, and Trunk, I also wanted to employ indeterminacy in composition. Investigation of Dada collage artists [16] and alliance with their practices of semiotic recombination, followed. As collage opens experience to a range of interpretations of ambiguous contextual relationships, so *CollageMachine* opens the experience of browsing [9].

Context

Context comes next in this model. Context can be considered on many levels. A broad sense of context, which takes into account many possibilities, and many underlying ecosystem relationships, enables the deepest possible impact. What is the environment that the artifact will function within? What are activities, yes, but moreover, what assumptions underlie its conception, perception, reception, and potential? Context involves political, economic, social, and cultural factors.

Ethnography is the process of discerning and representing cultural context. It inscribes culture, representing it as text, or multimedia. It forms anthropological knowledge. "Doing ethnography" begins with examining cultural forms, such as artifacts, events, rituals, customs, work practices, and symbol systems. This examination includes discovering the relevant background that makes the occurrence of these forms comprehensible. From examination, the ethnographer proceeds to analyze and render these cultural forms. According to Geertz, doing ethnography is an elaborate venture in "thick description" [4]. The explication of cultural forms requires referencing their context, including the social, historical, political, psychological, technological, and economic situations both of the ethnographer and her/his subject. Creating thick description means producing "piled-up structures of inference and implication." Codes of signification must be sorted out. Figures are rendered on grounds. Is a *CollageMachine* user at work, in a café, in the foyer of a public building, in a museum exhibition, at home in the living room, or in the bedroom? How old is s/he? Is s/he accomplishing a task or seeking entertainment? Or is some mixture of these goals and values in play? All of these influence how s/he will perceive the interactive artifact. Ethnography accounts for this. A basis of personal and institutional relationships provides the data of observations and interviews. Rendering means developing a multiplicity of complex conceptual structures, such as linkages, maps, diagrams, genealogies, lexicons, and other textual, visual, and aural forms.

In the case of *CollageMachine*, I considered the context of the web, and browsing, most broadly. I did not begin with particular users or usage scenarios. I was content to let such scenarios develop along with the artifact.

One contextual issue that motivates me is the rise of hierarchy in the World Wide Web. In its technological foundations, the web possesses strong meshwork attributes. There is the core, peer-to-peer TCP/IP networking technology, and its contrast with one to many publishing. HTML, the language of web pages, is not so difficult, conceptually to understand and author. Inexpensive personal computers are sufficiently powerful for production and, even, serving. Bandwidth sufficient for effective web serving is also inexpensive.

Structural forces also push the process of creating web content toward hierarchy. Nelson's critique of web technology is that it lacks the inherent mechanism for hyperlinked annotation. In his vision of hypertext, everyone is an author. Such infrastructure consistently enables one author to respond to another. Their content can be fluidly linked together, automatically. Because it constitutes content as an ongoing, multivocal conversation, such an authoring structure would be strongly meshwork, and so would sustain the powerful meshwork dynamics that support ongoing initiative towards invention.

Strong hierarchical forces in the economic context of multinational capitalism also push the web toward hierarchy. The largest media publishers, such as AOL Time-Warner, have positioned themselves as providers of web content. Most users use portals as starting points for browsing. In addition, while search engines appear to function as objective sources of web content, in fact, they sell positions with regard to key words.

The meshwork attributes of web technology are not sufficient to combat these hierarchical tendencies in the web's development. With *CollageMachine*, I intend to support meshwork dynamics by affording users a more active role in browsing. There is irony in suggesting that browsing with *CM* is more active than conventional browsing experiences. A typical browser acts only in response to the user. It only follows hyperlinks you select. As an agent, on the other hand, *CollageMachine* drives the browsing experience. It follows hyperlinks and presents media elements on its own volition.

While a typical browser gives the user complete control of which hyperlinks are followed, it presents the web according to the precise specifications of content designers. As the content viewed by most of the people most of the time is authored by a relatively small group of creators, representing a relatively small set of powerful publishers, this effects hierarchy.

In contrast, *CollageMachine* lets the user rearrange the display. *CollageMachine* puts the media elements it finds into an authoring space, like a design program. It puts the elements into the user's hands, instead of simply presenting them according to designers' plans. This gives the user a new control of browsing – to create look and feel. Browsing becomes art making. In addition, *CollageMachine*, through its web crawling, will bring the user to unplanned destinations. Thus, it opens the space of web destinations that the user sees. The "Web Page Tool" [6, 9] enables the user to directly connect this collage browsing experience with her/his conventional browsing.

The incorporation of feedback from the user's design operations into the model is an essential mechanism that gives the user control of the browsing experience. The artifact's success in acting on behalf of the user may be perceived through its success in choosing content and making layout decisions according to her/his desires. This success depends on the effectiveness of the agent model in actually representing the user's interests.

By presenting web content in an authoring space, and

laying content out with regard to the user's interests, *CollageMachine* reduces the role of a small set of content publishers in determining that experience. Thus, it can serve to subvert hierarchies and give the web more meshwork character. Part of the concept for *CollageMachine* is not only to be part of the prevailing web context, but also to influence and transform that context.

Design

Through design, the actual artifact takes shape. By design, I mean all manner of plans, strategies and tactics involved in realizing the concept in the situation of the context. Design is a situated [20] conversation with materials [21]. Design utilizes the properties of the materials – be they interactive devices, cameras, microphones, programming languages, paints, or fabrics – and of prevailing as well as imagined significant behaviors [7]. Design involves creating form for the concept in context. It builds and accounts for associated relationships. I construe design most broadly, including both the artifact's situation – that is, relationships with its context – and internals – that is, the means and manner of its formation from materials. Further, the distinctions between design and implementation – the leg at the base of the triangle – are fuzzy ones. There is a continuum which results both from the nature of the creative process, and from the back and forth flow of feedback and revision. Design and implementation are more connected than separated. This concrete making includes all appropriate science, engineering, interaction design, visual design, usability analysis, performativity, physicality, and sculpture. Accounting for cognitive factors is part of it. The design and analysis of languages – including semantics and translators – as well as data structures and algorithms - including running time– is involved. Likewise, included are object-oriented designs, which structure software to manage complexity. In social spaces, choreography and informal processes become significant.

As the development process proceeds down the bottom leg of the feedback triangle, towards final implementation, concrete usage scenarios develop. With *CollageMachine*, this transition was not planned. A demo version of the artifact took form. People started to see it, and to respond. I started to see how people would interact with what I was building. In response, I was able to think more concretely about both about how I wanted the artifact to work, and how people can use it. Each of these scenarios is associated with a particular environment. As these use contexts are specified, they become the appropriate targets for activity analysis, ethnographic inquiry, and usability studies. One current context for the artifact is as a tool that is available as part of the Interface Ecology Web [6]. It offers streaming collage browsing through the web. A qualitative user study has been conducted in this context [7].

Public Installations and Presentations

CollageMachine has also functioned in many public environments. These situations yield direct observations of user responses. Without statistics, these situated contexts provide valuable ethnographic data. For instance, the program has been installed on publicly accessible PCs for extended periods at sites such as Milia 2000 (Cannes), the New York Digital Salon, and SIGGRAPH 2001 (Los Angeles). Previously, the Web Page Tool would open a new window for each request. The way the runtime environment worked, if the web browser that launched *CollageMachine* was in full screen mode, the new window would also be full screen. It would bury the collage. Even if this did not confuse the current user, the session could get left in this state. The next approaching user would not see the running collage. The convoluted Java -> JavaScript solution involves passing the URL of the new web page as an argument to an intermediate web page in a hidden frame. The hidden page then uses JavaScript to create or access and raise, a single smaller popup window.

CollageMachine has been chosen on several occasions by hypertext poets and fiction writers to represent their work ensemble at performative public events. For the Electronic Literature Organization's 2001 awards ceremony, executive director Scott Rettberg used *CollageMachine* in order to present, "a dynamic visual representation of network literature that is linked to many universes of content," and "a reading experience that is necessarily temporal and impermanent."

CollageMachine can play a role in social spaces. At a recent Banff Centre New Media Institute Summit, *CollageMachine* created a collective visualization of the web sites of the 20 participants. Sher Doruff of Amsterdam's Wag Centre for Old and New Media observed, "People were captivated when you showed the collage of their websites. They were anticipating seeing their images and texts appear among others from the audience." The streaming collage became a means for participants to get to know each other, and see relationships between each other's work.

Participation in the *JumboScope* (2001) site-specific public ambient installation began with contributions of media through the web to a Tufts University community archive. *CollageMachine* then visualized this archive on a large; touch sensitive display, in a central campus lobby. The basis for the concept was to explore the community's diversity, and tensions between democracy, promotion, and censorship in public space. The system also used on demand client-server interaction to aggregate the interests of community members, as expressed through interaction, as a form of collective memory. It employed this persistent server-side model in the process of collage session seeding.

A CONCEPT-CONTEXT-DESIGN COGNITIVE MODEL

As interface development is a creative process, so it makes sense to consider it in terms of the Geneplore model [3], as it has been applied to collage [9]. The result is a concept-context-design cognitive model of the development of interactivity (See Figure 2.). The development of concept is the essence of the generate stage. Generate, like concept formation, is an internal process. While generation proceeds ultimately in response to the outside world, in a
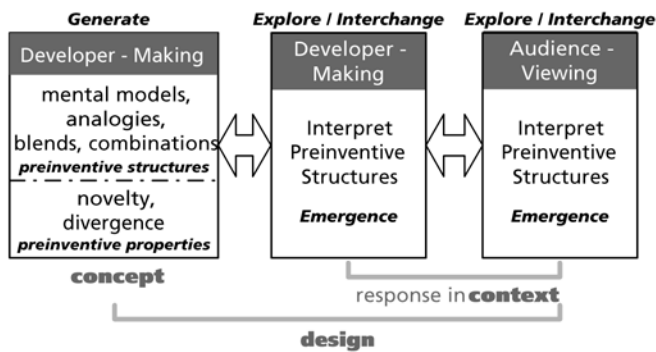
**Figure 2. The Creative Cognition of Collage ->
A Concept-Context-Design Cognitive Model**

feedback loop, it essentially consists of the artist's internally motivated process of reflection and creation. The initiation phase of the development of interactivity is similar. Consideration of context is an exploratory activity. Whether it is based on a broader sense of history and culture, or a particular usability scenario, context motivates the interpretation of concept and design preinventive structures in light of real world factors. Incorporation of such factors happens in the feedback loop that returns to generate. Emergence occurs as part of that generation in response, and during interpretation, when the artist or audience member senses that a generated design locks in with interpreted conditions. The collage artist and the human computer interaction developer engage in similar cognitive processes.

In this model, conception is an internal process of "generation", and interpretation is the interchange that involves getting feedback -- the world's responses to generated artifact forms.[1] Feedback flows through connecting linkages to get incorporated. Taking an ecosystem view, cognitive intention circulates.

COGNITIVE CIRCULATION IN HCI DEVELOPMENT
The triangular model addresses four kinds of processes that developers engage in. Concept is an internally generated sense that directs the conversation with materials, the definition of context, and its traversal. Context involves the world, both as a source of ideas and of constraints. Design and implementation engage materials and processes. As it gives form to concept, design straddles generate and interchange. While the flow of development starts with concept, and initially moves through consideration of context, before deep involvement in design, it circulates freely. Response to experience in any node can feed back to any other. This overall flow keeps things open and lets them be responsive. Creative, ethnographic, scientific, and engineering aspects of development are composed ecologically. Equivocal relationships develop meshwork.

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[1] I substitute the term *interchange* for *exploration*, because the latter comes with unilateral connotations of imperialism. Interchange, connotes a more symbiotic, multivocal flow. The developer doesn't just act upon the world, s/he works *with* it.

The activities and cognitive processes that comprise the development of interactivity are interrelated. As a project moves from inception to release, development shifts from internal and isolated to external and interpretive. Experientially, it becomes more interactive. Generate gives way to interchange. Even while there are no one-way arrows in this iterative model, the artifact moves from inception to completion. The triangular model does not address the practitioner's parallel shifts -- through an overlapping series of cognitive circulations. Generation and interchange are practiced through phases: initiation, conceptual walkthroughs, and usage. They are arranged iteratively in Figure 3. Each of these phases is a component of one or two modes. The first mode, conception, refers primarily to development in which developers work in isolation, in labs, studios, or more personal settings. During conception, circulation may be internal. Both imaginations and users/audience may play key roles. Mental models are generated and compared. Conception includes the initiation and conceptual walkthrough phases. The second mode, interpretation, is about getting feedback. It includes conceptual walkthroughs, again, as well as direct observations, usage experiences and usability evaluations.

The earliest cognitive circulations are meditative dialogues with self. When a project is collaborative, "self" can include any participants. Intuitive techniques, such as sketching, brainstorming and jamming may be used. So can rational methods, such as activity analysis. Initiation, the first phase of development, refers first to the initial development of concept, and then likewise to the initial development of artifact forms. Initial forms include mental models, notes, sketches, storyboards, and mockups. Until the concept takes form, feedback is limited. As concept takes shape, context becomes better defined. The interchange between them gets focused. When this definition reaches a certain threshold, implementation begins. Initiation is repeated. Concept, an internally conceived blueprint, serves as a guide. Developers use materials to form versions of the artifact. These processes can be iterated on different levels.

Conceptual Walkthroughs
Conceptual walkthroughs are the second phase of this interactivity development process. Conceptual walkthroughs straddle the border between conception and interpretation. I have coined the term by translating the common hci evaluation method of *cognitive walkthroughs*. As cognitive walkthroughs are a task-centered interface design method for evaluating a design without users [13], so conceptual walkthroughs are concept-oriented. *Task analysis* is replaced by *concept visioning*. In a cognitive walkthrough, developers act as if they are the users in their roles. They use the interactive artifact to perform representative tasks. They observe gulfs between the needs of the user performing her/his task and the actual function of the artifact. They iteratively redesign the artifact to bridge such gulfs.

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         initiation
              ↑
              ↓        conception
- - - - conceptual walkthroughs  · - - - - -
              ↑        interpretation
              ↓
usage experiences < > usability evaluations
```
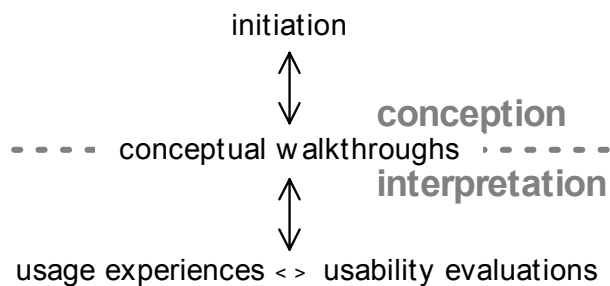
**Figure 3. Cognitive circulation in
the development of interactivity**

Conceptual walkthroughs evaluate an interactive artifact similarly, but with respect to its concept. The referents come not from "the other" user, but from the self. The developer attempts to use the artifact as s/he imagined it would be used. S/he notes gulfs between the actual experience of using the artifact, and the conceptualized one. These perceived gulfs could be general or specific. For example, with *CollageMachine*, the concept that the streaming collage session could be "steer-able" emerged early on. That is, I wanted the user to feel like s/he could maneuver the collage, so that its retrieval of media elements and documents would go in a desired "direction". This abstract concept was latent for years before I actually designed the current model of the user's interests, and the Collage Visualization Grid.[2] As it takes form, such a concept can be evaluated via (conceptual) walkthroughs. How does the user's intent, as expressed through interactive collage design, manifest in the collage?

As a mechanism of steerability, the Collage Visualization Grid dynamically allocates screen real estate in order to best display the most significant elements. The next media element to be displayed is chosen via the selection random variable, which operates on the set of known elements which have not yet been displayed. This metric uses authored attributes, such as number of encountered links to an element, and closeness (in page traversals) to the original collaged documents (favoring breadth-first search). It also employs aggregated user interest attributes, which come from collage design interactions, using expressive tools [8-10].[3] Element size is chosen in proportion to its significance relative to other elements already in the visualization. The element and size are passed to the UpdateGrid operation.

UpdateGrid uses an altered metric to rank the current importances of all *displayed* elements. The selection metric is extended through factors such as on-screen aging, and positive direct manipulation. The displayed elements are sorted, to determine their stacking order (more important on top). The display is broken down into a grid, typically

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[2] Adding dimension to collage steerability is ongoing research.

[3] These are, by inference, propagated to related elements.

24x24. The program computes the sum of importances for each "candidate grid region" of the appropriate size. It uses these candidate region weights to drive a random variable that selects the position of the new element.

Tuning the operation of the model and the Collage Visualization Grid in order to realize the steerability concept is an essential practice. When the user clicks on a media element with the "Positive Grab" tool, I want her/him to experience the introduction of similar material into the evolving collage. How do relationships, such as being part of the same document, or of a hyperlinked document, translate? Evaluating the performance of the artifact in such a situation involves very detailed analysis of the state of the agent model. What elements are in the grid, and the available collections? What are the values of their attributes and computed metrics? How does clicking change these values? Further, does the flow of operators and values translate into the conceptualized user experience? And is the artifact doing what I meant or are there bugs? Recently, I was working on features for *JumboScope* that support model propagation from the client to server. I had to look at exactly what was being sent. In the process, I noticed a bug in the client-side model propagation code that was probably two years old. Identifying and fixing such bugs is a very specific, detail-oriented undertaking. This process of conceptual walkthrough both identified the bug, and its resolution. The result is a more steerable user experience.

Developing *CollageMachine*'s agent model and visualization involves *tuning* the values of constants and structures of equations. By and large, these procedures are very application context specific. I futz with them almost every time I work on internal *CollageMachine* development. I don't have any final results to report on them. They remain an ongoing work in process. Yet, their form, as an ensemble, is critical to the application's function. It is possible that at some point I may decide to subject certain parameter value and computational structure choices to usability testing. Meanwhile, I tune constant value parameters, and establish the equations through which parameters influence each other, through conceptual walkthroughs. I work like this: first, I intuitively set the values. Next, I run *CollageMachine*, and play with it. I examine the results. I correspond what I am seeing with the values and equations that I have set, as well as with the concept. Here, by the concept, I mean my imagined sense of how it should work, the feel I am looking for. I iterate, modifying the implementation, running, and inspecting again. This common practice is *tuning*.

Usage Experiences and Usability Evaluation

Usage can be interpreted directly through experience, in the body, and through observation. A series of examples have come through public presentations of *CollageMachine* (See above.). One advantage of direct observation is that it involves actual users, in context.

Interactivity developers also practice the interpretation

mode of cognitive circulation through scientifically construed usability evaluations. They can be more or less formal, qualitative and quantitative. Cognitive walkthroughs and heuristic evaluations are processes conducted by designers acting as if they were other users. Informal demos and usability tests are constructed scenarios that get the developer out of control of the artifact during the evaluation process. The "other" becomes the "user." Channels of communication are opened.

In an informal demo, a developer sits with another person and shows her the artifact. Perhaps the other gets to hold the mouse for a while; perhaps not. Agency for operating the artifact is distributed between the developer and the other. Qualitative and quantitative tests remove the developer. Qualitative tests statistically track subjects' tendencies. Quantitative tests measure (in cases where efficiency is relevant) the time it takes subjects to perform an operation.

The relationships between the contexts of usability evaluations and the contexts of actual use effect the significance of evaluations. For direct observation in public sites of interactivity, these contexts are the same, yielding clear results. The correlation may be weaker between evaluation and target usage in the formal usability tests that are popular in SIGCHI. When statistics are involved, the construction of sample space (Who are the subjects?) is a hidden key to validity. A survey of the *Proceedings of CHI 2001* indicates that of 65 papers published, 54 included usability tests. Of these, only 16, or 30%, substantially linked the range of backgrounds among the subject population with the domain of conclusions. Potential effects of biases in the sample space, such as relying entirely on students or employees of the host institution, were ignored. While the selection of convenient samples is somewhat understandable, from a pragmatic perspective, the result is that the significance of the statistics is overstated. Further, most usability tests are biased toward the experiences of novice users. Informal, qualitative methods may be as valid or more than formal, quantitative ones.

CONCLUSION

Through its exclusion of developers' imagination, user-centered design limits the range of interactivity development. An alternative model, the triangular concept – context – design loop, allows development to proceed appropriately, without being unduly constricted by the epistemologies and methods of a single discipline. The modes and phases of cognitive circulation involve formal and informal methods. Scientific, ethnographic, and artistic practices are allowed to mix. These models are meshworks. Their invocation enables development to proceed ecologically, just as the user experiences the resulting artifact as an ecosystem. While statistical analysis may be worthwhile, critical analysis of usability evaluation practices indicates that intuitive and qualitative methods are equally valid.

The triangular model was developed bottom up. It was distilled through reflection on practice. It emerged as a blueprint for future ecological development of interfaces from consideration of my experience of *CollageMachine* development. This model represents interface ecology principles in the context of the process of developing interactivity.

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