

HUMANITIES APPROACHES TO INTERFACE THEORY

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Interface is a concept we have only paid careful attention to for about fifty years. The term comes into play early in the process of computational design. The pioneering work of flight simulators, of head gear, foot pedals and other apparatuses that would discipline the body to conform to a regime of screen-based and device-driven affordances made the discussion of these relationships into a field of its own known as HCI (Human-Computer Interaction). Imaginative as Doug Engelbart and Ivan Sutherland were, with their profound realization that all the complex processing in the world would not result in effective use without a way to get human beings to have real-time relationships with these ‘machines’, even they were coming from a place in which engineering values dominated their approach to design. Task-oriented and efficiency driven, they focused on feedback loops that minimized frustration and maximized satisfaction with mouse clicks and joy sticks and rewarding bells and whistles. From their innovative beginnings came a robust industry whose practitioners approach their challenges through scenarios that chunk tasks and behaviors into carefully segmented decision trees described in prose and designed to abstract their use from any whiff or hint of ambiguity. ‘Analysis’, ‘prototype’, ‘user feedback’ and ‘design’ are locked into endlessly iterative cycles of ‘task specification’ and ‘deliverables’.¹ This language does not come from a theory of interface, but from a platform of principles in the software industry. Deliberately mechanistic, it eliminates the very element crucial to humanities work – substituting the idea of a ‘user’ for that of a ‘subject’ whose engagement with interface in a digital world could be modeled on the insights gained in the critical study of the subject in literary, media, and visual studies. A theory of interface for the humanities might well return to the work of Kaja Silverman, Paul Smith, Stephen Heath, Laura Mulvey, Margaret Morse, and the many other writer-theorists whose synthesis of structuralist and post-

structuralist approaches created a rich understanding of enunciating and enunciated subjects (the speakers and the spoken). Because the interface environment is so distinctly graphic (and haptic) in its formal expression, however, I want to suggest that we also need to bring into play a number of other analytic tools – from graphical reading, frame analysis, and constructivist theories of perception -- to flesh out our descriptive understanding of the principles and properties of the GUI space that we refer to with casual familiarity as ‘the interface’, without really stopping to consider what that space is and how it provides the provocations and affordances through which we cognize our experience of it. A humanities theory of interface begins with the theory of the subject assumed – we know those lessons well and can readily recall the psychoanalytic, linguistic, and textual studies precepts in which we learned that ‘we are spoken by the text’ as much as we ‘speak’ it. I want to concentrate, instead, on the less familiar elements of my approach mentioned above.

The motivation here is simple. The authoring and reading environments for interpretative scholarly work are only just beginning to be designed in such a way that the linear, finite conventions of print media can be changed for the constellationary, distributed, multi-faceted modes of digital media. The capabilities of networked environments and computational tools have supported the aggregation of geographically distributed materials in a virtual space, social networking in real and asynchronous time, data mining, GIS and mapping, and visualization aids to analysis and argument more than the development of a digital paratextual apparatus. As this process develops, a challenge for humanists is to reflect on and articulate the theory of interface that underlies the design of our working environments.

I want to move immediately into the elements of graphical interface from the theoretical perspective, using the principles of frame analysis from cognitive studies, interface theory, graphic organization, and content modeling to think about the semantic value of relations among elements of interpretation in a screen environment. By this I mean that we can combine formal analysis (a discussion of the ways basic features such as proximity, overlap, hierarchy, dependency, and sequence can order and structure meaningful relations among elements of interpretation) with a constructivist model of the subject.

Some work on the formal features of graphical reading comes from studies of graphic novels and comics, those print formats whose dependence on graphical features pushes this issue to the fore in ways that can then be folded back onto the traditional codex as well as extended to electronic documents and collections of documents. But in addition, the affordances of search, sort, and semantic web add dynamic dimensions to these basic features. As we attend to formal and technical affordances, we need to keep our critical foundations in view.

The reading of digital environments extends the theoretical approaches to reading practices spawned at the intersection of post-structuralism and graphical analysis. These produce a theory of a constituted subject created through the process of reading, rather than a mechanistic consumer-model of autonomous viewer. So, attention to the specific relations between properties and affordances of electronic environments *within* a system of co-dependent relations of production will be the starting point for assumptions about interface as a space that supports interpretative events and acts of meaning production. Though we still have some way to go before arriving at the graphical conventions that will serve our purpose, the intellectual basis for this design seems within reach, as does the formulation of this theoretical foundation: the constructivist subject of the digital platform emerges in a codependent relation with its affordances. This is the 'subject of interface' when interface is conceived as a dynamic space of relations, rather than as a 'thing'. Ultimately, a new language of description and analysis will take into account the spatialization of meaning and the meaning producing features of spatialization--the language of a diagrammatic electronic environment grounded in constructivist principles. Now to sketch the basic outlines of this model by drawing on these various fields alluded to above--graphical reading practices, interface theory, and frame analysis.

Graphical reading practices

In 'Blood in the Gutter', a crucial chapter of his foundational work *Understanding Comics*, Scott McCloud lays out the ways in which we make connections across the graphic frames that separate one moment in a visual narrative from another. Shifts in scale, point of view, character and so on are each marked graphically, and our ability to connect what we see (the *telling* of the tale) with what we read or know (the *told* of the story) is supported by specific

conventions. Many of these conventions follow the same pattern as cuts in film shooting and editing. We correlate the changes in point of view in the same ways we process conversation in a shot-reverse-shot film sequence, for instance. Framing, details of scene, costume, character, all allow us to connect one fragment to another within the unfolding tale. Visual cues are the basic means by which comics work, reinforced by textual information.

McCloud's categories of connection within the codes of comic book layout are clear and sensible: panel-to-panel (or following moment-to-moment activity), action to action (progressions of the story), subject-to-subject (by which he means connecting themes or strains of a narrative), scene-to-scene (connecting spaces), aspect-to-aspect ('a wandering eye' in a place, or to set atmosphere and mood), and finally, the non-sequitur. This final category is part catch-all and part meta-category in which the relations of frames are not specified by the more linear or conventional story-telling activities of the other relations. A tremendous number of connections in electronic space fall into the non-sequitur category. We shift from editorial text to advertisement, from personal communication to social networking, from embedded video to text, audio to image, and often, in the process, from one domain of activity to a radically different sphere of activity. The graphic environment of the web is often a scene of infinite distractions, unless we are inside a controlled environment – a library collection or single resource. But even in those situations we are constantly offered alternatives – not so much a garden of forking paths but a hopscotch of hotspots, launch pads, and sinkholes through which our attention runs at whim and will.

Nonetheless, our cognitive ability to make correlations is staggering. We make sense of one piece of information or experience in relation to another, stitching fragments of what are graphically related elements together into a narrative, or making our way through unrelated fragments until some chain of compelling connections captures our attention. We expect the elements in a story to mesh, and the conventions of the comic book, or graphic novel, like those of a film or video, assist those expectations. But in the graphically complex multimedia environment of the web, no pre-existing narrative organizes our task of correlation. We are constantly in the frame jumping state that disorients the reader, trying to create relations across varied types of material – images, videos, maps, graphs, texts, and the many structuring elements of layout and format that organize the graphic environment. The front page of the online *New York Times*, for instance, encodes many varied tasks and

possibilities, all fully legible to us. The elements of navigation and way-finding that help orient our experience far exceed the simpler set of devices that guide our reading of comics, and not only do we have to process many more types of frames and relations, but we are often crossing between one mode of media and another.

The visual aspect of graphical interface connects it to the embodied condition of users, a fact that was evident even in the early days when Engelbart and Sutherland were struggling to figure out how to use hands, feet, body movements, and orientation to the screen as part of the basic computational apparatus. The tactical, haptic, and acoustic aspects of interface have only intensified in the intervening years, though the graphical features that organize interface remain essential to our use of digital environments. These more fully embodied aspects of user experience are always present in the background of my discussion, but my focus will be on the challenges of reading across very disparate frameworks and modalities (media types) within the graphical interface environment.

I come back to McCloud's final category of non-sequitur relations among frames, the most difficult to characterize and process. Non-sequiturs within a graphic novel or comic book narrative often enact a shift in the basic cognitive frame from which the story unfolds and within which it is being conceived. This kind of shift is akin to the mind games in science fiction and fantasy tales in which the story itself turns on the revelation of an unreliable narrator, or changes the basic foundation on which a story is being told. A dream turns out to be real, a character turns out to be the creation of another character, or the breaks and ruptures in a story are signs of amnesia, trauma, drug states, or other altered or abrupt shifts of consciousness. Unlike the other relations across panels listed in McCloud's inventory, shifts in cognitive frame do not simply mark themselves with graphic means. We have to bring our extra-narrative experience into correlating what has happened in the jump from one cognitive platform to another.

In graphical readings – that is, the processing of visual cues—we integrate the format features of presentation into the production of meaning. Elements like color continuity let us follow a character or story element, the relation of smaller to larger frames produce micro-levels of story detail, slowing action to micro-units. Embedded elements produce reflection, interior commentary, changes of point of view in relation to existing frames. In short, a full language of graphical relations is articulated in format features,

visual elements, but also, these graphical features articulate semantic information at the level of the story at the same time. A full typology of these features would include the seven graphic variables of static, analogue technology (size, shape, position, orientation, color, texture, tonal value) plus variables specific to digital environments (rate of change, movement etc.). An additional typology of relations among elements would include the fundamental properties identified by Gestalt psychology (emergence, multi-stability, reifications, invariance) and its laws of *pragnanz* (closure, similarity, proximity, symmetry, continuity, and common fate). These elements are fundamental to visual perception and cognitive processing. But in addition, we have to add another layer of analysis that addresses cognitive frames because the elaboration of these basic graphic practices, though essential to formal analysis, is not sufficient to account for cognitive activity—or for the model of a subject constituted in a codependent relation to interface as experience.

Frame analysis

Frame analysis, as outlined in the work of Erving Goffman (1974), is particularly relevant to the processing of a web environment where we are constantly confronted with the need to figure out what domain or type of information is being offered and what tasks, behaviors, or possibilities it offers. To reiterate, on its own a typology of graphical elements does not account for the ways in which format features provoke meaning production in a reader or viewer. The cognitive processing that occurs in the relation between such cues and a viewer is not mechanistic. Graphical features organize a field of visual information, but the activity of reading follows other tendencies. These depend on embodied and situated knowledge, cultural conditions and training, the whole gamut of individually inflected and socially conditioned skills and attitudes. Frame analysis is a schematic outline that formalizes certain basic principles of ways we process information into cognitive value – or go from stimulus to cognition. Filling in the details of ideological and hegemonic cues, or reading specific artifacts as a production of an encounter – the production of text (reading) and production of a subject of the text (reader)—is a process that depends on specific cases. But the generalized scheme of frame analysis puts in place a crucial piece of our model of interface –the recognition that any piece of perceived information has to be processed through a set of analytic frames that are grounded in cognitive experience *in advance*

of being read as meaningful. We have to know where we are in the perceptual-cognitive loops – what scale the information is and what domain it belongs to, for instance—before we can make any sense of it at all.

In a networked environment, such as an iPhone, for instance, the literal frames of buttons and icons form one set of organizing features. They chunk, isolate, segment, distinguish one activity or application from another, establishing the very basis of expectation for a user. Engagement follows, and then returns to the interface in an ongoing process of codependent involvement. But ‘frames’ are not the same as these conspicuous graphical instances. Once we move away from the initial menu of options and into specific applications or digital environments, a user is plunged into the complex world of interlocking frames – commerce, entertainment, information, work, communication etc.—whose distinction within the screen space and interface depend on other conventions. For scholarly work, the ultimate focus of my inquiry, the relation among frames is integral to the relations of what are traditionally considered text and paratext. In a digital environment, those relations are loosened from their condition of fixity and can be reorganized and rearranged according to shifting hierarchies of authority and priority. A footnote to one text becomes the link to a text which becomes the primary text in the next window or frame, and so forth.

The basic tenets of frame analysis depend on a vocabulary for describing relations (rather than entities). Frames by definition depend on their place within a cognitive process of decision making that is sorting information along semantic and syntactic axes – reading the metaphoric value of images and icons as well as their connection to larger wholes of which they are a part. In traditional frame theory certain behaviors are attributed to relations between frames. A frame can extend, intensify, connect, embed, juxtapose, or otherwise modify another frame and perception. The terminology is spatial and dynamic. It describes cognitive processes, not simple actions of an autonomous user, but codependent relations of user and system. In invoking frame analysis as part of the diagrammatic model of interpretation, we have moved from a traditional discussion of graphical formats as elements of a *mise en page* to a sense that we are involved with a *mise en scene* or *système*. This puts us on the threshold of interface and a theory of constructivist processes that constitute the interface as a site of such cognitive relations. Interface is not a thing, but a zone of affordances organized to support and provoke activities and behaviors probabilistically,

rather than mechanically. Only by taking into full account the constructivist process of codependence that is implicit in frame analysis have we been able to move from a simple description of graphic features – as if they automatically produce certain effects – to a realization that the graphical organization only provides the provocations to cognition. They constrain and order the possibilities of meaning producing conditions, but do not produce any effect automatically. In fact, the very term ‘user’ needs to be jettisoned – since it implies an autonomy and agency independent of the circumstances of cognition—in favor of the ‘subject’ familiar from critical theory. Interface theory has to proceed from the recognition that it is an extension of the theory of the subject, and that therefore the engineering approach to interface that is so central to HCI practitioners, will need some modification.

Interface theory

What is an interface? If we think of interface as a *thing*, an entity, a fixed or determined structure that supports certain activities, it tends to reify in the same way a book does in traditional description. But we know that a codex book is not a *thing* but a structured set of codes that support or provoke an interpretation that is itself performative.² Interface theory has to take into account the user/viewer, as a situated and embodied subject, and the affordances of a graphical environment that mediates intellectual and cognitive activities. Roger Chartier (2004) referenced this concept of embodiment as the ‘engagement of body, inscription in space, relation to oneself and others.’ Geoff Nunberg, in a now-classic 1993 article, ‘The Places of Books in the Age of Electronic Reproduction,’ cited Chartier and made his observations relevant to the then still very new questions of electronic surrogates and displays. The design of environments for doing scholarship digitally depends on the graphic and spatial organization of these environments, but also on the basic conception of interface. But recognizing embodiment only gives us a place from which to begin thinking about cognitive processing, it does not supply a basis for a theory of interface.

Twenty years ago, Brenda Laurel (1990) defined interface as a surface where the necessary contact between interactors and tasks allowed functions to be performed. She noted, as well, that these were sites of power and control, infusing her theoretical insight with a critical edge lacking from the engineering sensibility of most of the HCI community.³ In 1989, Norman Long, a sociologist responsible

for 'Social Interface Theory', described it as 'a critical point of interaction between life worlds.'

Interface in a dynamic space, a zone in which reading takes place. We do not look rather through it (in spite of the overwhelming force of the 'windows' metaphor) or past it. The desktop metaphor at least suggests a space of activity in which icons stand for objects with behaviors we enact. The surface of the screen is not merely a portal for access to something that lies beyond or behind this display. Intellectual content and activities do not exist independent of these embodied representations. Interface, like any other component of computational systems, is an artifact of complex processes and protocols, a zone in which our behaviors and actions take place. Interface is *what we read* and *how we read* combined through engagement. Interface is a provocation to cognitive experience.

If we usually separate what we think of as 'content' from the wireframes and display techniques, then we are performing acts of blindness. We do not read content independent of interface on a screen any more than we do when we read the newspaper. We have only to strip away the graphical codes of a printed text – put its letters and words into a simple sequence, remove paragraphing, hierarchies, word spacing etc. – to see how dependent we are on these format elements as an integral part of meaning production.⁴ We receive 'content' embodied in graphical codes that structure our reading and viewing and perform a quasi-semantic function, not merely a formal or syntactic one. The specific qualities of the encoding that distinguish the many modalities of the electronic environment intensify the process of jumping from one frame to another. Distinctions among modes (by this I mean the ways we sort out whether something is an advertisement, editorial copy or something else, as well as distinguish audio from video etc.) are largely signaled by various graphical and formal codes that are readily recognized through their conventions.

The processes of frame jumping – moving from one cognitive frame to another in repositioning ourselves as reader/viewers in the multi-media environment – are probably less well understood or articulated as a set of practices and behaviors. In part that is because we can use the techniques of traditional analysis – from art history, design, semiotics, cultural studies and so on – to describe the characteristics and ideological cast of media modes. But the description of frames and their relations belongs to an emerging field. If we have an elaborate, extensive, language for describing

things, or entities, in any number of useful ways, we have an impoverished vocabulary for describing relations among them, especially when those relations are not static, but dynamic, and constituted as events, rather than fixed in hierarchies (like kinship, value systems, or databases, to cite a few examples). In short, these relations belong to the realm of diagrammatic activity and these specific characteristics have to be articulated in a theoretical vocabulary of spatialized relations.

We are used to thinking about relating to the digital environment 'through an interface'. But this brings me back, again, to the basic question: what is an interface? In the world of interface cum interface – the HCI community – the concept is approached through an engineering sensibility driven by mechanistic pragmatism, as exemplified in Jesse James Garrett's much cited graphic. Garrett's analysis of the elements of user experience addresses a fundamental duality between the web as an information space and as a task-supporting environment. His observation that the difference between these conceptions leads to confusion in design has fundamental implications for interface design. Garrett's insight gets to the basic tension between a rational organization of content and the need to balance this with an intuitive way of using that content. Interface is the space between these two – it is neither the transparent and self-evident map of content elements and their relations, nor is it simply a way to organize tasks. The pair are as intimately related as the reading of a text in a book is governed by its graphical organization and the specific individual reading experience produced as a 'performance' of that environment. Garrett's scheme of organization provides an essential insight, but a full theory of interface goes beyond the design of information structures and tasks into the realization that these are only the armature, not the essence of that space of provocation in which the performative event takes place.

A book is an interface, so is a newspaper page, a bathroom faucet, a car dashboard, an ATM machine. An interface is not so much a 'between' space as it is the mediating environment that makes the experience, a 'critical zone that constitutes a user experience'. I don't access 'data' through a web page; I access a web page that is structured so I can perform certain kinds of queries or searches. We know that the structure of an interface *is* information, not merely a means of access to it. The search and the query modes are what I see. Sliders, for instance, with their implication of a smooth continuum, impose a model of what information is through their expression of

how to manipulate a value, while a dialogue box that asks for a keyboarded number imposes an equally rigid model of discrete values. When we are looking for dates for travel, it will make an enormous difference whether we are able to state our request in discrete or continuous terms. Interface designers are fully versed in the strategic variables according to which information needs to be structured to be manipulated effectively. The design of interface is permeated by analytic techniques. It takes place in zones where 'human factors' are incorporated 'in engineering' and where 'human computer interaction' is produced according to the rigors of empirical experiment and user trials. Interface design also draws on cultural analysis – I'm thinking of the work by Aaron Marcus and Associates that studies front pages and their relation to various cultural factors. Building on work by sociologist Geert Hofstede, they looked at the ways cultural value systems are expressed in web design.

Hofstede's categories are open to contestation, but they provided a way to look at design features. Different cultural groups have different degrees of tolerance for ambiguity and uncertainty, they give greater value to individualism or show a preference for collectivism, or register different degrees of dissatisfaction with inequalities in power relations. These features find expression in the graphic organization of information, Marcus and his associates showed. Interactions with interface would, presumably, exhibit some similar features, though Marcus's group did not look at movement through the information structures or at the web architecture to see if that held true. If we look at web based design, however, the navigation paths, search and query results, browse features – in brief, every aspect of the web content management and display—embody values that are inherent to the reading process, even if they are largely ignored or treated as transparent or invisible. But after all, the same has been true of the ways we look at print materials, as I mentioned above.

The human factors and HCI communities work to design effective environments, ones in which satisfactions are balanced with frustrations, and efficiency can be maximized. Their focus is on the literal structure of the design, the placement of buttons, amount of time it takes to perform a task, how we move through screens and so on. In 'The Theory Behind Visual Interface Design', Mauro Manelli lays out a comprehensive mechanistic approach to the stages of action involved from 'forming an intention' and 'specifying an action' to 'evaluating the outcome'. Manelli's approach reflects on

the design process in relation to a concept of ‘user experience’ that approaches to map structure and effect directly. This is akin to doing close readings of a text’s formal features as if it locked that text into the reading. We know, of course, that every reading produces a text, and that what we are noting here is the distance between the interface design community and that concerned with critical theory. Interface theory has to close that gap.

If we base our theory of interface on the ‘user experience’ approach, it would be reductively mechanistic, based on a concept of interface as an environment to maximize efficient accomplishment of tasks – whether these are instrumental, analytic, or research oriented – by individuals who are imagined as autonomous agents whose behaviors can be constrained in a mechanical feedback loop. Challenges to that conception arise from within the information studies community –where interface is embedded in the motivations of an embodied user engaged in some activity that may or may not be goal oriented, highly structured, and/or driven by an outcome – but might equally be the diversionary experience of wandering browsing meandering or prolonging engagement for the purpose of pleasure or an even lower level notion like keeping boredom at bay or idle distraction and time squandering. We could imagine a historical dimension to this conversation that would connect the pioneering activity of Engelbart and Sutherland to the work of aesthetic theorist Roy Ascott and/or artists Myron Krueger (of ‘Glowflow’ and ‘Metaplay’ experiments, and his essay ‘Video Place and Responsive Environment’), or jodi.org and others who challenged the engineering paradigm. The aesthetic dimensions and imaginative vision makes interface a space of being and dwelling, not a realm of control panels and instruments only existing to be put at the service of something else. Work by Donald Hoffman (1989), on perception as interface, extends the constructivist approach to human cognition into analysis of experience by positing interface as the very site of construction, an approach I will return to in a moment.

I bring up these contrasting communities because they shatter the illusion of interface as a *thing*, immediately making it clear that a theory of interface can’t be constructed around expectations of performance or tasks or even behaviors. Interface and its relation to reading has to be theorized as an environment in which varied behaviors of embodied and situated persons will be enabled differently according to its many affordances. That kind of statement is so maddeningly vague and abstract that it seems almost useless.

But what if we shift from the HCI world, and the interface, into fields closer to graphic design and media theory? For one thing, this will allow a very important move in the way I want to think about reading. For the HCI community, the notion of a continuum of experience, within and structured by engagement with the interface, is never broken by engagement with representational content. So long as we think of interface as an environment for doing things, performing tasks, work, structuring behaviors, we remain linked to an idea that 'reading' the digital environment is restricted to an analysis of its capacity to support the doing of tasks. As if all of the interface work were happening on what we would call a plane of discourse, or the level of the telling, rather than the told. The notion of HCI is that the single 'frame' is that of the user experience. Thus a mantra like Ben Shneiderman's 'Overview first, zoom and filter, details on demand' assumes that one is working in a very restricted, highly structured, and discrete environment. For interactive database design, his approach makes sense, since there the interface is a way of displaying search results that come from the combination of variables or filters. Dynamic information visualization flattens the planes of reference, discourse, and processing so that they appear to be a single self-evident surface. The naïveté of that approach is easily critiqued – it is semiotic child's play to take a graphical interface with sliders, windows, dials, and variables and demonstrate that it is an expression of motivations, agendas, and deliberately concealed factors, no matter how earnestly or usefully it may serve a specific purpose. This is true whether we turn our critical attention on Travelocity, Yahoo, Flickr, or Lifelines2 and its display of 'temporal categorical patterns across multiple records'.

'Reading' these frames is not just a matter of consuming their content, of course, nor of analyzing their construction according to a bunch of 'Ideology 101' principles. Looking at a site through theoretical filters inherited from media theory and classical semiotics provides some insights into the way the relations of one kind of presentation works with another. Recalling 'The Third Meaning' by Roland Barthes, for instance, and its analysis of Soviet film montage, reminds us that looking at a web environment through a theory of cuts and connections makes some sense. That said, we have to remember the fundamental distinction between reading a received text and producing a text/work through the act of reading. Web environments are more mutable and modular than films, and the analogy between old new media and new breaks down when we realize that all segments of film, no matter how radically they are spliced and combined, are segments of the same order of

thing. They may, and do, require significant jumps in cognitive framing, but they are part of the same modality – film texts/sequences. All film segments and video segments unfold according to the same set of temporal principles – continuous and forward moving in a unidirectional manner. But the temporalities of web environments are varied. They don't conform to a single mode. The refresh rate of headlines, stories, videos, ads, banners, pop-ups, stories, other reports, links and user contributed information are all different. But also, the ways our bodies engage with these are distinct at the level of manipulation and cognitive processing of the experience.

If I watch an embedded video, track events on a map that zooms, scales, and shifts between a schematic map to a street view with its photographic codes while I am reading through a text, following links, opening a series of windows, and so on, then what is it that constitutes the interface? And what organizes the relational experience? Unlike the controlled experience of viewing a film, reading a graphic novel, or even performing the discontinuous reading of a book or newspaper, this experience has no a priori unifying ground on which the fragments relate. The exterior frame of a graphic novel, the defining frame that delimits its boundaries, has more porousness and more fragility in a web environment. We note the limits of a site or repository, which may have a siloed isolation and autonomy. But in most web environments we are reading across a multiplicity of worlds, phenomena, representations, arguments, presentations – and media modalities. The way we make connections across these disparities is different than when we work in a single delimited frame. The points of connection are perhaps best described in some combination of mathematical figures and architectural spaces – as nodes, edges, tangents, trajectories, hinges, bends, pipelines, portals. These are not the language of old media transferred to new, not a language that derives from theories of montage or cuts, editing or pastiche, allegory or appropriation. Instead, these are structuring principles that refer to the constitutive nature of interface experiences of reading.

Reading was always a performance of a text or work, always an active remaking through an instantiation. But reading rarely had to grapple with the distinctions between immersion and omniscience—as when we are experiencing the first person view of a video juxtaposed with manipulation of a scalable map, with watching the social network reconfigure itself around a node of discourse even as the node is changing.

The dynamic nature of the interface environment reconfigures our relation to the act of reading, ratcheting up the insistence on what Donald Hoffman refers to as ‘the interface theory of perception’. Hoffman’s constructivist approach outlines perception as a constitutive act. Countering traditional notions of perception as a species ability to ‘address the true properties of the world, classify its structure, and evolve our senses to this end’, he suggests that perception is a ‘species specific user interface that guides behavior’. Like the Chilean biologists, Francesco Varela and Humberto Maturana, Hoffman demonstrates that no experience exists a priori, the world and its reading come into being in a codependent relation of affordances. The new affordances of web-based reading are not distinct from this, they are not another order of thing, a representation already made and structured, but a set of possibilities we encounter and from which we constitute the tissue of experience. The constitutive act, however, in this new environment, puts our bodies – eyes, ears, hands, heads—and our sensory apparatus – into relation with rapidly changing modes. The integration of these into a comprehensible experience seems to have emerged intuitively, since the frames within frames of the web interface provide sufficient cues to signal the necessary shifts of reading modes.

The intersection of questions about the future of reading and the nature of interface are intimately connected. The articulation of a fuller theory of interface lies ahead. It won’t be addressed on simple formal grounds – through analysis of tasks, behaviors, graphic design choices, and the observation of eye tracking machines – but needs to be conceived in terms of a constructivist approach to cognition, and to the constitutive character of the ergonomics of the reading experience across frames and in these varied modalities. We have learned, in the last fifteen years, to hold in mind any number of irreconcilable distinctions. Web reading does not resolve into a singularity, into a whole, a tale, a narrative, even if our movement through its varied spaces is an act of way-finding guided by navigation and our internal monologue has an organizing thread. The image of a forking path may have worked for simple hypertext, but in the realm of multiple modularities, no common ground for organizing experience exists. The constitutive experience is at the interface, and that is what we read. The single cognitive frame is the boundary of whatever screen we are using to view; but within that, the lines of parallax constantly fracture and rupture our reading. Our understanding of the cognitive activity that constitutes that reading experience is only at the early stages, but the approach to that understanding seems best served by a constructivist approach to

perception that takes the embodied conditions into a codependent relation with the constitutive affordances of interface as a structuring environment. Interface theory in the form I have sketched here synthesizes the principles of graphical reading, frame analysis, and constructivist approaches to the subject as fundamental to understanding the dynamic space of codependent relations between environments and cognitive events.

Diagramming interpretation in electronic space

Finally, then, with all of this discussion of interface theory, we come back to the basic question of how to establish graphic conventions for enabling interpretative activity in electronic space (e-space), specifically, scholarly activity of glossing, commentary, reference, and mediation. How will the relations between texts and commentary be coded so that we can follow threaded conversations, semantic webs of networked references, and a shifting balance between primary and secondary texts? We have very little precedent in the print or manuscript environment on which to draw for such graphic conventions and for creating relations among them. Certainly, a table of contents and an index are two different facets and views of a text, and a simple 'page' view is another. We know how to correlate these facets in our reading activity. Likewise the multiple views in online games offer some contributions for thinking about the ways we can navigate complex interactions among the multiple players or scholars. To display the faceted aspects of scholarship as a social and collaborative activity will we have to activate multiple dimensions of interpretation? Interpretation in electronic space is, as we have pointed out elsewhere, n-dimensional.⁵ At any point in a scholarly text an infinite number of interpretative lines can be extended as lines of inquiry, reference, contestation, debate.

Speculative thoughts abound. We can imagine multiple tables of contents drawn from a single set of texts, database records, and metadata entries. These can be juxtaposed to semantic web diagrams mapping textual connections based on proper names, place names, frequency distributions of word combinations, or other textual features. The combination of abstract visualizations, mediating the viewer's relation to large corpora of texts, and the ability to use such visualizations as access points to the digitized documents, makes the relation of large scale and minute granularity readily possible.

In scholarly work, we want to distinguish between controlled environments like repositories and the wider world of socially networked exchange. Interpretative scims will need to work across these boundaries. A scholarly text might provide an intellectual 'guided tour' that references objects in multiple repositories but puts them into a single narrative or argument. These arguments, in turn, will generate their own discussions and commentary, signaled by a graphic cue, but then able to expand as their own sequence of arguments, references, discussions. The commentaries of multiple viewers, engaged in dialogue and debate, will need to be able to be searched and sorted. At all points in this living, growing web of interpretative activity, work will be seen from a point of view and need to be able to move selectively and at selected scales. This sounds complex, but the unfamiliarity of these modes, rather than the difficulty of the problem, is probably responsible. Once we accept the idea that we move through a discourse field, a web of interpretative activities that assumes spatial dimensions on the screen, rather than being flattened into the space of pages in the freeze-frame mode of manuscript and print, the navigational task can be redefined as way-finding. The process will resemble the task of *moving through* a library or archive, a landscape, rather than *looking at* the outline or scheme of that space in a flat map or plan. We can borrow from the conventions of electronic games and offer multiple views simultaneously. A display for navigation and one for reading and another organized as a topic map or semantic web complement each other without redundancy, as long as the relations among them are made explicit through shared clues—elements or reference frames.

When we are inside the experience, the cognitive tasks are shifted towards response to situated cues, orientation to their place within the path (rather than a grasp of a 'whole' that is assumed to exist outside of experience). Recognition that we have a partial, situated, and circumstantial view of a discourse field is not so different from the same realization with respect to printed documents and archives, except that in the electronic web we may be able to mark and map our trail of interconnections along a spine of experience that is at every point expandable into a semantic web whose diagrammatic properties are organized according to search criteria or parameters set by the reader or viewer. The difference between print and electronic environments is the ability to repurpose materials through different intellectual models of their relationships to each other. A table of contents according to chronology can be generated from the same material as one organized by theme. Likewise, a set of

commentaries could be organized to display by date, by commentator, or any other aspect of the text, data, or metadata.

Some graphic conventions we can use for interpretative activity will extend the familiar features of the codex while taking advantage of the capabilities of networked environments and digital display. Navigational features will combine views, and the ability to correlate across these will depend on having sufficient common reference points in one conceptual organization, or graphical frame, and another. The combination of 'bread-crumbs' trails that mark a place in a hierarchy or a sequence of moves or events with displays that make use of different scales and devices for shifting granularity will provide multi-faceted but integrated views. Again, I invoke the gaming world, with its combinations of first-person perspectives and schematic overviews, which are as critical to its navigation as are similar features in military software and other text simulations. As we extend these into the realm of scholarly activity, however, the fundamental cultural differences between a humanistic world in which the values of ambiguity and uncertainty claim authority and those of an engineering world in which efficiency is maximized will need to be accepted and understood as well. Codependence and contingency, the performative experience of knowing produced in a relationship between environment and subject, are the defining terms of interpretative interface.

Though the coming of electronic media helped bring these observations into focus, the dynamic operations of the codex could already be described before the coming of hypertext, as we have seen. Clearly those with rich experience of book culture perceive the dynamic properties usually attributed to new media already active and present within the older forms, and rightly so. The 'book' is no more self-identical, static, or fixed, than any other artifact that provokes a constitutive reading or response. Strict binarisms and technophilic exuberance lend themselves to exaggerated inaccuracies and hyperbolic rhetorical claims—charming in their own way, but perhaps not so useful for actual design. Many points of continuity exist between print and digitally networked artifacts and these don't have to depend on the seductive, special-effects, images of frictionless manipulation in holographic information spaces that will supposedly enable our lives in some fantasmatic future.

Books, after all, are structured environments that provoke a reading that is probabilistic, not mechanistic, and the text or work is produced as an event, not an entity. The printed book also serves as

a site of mediation, a means of acknowledging and forming communities of exchange, aggregating materials and dialogues across time and space, containing linked fields of reference, and able to be changed by the annotations and alterations of readers. The electronic spaces of interpretation will also serve as sites of mediation, and finding our way selectively among the many threads of this n-dimensional environment will depend on the emerging relation between diagrammatic imagination and consensual conventions in a scholarly community.

Endnotes

¹ See, for example, the front page for the Epicenter design firm, though a Google search on HCI, or interface design, or user-centered design will turn up a wide-range of very similarly worded sites.

http://www.epicenterconsulting.com/images/interface_design.jpg

² See my paper, 'From Entity to Event: from literal, mechanistic materiality to probabilistic materiality'; and also 'The Virtual Codex: From Page Space to eSpace.'

³ Here I am paraphrasing Matthew Fuller, *Behind The Blip* (2003: 103).

⁴ Kenneth Goldsmith does just that in *Day* by presenting the entire text of one day's *New York Times* in 12 point Times New Roman – as a single string of letters (though he did preserve paragraphs and word spaces).

⁵ See Jerome McGann, 'Texts in n-dimensions: Interpretation in a new key,' and also my work in *Interpret texts and presentations*.

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