University of Alberta

Visualization in Humanities Computing

by

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I. Introduction

How can I tell what I think till I see what I say?
—E.M. Forster

Janet Cardiff is an artist who works with sound. Her "40-Part Motet", for which she won the Millennium Prize from the National Gallery of Canada, is a reworking of Thomas Tallis's 1575 chorale work, "Spem in Alium." Tallis's piece, written for 40 voices, is presented in a room where each voice is played back through a separate speaker. As her web site explains:

> the viewer/listener often proactively moves through the space activating sounds and unfolding narratives. Forty Part Motet allows the audience to experience sound from the viewpoint of the choir by physically involving them in the piece. When listening to live music the traditional position is to be at the front, looking on. In Forty Part Motet each speaker unit becomes a mouth; the audience unravels the composition by intimately moving amongst the speakers and hearing harmonies change as if singers were standing next to them. It allows sound to be heard as a changing construct, to be interpreted quite differently, to be carefully considered in a sculptural way and experienced at its best.

Cardiff's work shows how technology can be used to create new spaces of interpretation: The individual can explore the space presented, choosing to listen to a particular voice or a set of voices while never losing the impression of the whole. It respects both the original work as well as the individual listener, never trying to force an interpretation but instead letting the work speak (literally) for itself. It is a deeply moving experience.

Most of our experience with technology, and with computers in particular, is not as deeply felt. Nor should we expect it to be. However, most of our experience with computers is not as engaging, nor does it allow us the freedom to explore that an installation like Cardiff's gives. Computers are often seen as tools that are aimed at getting specific jobs done, and all too often are approached as a necessary evil that must be dealt with in our modern world. So how can such a constraining machine be used for such an unconstrained activity such as literary interpretation?

The computer is a tool that has a place in literary studies. Its benefit to the researcher in terms of searching and indexing has been proven. However, with the advent of more powerful computing facilities, another aspect of this tool opens to the researcher: visualization. The computer offers a medium in which visual displays of information may be generated and quickly changed, where iterative probing of texts can take place, where hypotheses may be both generated and tested. In this thesis, I will be looking at a few of the ways that visualization is currently used in humanities computing, and the need to address these visualizations explicitly, as well as some of the possibilities that visualization may afford us. To do this, it is necessary to look at the ways in which the computer has been used in literary studies, and the issues that have arisen from this practice.

In Understanding Computers and Cognition, Terry Winograd and Fernando Flores characterize a word processor not by what it is—a program to manipulate textual tokens—but by what it does: "it is a medium for the creation and modification of linguistic structures that play a role in human communication" (5). To paraphrase Winograd and Flores, I will argue that what the computer can provide is a medium for the creation and modification of visual elements which enhance our understanding of literary texts. I do not mean systems to manipulate symbols on a screen, but participatory spaces that exploit the facilities of the computer to quickly change and modify visual displays. These visualizations are not aimed at making meaning, but instead at assisting in creating meaning. Nor are they aimed at representing mental processes.

My focus is on the use of the computer as a tool for research, but we cannot take for granted the characteristics of the tool itself, particularly in the case of such a complex tool. The computer both enables and disables us; it simultaneously affords opportunities while circumscribing actions, so we must make explicit both the possibilities and the restrictions of the machine. The potential we can dream of is balanced by the procrustean bed we're in when using the computer.

The computer affords us opportunities not available in any other media. Using computers as a visualization tool means that we can create new ways of approaching and facilitating research. Visualizations have the potential to push theory. They may be compared to the function of experiments in science: they invoke the paradigms of both demonstration and repeatability; they have the potential to expose situations or conditions that theory may not account for.

I will be using the term 'visualization' in a broad sense. Thus a visualization may be an icon, a graph, a map, a diagram, or some combination of all of these. I will not be referring to images that are intended to produce a likeness of a scene, that is, photographs, paintings and sketches; these lie outside of the scope of this thesis. My definition of visualization may seem to place it in opposition to text, but I do not wish to construct a binary between the two. Creative use of typography is a visualization. As we will see, the marks and glyphs that make up a typeface are visual signs of the sounds we make. And visuals often incorporate text. One instance is in the navigational features that are part of a book: the table of contents, running heads, and chapter titles are textual cues that make up part of the structure of a book.

Visualization is an inherent part of many existing computer implementations. Stylistic studies frequently use visualization in the form of graphs. Hyperlinks are inherently visual—they move us from one page to another, from one "place" to the next. Markup schemes use sophisticated transformations to present and render data on to the computer screen. Other more immediately apparent applications of visualization abound. One is the Visual Thesaurus, which will be examined below.

Visualization is not new, but the computer offers new possibilities for visualization. Computers can render displays dynamically, enabling the user to rearrange the visual presentation of material at the click of a mouse. This ability plays an important role in conveying information to the researcher; changing the view can literally change our perspective on the material. At the same time, visualizations can distract the reader from the task at hand. The visual presentation may overwhelm the material being presented. Again, I wish to avoid a dichotomy between form and content. Instead, I wish to emphasize that form and content, material and presentation, are intricately and inextricably intertwined.

I wish as well to explicitly acknowledge that I am not talking about visuals as a form of mental memesis—whether the mind works through association or causality or networks or something else altogether. Nor am I talking about artificial intelligence in the sense that the computer performs something which we might call interpretation. I wish to discuss visualizations that assist the mind to do its work—to group and classify, to make connections, networks, causal sequences, and associations.

In the first section below, I will present a brief theoretical background. In the following three sections, I will take a look into some of the history and issues of Humanities Computing. The term "humanities computing" refers to a general rubric under which many types of computer-aided study fall. In "Humanities Computing: Essential Problems, Experimental Practice," Willard McCarty describes three main branches of scholarly enquiry in Humanities computing: "the *algorithmic,* the *metatextual,* and the *representational*" (103). These branches are concerned with text analysis, hypertext, and markup, and all of these activities are used by scholars engaged in literary criticism. In the following discussion, I will address each of these areas, using specific cases that apply to literary criticism and to visualization. A detailed discussion of any one of these branches would require a volume, or perhaps several volumes; so what I intend is not an exhaustive treatment, but rather a look at a few cases that exemplify the practices, problems, and potential of each of these branches of humanities computing.

Each branch has its own practices, problems and issues facing the scholar who wishes to preform literary analysis. An examination of these will inform a study of visualization. In each of these branches—algorithmic, metatextual, and representational—assumptions must be made about the nature of the text in order to represent it. Some of these assumptions are common to all, and some result from the problems of representation unique to that area. One basic question is common to all of these areas of inquiry: what is a text? In Writing Machines, N. Katherine Hayles notes how copyright law debates in the eighteenth century determined literary texts to consist solely of "style and sentiment," and that the medium of representation was, quite literally, immaterial (31). This resulted in a conception of literary texts as existing in the imagination and the intellect, where the physical representation (print on paper) was merely a vehicle to convey the thoughts of the author. This conception has been increasingly challenged by literary critics in recent years, and new areas of criticism address the materiality of the text, taking their cues from bibliography and book history. Hayles asserts that:

> As the vibrant new field of electronic textuality flexes its muscle, it is becoming overwhelmingly clear that we can no longer afford to ignore the material basis of literary production. Materiality of the artifact can no longer be positioned as a

> subspecialty within literary studies; it must be central, for without it we have little hope of forging a robust and nuanced account of how literature is changing under the impact of information technologies (19).

This materiality of the text is at the basis of humanities computing. It is made explicit each time a researcher wishes to represent a text electronically. In order to represent, or to manipulate, we need to first have ideas and models of what it is we're working with. This thesis examines the models used by humanities computing researchers, the limitations of those models, and what we learn from the practice of humanities computing.

We will see as well that the practice of humanities computing is not a merely a service to the humanities, but a discipline in its own right. It is where theory meets practice, where the researcher must contend with the compromises and surprises that arise from the combination of theory and practice. Both the results and the problems we will encounter will shed light on humanities computing and the study of literature, and where they intersect. We will see how quantitative studies inform us about the nature of the methods used in humanities computing; we will see how hypertext is not the realization of postmodern dreams of the writerly text; and we will see how markup schemes interrogate our notions of the text. We will see how the failures and the problems of applying computing to literary study tell us as much as the successes.

In How We Became Posthuman, Hayles makes use of a term from archaeological anthropology to describe the evolution of concepts and artifacts. She defines this term, the *skeuomorph,* as "a design feature that is no longer functional in itself but that refers back to a feature that was functional at an earlier time" (17), and uses the vinyl stitching on the dashboard of her car as an example. Another common example is the use of the desktop metaphor for the computer screen. In this thesis we will see several examples of the skeuomorph, in practices and elements which function at times as both physical and psychological transitions between technologies. This process of using new technology to duplicate existing practices is to be expected, for we are still in the incunabular stages of humanities computing.

We will also see a move towards both visual and dynamic structures. By visual, I am referring to graphical representations on computers, where increasing attention is paid to the graphical presentation. This is most commonly exemplifed in GUI vs. command-driven interfaces. By dynamic, I am referring to the sense that different views of the same material can be presented within a very short time (seconds or less).

I will also comment on the use of theory in humanities computing. We will see that at times, theories such as poststructuralist and postmodernist approaches to reading are co-opted by new theories. Other times, we will find that theory has not yet been developed that is adequate to the processes being theorized.

This thesis is not a narrative of progress; the sections do not indicate linear developments that follow one another in a progression of increasing complexity. McCarty's three branches describe different approaches that computing humanists have taken: each informs, and is informed by, the others. At the end of each chapter I will give some examples of how each of these branches uses visualization.

Winograd and Flores, writing almost twenty years ago, offered an invitation that is still valid today: "The challenge . . . is not simply to create tools that accurately reflect existing domains, but to provide for the creation of new domains" (12). Visualization is an area that holds great possibilities for meeting this challenge.

I. Thinking

You can observe a lot just by watching.
—Yogi Berra

In this chapter, I argue that visualizations can present information to us in ways that language cannot. I will start by noting that in traditional western thinking of the last few centuries, language has been the primary mode of the communication of thought and of information. In contrast to the sequential, linear logic of language, I note how diagrams can present a great deal of information simultaneously. I also argue that we do not "read" an *a priori* structured world but rather we participate in the creating of meaning; that knowledge comes from participation and experience, and this is what the computer can offer to the researcher: the ability to engage in a participatory exploration of meaning-making and interpretation using visual elements.

The effect that a text has upon us far exceeds the sum of the individual words that make up the text. What a text 'says' is often an emergent property of the whole; the sum is much greater than its parts. When we try to explain a text, we often find its meaning is not easily conveyed. Explication has a tendency to become obfuscation. In the preface to Andrew Harrison's book, Philosophy and the Arts, Ray Monk notes: "that there are important truths to be learned from a novel, a painting, a poem, or a piece of music, that there are things that can *only* be learned, communicated, through works of art is a thought that is easy to accept but almost impossibly difficult to articulate clearly" (xi, emphasis his). The effect, the meaning, the explanation of a text often exceeds our ability to express it in language, and we are faced with a conundrum: to explain language by using language. Visualizations offer possibilities for explication that complement traditional written explications. The eye takes in visual information at an astonishing rate.

Patterns, anomalies, and other visual features are recognized very quickly, since a visual model is presented as a whole, in contrast to the linearity of language or the temporality of speech. The entire object is apprehended at once, and relationships between the various components are immediately apparent. John Bradley and Geoffrey Rockwell outline some of the advantages of building visual models in their article "What Scientific Visualization Teaches us about Text Analysis." They note that by visualizing data, "the researcher is able to gain better insight into what structures and forces may lay behind it" and that "patterns and abnormalities might be strikingly visible." Comprehending something visually, even if it is a representation, gives an impression that the object is real. Visual presentation frees the researcher from the task of mentally modeling the object she is thinking about, thereby allowing her to delve deeper into the details.

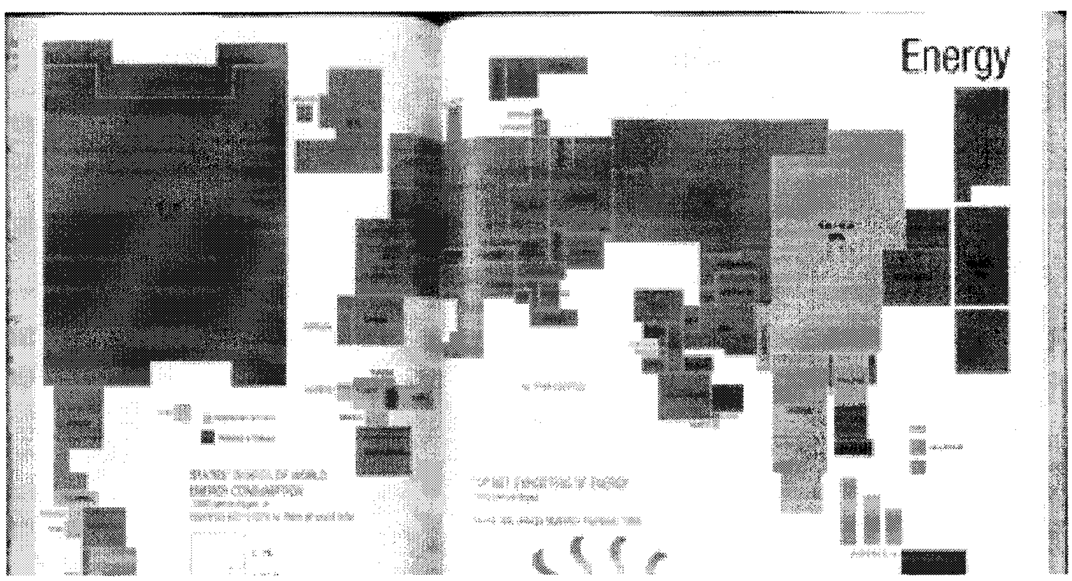
Visual presentations can indeed be strikingly real, but this reality-effect has inherent dangers. Aside from the issues raised by limits placed on what is to be represented (which will be discussed below), there is the more obvious issue of confusing and conflating the representation itself with the object or concept it is representing. It is easy to get lost in the representation, or to start thinking that the representation is the reality. As well, we must always remember that any representation is but one of many ways of 'looking' at a text. Representations are simply particular viewpoints of some aspect of the world. That there are many views of the world is noted by Nelson Goodman in Languages of Art: "the world is as many ways as it can be truly described, seen, pictured, etc., and there is no such thing as *the* way the world is" (6, n. 4; throughout this thesis, quoted emphasis is from the original unless otherwise noted).

To make an image, we must first recognize an object. In doing so, we become the interpellators that constitute the subject. In turn, the objects that we choose, categorize, group, and mould into images—physical or mental—become part of our ideologies (in Althusser's terms), or in other words, our world views. What is contained in our frame of recognition is a grouping of things to which we have ascribed properties. We are recognizing the existence of these objects. In turn, what we recognize—physically and mentally—is created by, and in turn creates, our world-view. What is included determines what is excluded. The groups we make and the contexts we create reflect our world and that reflection influences our thinking.

A famous example of the way such groupings create a world view appears in Michel Foucault's The Order of Things. Foucault opens his book with a passage from Borges:

> This passage quotes " a certain chinese encyclopedia" in which it is written that "animals are divided into: (a) belonging to the Emperor, (b) embalmed, (c) tame, (d) sucking pigs, (e) sirens, (f) fabulous, (g) stray dogs, (h) included in the present classification, (i) frenzied, (j) innumerable, (k) drawn with a very fine camel hair brush, (l) et cetera, (m) having just broken the water pitcher, (n) that from a long way off looks like flies." In the wonderment of this taxonomy, the thing we apprehend in one great leap, the thing that, by means of the fable, is demonstrated as the exotic charm of another system of thought, is the limitation of our own, the stark impossibility of thinking that. (xv)

Just as this list demonstrates another way of approaching classification, so does visualization offer another way of approaching literary analysis and interpretation. Interpretations of text, done in text, can offer both evidence and expression, analysis and affection, but they must still comport themselves in text. Visualizations offer another means of representation and interpretation.



Figures 1-1 and 1-2. Visualizations allow for fast interpretations, e.g., population and energy use.

Interpretation is an activity that occurs in an already present background. We are continually interpreting. Foucault notes that we must continually limit and filter what we see in order to render it into language (135). To enter into a formal interpretive space, such as when we endeavour to analyze a literary text, we make explicit certain conditions of interpretation. However, many other conditions, such as the linguistic and cultural milieu that influence our interpretation, are present but not explicit. We can view the interpreter/researcher/scholar as literary ethnographer, an observer who affects the culture, is thrown into it, and must become aware of their own prejudices and biases. This is always a difficult task, and is possible only to a certain extent. We are always studying things from the inside, and as we study them, we affect them.

In Understanding Computers and Cognition, Winograd and Flores use Heideigger's phenomenology, Maturana's autopoietic theory, and Austin and Searle's speech-act theory to argue that

> knowledge and understanding (in both the cognitive and linguistic senses) do not result from formal operations on mental representations of an objectively existing world. Rather, they arise from the individual's committed participation in mutually oriented patterns of behavior that are embedded in a socially shared background of concerns, actions, and beliefs. (78)

In other words, we cannot understand the world by making abstract mental models of it, models that place abstract concepts and entities into formal systems which are amenable to computer implementations. Winograd and Flores emphasize that it is participation that leads to understanding.

Language is an interaction with the world. It is a process, not a set of labels and grammatical connectors that describe the world. It strongly influences our view of the world. The Sapir-Whorf hypothesis proposes that the language(s) that we speak determine our view of the world. This has the unfortunate consequence that what we think is limited by the languages we know, and language becomes the circumscription through which we are able to think about the universe around us. However, language itself is not restricted to verbal utterances; we can extend the definition of language to encompass all of our sensory and mental processes, including the visual. Few modern linguists would subscribe wholeheartedly to the linguistic determinism of the Sapir-Whorf hypothesis, but most would agree that language *influences* our thought.

Winograd and Flores declare that "language cannot be understood as the transmission of information. They assert that

> language is a form of human social interaction, directed towards the creation of what Humberto Maturana calls 'mutual orientation.' This orientation is not grounded in a correspondence between language and the world, but exists as a consensual domain—as interlinked patterns of activity. (76)

In their view, language is not a conduit that conveys messages, it is an activity. It does not describe an objective reality that is 'out there' waiting for description. It has much to do with thought, but does not determine thought. We are thrown into it, in the Heideggerian sense of thrownness: we are as the person who is hammering a nail: the hammer becomes a part of us, we are not conscious of it unless something breaks down in the act of hammering. Similarly, for the literary scholar, language is the medium in which interpretation takes place. Language is part of the shared background that makes interpretation itself possible.

Our use of metaphor and of tropes in speech call attention to the complexities of our interactions with the world. Through metaphor, we cast our understanding of one thing in terms of another. In Semiotics: The Basics, Daniel Chandler points out how linguistic tropes can be seen as "a process of rendering the unfamiliar more familiar" (124), thus helping us to understand novel concepts. The metaphors and tropes that we use so fluently become part of the baseline for understanding in our culture; we lose sight of them as being metaphors and tropes because they are so common. As Chandler points out, "figures of speech retreat to 'transparency'" (124). However, we can see them for what they are when we move outside of language and attempt representation in another medium. Remediation can expose these figures of speech for what they are: remediation prompts re-cognition. Visualization can also be used to render familiar concepts unfamiliar, that is, to expose some of the cultural conventions implicit in our language and our conceptions of the world around us. Such defamiliarization is a common theme of twentieth-century art. A famous example is Magritte's "The Treason of Images."

Figure 1-3. "The Treason of Images" (1928-9). Rene Magritte.

Casting one thing in the terms of another gives us new insights into the nature of both. Interpretation frequently uses metaphoric language to give new understanding. In this respect, metaphoric language becomes a container in which ideas are kept and subsequently communicated. However, the communication is never a crystal clear one, since any person's understanding and experience is unique. Literature, so full of metaphoric language, is one of the ways in which cultural knowledge is communicated.

New perspectives on texts need not come from language alone. Harrison points out that "what cannot in principle be said, might well be drawn or painted, and that what this is is not a simple visual experience, but a 'pictorial thought' which the social, even the political, pressures of our 'logo-centric' culture tends to suppress and to marginalize" (6). To create a visualization of a text is in a way transgressive, since it displaces language as the primary medium through which interpretation is done, and instead institutes a focus on the visual and on the act of modeling. This shifting of discourse is bound to encounter resistance: one can anticipate questions such as "what does it *mean*?" Such a question is not a request for explanation: the interrogator is not asking for a clarification but instead an elucidation *in language* of what the model is about. What I propose is that the question be deferred. We can look at the process of constructing visualizations as analogous to learning new metaphors. Learning a metaphor is often a process of restating it in more familiar terms until we have reached a competence with the subject.

Visualizations have great potential to create new metaphors. This potential arises from the multiple methods of signifying that we can use. Jacques Bretin, in Semiology of Graphics, distinguishes between systems that are monosemic and those that are polysemic. In monosemic systems, such as mathematical formulae, the meaning of the sign is known prior to observation, while in a polysemic system, such as language, the meaning arises from the collection of signs. Visual models of texts can combine both – a graphic, monosemic representation along with the polysemy of language. Meaning arises from the predefined signs as well as the linguistic elements of the model, and both the mono- and polysemic components combine to produce further meanings.

Chandler points out that "rhetorical forms are deeply and unavoidably involved in the shaping of our realities" (123). Unfortunately, not as much attention has been paid to the visual forms that also shape our realities. In "Diagramming as a Way of Thinking Ecologically," Jorge Frascara argues that "picture making has been relegated to self expression and recreation, while verbal language has provided the paradigm for thinking" (165-6). He criticizes verbal language on the basis that "it promotes linear thinking and sequentiality, and is very poor for the presentation of hierarchies, inclusions, simultaneity, distinction of levels, multiplicity of kinds and complexity of connections" (166). This, he contends, "fosters a decontextualization of knowledge" (169). He argues that "because diagrams can synthesize different factors or dimensions of a situation, they lend themselves to exploration of complex interrelationships that would otherwise escape attention" (169). In the gestalt presentation of a diagram, we can see the multiplicities and simultaneities that Frascara is talking about. A diagrammatic presentation makes an immediate impression of a situation that simply is not possible in language alone.

The dichotomy between seeing and thinking is also addressed by Rudolf Arnheim. In "A Plea for Visual Thinking," he states:

> Perception and thinking are treated by textbooks of psychology in separate chapters. The senses are said to gather information about the outer world; thinking is said to process that information. Thinking emerges from this approach as the 'higher,' more respectable function . . . the exercise of the senses is a mere recreation. (171)

Arnheim expounds on this idea in his book Visual Thinking. He declares "perceiving and thinking are indivisibly intertwined" (v) and argues for a "reunion of sense and reason" (vi). In the word "sense" we have both perception and understanding: we sense our environment and make sense of what we perceive. It is all too common, however, that sense is divided into two poles, where perception is viewed as passive and thinking as active. Arnheim notes how visualization helps the scientist work through problems: "What happens first is that suddenly the imagined object looks 'beautiful' — an expression that mathematicians and physicists like to use when they have attained a view that offers a surveyable, well-ordered image of a problem's solution" (173). While literary criticism is not seeking a 'solution' to the text, it is easy to imagine situations where analogous insights take place, where the various elements that a researcher is investigating fall into a structure that she can grasp and survey.

James J. Gibson also takes a participatory approach to the sense of vision in The Ecological Approach to Visual Perception, where he argues for new theories of visual perception based on "the pickup of information" (238). Gibson uses the term "information" in a very specific way:

> The term *information* cannot have its familiar dictionary meaning of *knowledge communicated to a receiver.* This is unfortunate, and I would use another term if I could. The only recourse is to ask the reader to remember that picking up information is not to be thought of as a case of communicating. The world does not speak to the observer. (242)

Gibson's view of perception is that of an active system: "a keeping-in-touch with the world, an experiencing of things rather than a having of experiences" (239). His theory of information pickup holds that knowledge arises through the perception of persisting structures. Gibson's theories fit in well with phenomenological theories, poststructuralist theories of literature, the autopoietic theories of Maturana and Varela and even the physics of uncertainty. In all cases, the observer and the system cannot be separated: perceptions are not passively received within a prestructured physical or mental environment. Everything affects everything else in this intricate ecology.

Being, exploring, and understanding are all part of the engagement of ourselves with things in the world, and form an autopoietic construction of the world: the ways that we experience the world determine the world that we see. Yet, our view of the world is not simply determined but rather, is a process of engagement, of interpretation filtered through experience and knowledge and being-in-the-world, of analysis fed by and feeding into this engagement/experience. When we communicate we need to take into account the autopoietic nature of perception as we represent our ideas.

The act of representation is not predefined: it is constructed. We choose the elements we wish to represent, and the methods and media in which to present them. In The Order of Things, Foucault describes how in the seventeenth century, the arrangement of collections, such as assortments of plants, animals, and fossils, changed from a linear procession to a layout of things arranged in a table. This in turn allowed the creation of catalogues, and later, of graphical representations. Tabular representation made for new ways of ordering and classifying, and the underlying theory of classification changed as a result. Things were no longer ordered on the basis of similitude; instead, difference became the primary act of analysis. Foucault notes that

> the activity of the mind . . . no longer consist[ed] in *drawing things together*, in setting out on a quest for everything that might reveal some sort of kinship, attraction, or secretly shared nature within them, but, on the contrary, in *discriminating*, that is, in establishing their identities, then the inevitability of the connections with all the successive degrees of a series. (55)

Visualization also involves distinguishing – articulating the differences between objects or 'parts' of the model. However, there need not exist hard and firm categories prior to the process. One of the functions of visualizations is to interrogate categorizations, to discover where they work, where they do not operate, and why. Visualizations can facilitate this process, since the presentation allows us simultaneous apprehension and comparison of the categories we have chosen.

Visualization can also mean the creation of a space in which breakdowns occur. A breakdown, in Heideggerian terms, serves to create states which unconceal things of concern. As Winograd and Flores explain, "breakdowns serve an extremely important cognitive function, revealing to us the nature of our practices and equipment, making them 'present-to-hand' to us, perhaps for the first time" (77-78). Remediation, particularly the making of a visual image, can perform this function of making present, of re-presenting material in novel ways. Taking remediation one step further, we can use reflexivity as a method of exploring breakdown. The remediation of an idea or a communication can be reflected back to the original medium in which that idea was given form. Reflexivity can ask the question: in what ways is a thing not like itself? To be more specific, in what ways is language not like language? How does visual language differ from written language? How do our approaches to these two forms of communication differ? Such questions prompt us to ask: what does language do? How do we understand language? It makes visible our approaches to language, whether as a semiotic system of signals or a shared participation in the world. The function of visualization then, is to reveal, both literally and figuratively, our space of interpretation and where the possible spaces for breakdown lie. Visualization has the potential to reveal patterns, to make explicit our position as observer. It has the potential to reveal the gaps in our concepts, the interstices of our mental models. Jerome McGann opens Radiant Textuality with an epigraph from Leonard Cohen: "There is a crack in every thing, / That's how the light gets in." Visualizations can help to expose these cracks.

But isn't visualization just a deferral? Is it not just simply moving the interpretation into another site that is ultimately replete with its own problems? Can a computer be used as a tool for interpretation? Winograd and Flores remark that "the essence of computation lies in the correspondence between the manipulation of formal tokens and the attribution of a meaning to those tokens as representing elements in worlds of some kind" (74). So how does visualization differ from computation? Isn't it just another invitation to manipulate representations? The idea behind visualization is to create a space in which the scholar/interpreter is neither the subject nor the object, not a shifter of tokens, but an explicit participant in the creation of the interpretation. The visualization tool creates a participatory, ludic space amenable to exploratory interpretation.

The semiotic square provides a good example of both the power of visual representation and of participation in the model. Developed by A. J. Greimas, the semiotic square is a visual device that maps the conditions of logical relationships. Two opposite terms form the top of the square, and below them are two more terms that define how the relationships amongst all the terms work. If we number the edges of the square, and start at the top left, going clockwise we have: 1) the initial concept; 2) its opposite; 3) a term which is the contradiction or absence of the first and helps define the relationship that generates the opposition between the first two terms; and 4) a contrary term to the third which makes explicit the framework of understanding. In Culture and Cognition, Schleifer, Davis, and Mergler describe how the square "attempts to map with logical rigor the elements that constitute the cognitive understandings of meaning" (3). In the semiotic square below, I can represent some of the aspects of this thesis.

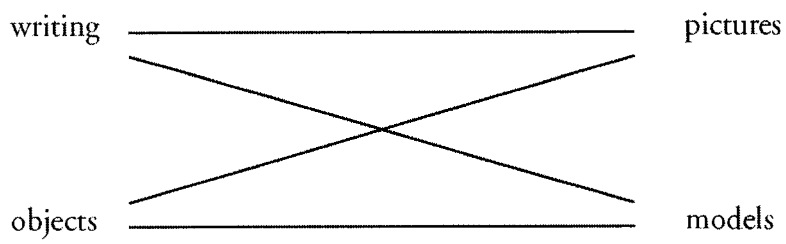


Figure 1-4. The semiotic square.

The square presents several dialectics simultaneously. On the top horizontal axis, writing is set in opposition to pictures. The opposition between writing and pictures is constructed along an axis of explanation. The third term, models, may be seen as the absence of writing, and also as defining the relationship between the first two. (We can see at once that a visual such as this quickly generates interpretation and argument.) The fourth term, objects (as in the material subjects of text and images), may be seen as the opposite of models, and as the contradiction of the second term. We can also quickly see from the square that models are related to pictures. As well, writing can be understood as the inscription of the objects of the world. Objects and models are both instantiations whereas writing and pictures are explanations or interpretations. Writing, pictures, and models are all defined by objects; that is, they are expressive of objects.

We still have not exhausted the square; there is room for more meaning to be made out of this simple diagram of four words and four lines. The diagram lets us see how any one category is constitutive of the other. We can see that meaning emerges from the relationships between the words and the placement of the words in the diagram. We apprehend the diagram as a whole and tease out the signifiers, the connotations and denotations, the tensions between terms, all of which increase our understanding of the subject. As proof of the power of visual models, one can easily see that, once the basics of it are understood, the semiotic square is a concise and generative representation that allows interrogation of the relationships between the terms and our understanding of such relationships.

In this section, I have asserted that the way we think about the world has a lot to do with the way we see the world. The world is not simply "out there," available for interpretation. Our ideas of the world come from interaction with it, and a good deal of that interaction takes place in language, both spoken and visual. However, our tradition of thought has privileged spoken and written language as the primary processes in which thought is communicated, neglecting the visual. By explicitly addressing visuals as a medium for thought and communication, we can gain new insights into how we interact with the world.

2. Counting

Computers are useless. They can only give you answers.
—Pablo Picasso

In this section, I look at early humanities computing methods. I argue that the computing resources available in the early history of humanities computing led to a focus on quantitative studies. This focus on quantitative methods attempted to move the discipline of literary criticism into a 'scientific' mode (a motion already underway in certain critical schools), but was unsuccessful in influencing the mainstream of literary criticism. However, these studies have produced useful results and have established a research community of their own.

One of the first visualizations literature students encounter is that of Freytag's pyramid. Gustav Freytag introduced the diagram in his Technique of the Drama, published in 1863. The pyramid describes the typical plot of a five-act tragedy, though it has been applied to prose as well as drama.

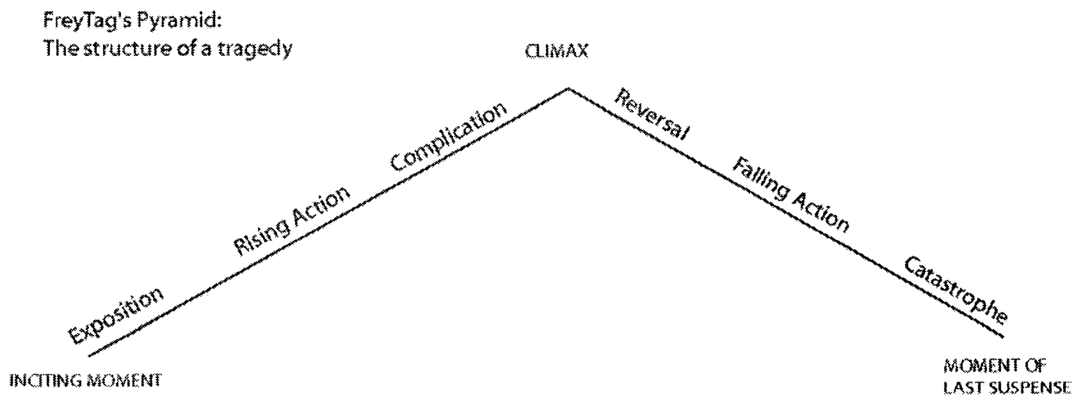
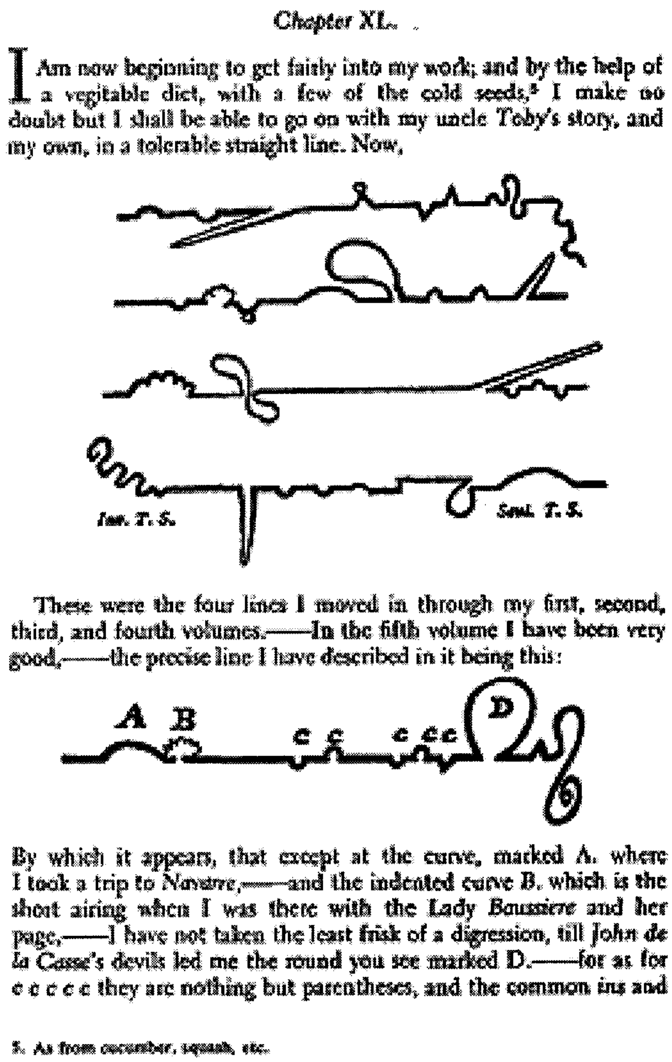


Figure 2-1. Freytag's Pyramid

A much earlier plot diagram is seen in Laurence Sterne's Tristram Shandy. First published in installments between 1759 and 1766, it offers one of the first examples of visualization of literary texts. Two-thirds through the book, Sterne diagrams the plot, along with an explanation of his diagramming aids:



Chapter XL.

I Am now beginning to get fairly into my work; and by the help of a vegitable diet, with a few of the cold seeds,[5] I make no doubt but I shall be able to go on with my uncle *Toby's* story, and my own, in a tolerable straight line. Now,

These were the four lines I moved in through my first, second, third, and fourth volumes.——In the fifth volume I have been very good,——the precise line I have described in it being this:

By which it appears, that except at the curve, marked A. where I took a trip to *Navarre*,——and the indented curve B. which is the short airing when I was there with the Lady *Baussiere* and her page,——I have not taken the least frisk of a digression, till *John de la Casse's* devils led me the round you see marked D.——for as for c c c c c they are nothing but parentheses, and the common ins and

5. As from cucumber, squash, etc.

Figure 2-2. Tristram Shandy plot line.

While waggery may be at the root of Sterne's diagramming (as it so often is throughout his storytelling), nevertheless, the diagram has much to tell us. First, we are expected to read it as we read text: left to right (which may lead us to wonder if the diagram is reversed in Arabic translations). Second, we associate plot with a continuous line. Third, the line is supposedly leading us somewhere; deviations from an imaginary straight line drawn between the start and end points of this line are interpreted as deviations from the plot; they are digressions or subplots, that, though related to the plot, do not advance it. The diagrams provide some visual information as well: we interpret smooth curves as smooth transitions in the plot, and spiky graphics as near-discontinuous digressions. The text also conveys the valuable information that a "vegitable diet" and a "few of the cold seeds" can help in plotting.

Graphs appear in the early efforts of humanities computing, which is not surprising since humanities computing begins with numbers. As we proceed through a history of humanities computing, we see that visualizations become increasingly important. One of the factors in using visualizations has been the ability of computers to produce graphs from the information gathered by computing humanists. The increasing availability of software and hardware for graphing results in more sophisticated graphs.

Historians of Humanities Computing often begin with Father Roberto Busa's concordance, the *Index Thomisticus*. According to Duane Harbin, Busa began his work in 1949, initially using punch cards and electromechanical sorting machines, "pioneer[ing] many of the techniques required to encode a complex textual corpus to produce a comprehensive, analytical, contextual concordance". At the time, no computer programs existed for text analysis (indeed, few computer programs existed at all!). It was not until the early 1970s that Busa's work was finally published. One of the main thrusts of the work was to eliminate the huge manual effort involved in producing a concordance. The computer was seen as a machine that could take over some of the manual tasks that a concordance required, doing these tasks more efficiently and accurately, and thus freeing the researcher to focus on the results of the analysis rather than on the work of assembling the concordance itself. The use of a concordance assumes that examination of words in their context can provide the researcher with insights into the text. This assumption carries through much of the algorithmic branch of humanities computing.

Rosanne Potter's 1989 book Literary Computing and Literary Criticism is a collection of essays on text analysis. The book is divided into three parts: theory and hypothesis testing; theme and semantic analysis; and rhetoric and syntactic analysis, all areas that lend themselves to computer-aided studies. All involve computational stylistics in one way or another; most of them use numerical methods. Counting is a process that is highly amenable to computation, and so it would seem that such studies are therefore suited to a computational approach. But mere numbers don't tell the story: they must be interpreted. Even more important is the approach taken by such studies, the assumption that there are elements that can be isolated and counted, and by doing so hypotheses can be formed and tested. At the core of such studies lies a reliance on empirical data. However, numbers are not simply verification of hypotheses. The researchers mention new, unexpected results appearing, and Potter notes that they "routinely draw inferences from the data that would not have been predictable without the minute attention to detail made possible by the technology" (xvii). A benefit of such projects is the requirement for specificity and disambiguation that computers require.

In the 1960s and 1970s, computing was done on large mainframe machines. Computing tasks were done in batch, that is, the task was submitted to the computer, typically on an input medium such as 80-column punch cards or magnetic tape, and the computer then processed the job and output the results, typically on a printer. Not until the latter half of the 1970s did terminals connected to the mainframe become common. Computer operating systems were command driven; one had to acquire a great deal of technical knowledge in order to set up the computing environment which would process the job. Typically, programs had to be custom-written to process the data, so often the data that were processed depended on the availability of software. Much of the software available at this time focussed on processing statistical data.

One such statistical study is J.F. Burrows's analysis of Jane Austen's novels, which he describes in his book Computation Into Criticism. What he finds is unexpected: "*From no other evidence* than a statistical analysis of the relative frequencies of the very common words, it is possible to differentiate sharply and appropriately among the ideolects of Jane Austen's characters and even to trace the ways in which an ideolect can develop in the course of a novel" (4). (Quoted emphasis is the author's throughout this thesis unless otherwise noted.) His findings are startling: one would not expect that counts of words such as *the, of, I* and *not* would provide distinguishing markers of characters' dialogue. Burrows notes that we would expect the words that have more semantic content to be more influential in determining character. Findings such as this allow him to articulate (and disprove) "the assumption, not always made so explicit, that, within the verbal universe of any novel, the very common words constitute a largely inert medium while all the real activity emanates from more visible and energetic bodies" (2). Burrows shows how the analysis of a single word—'we'—can give important insights into the status of characters in the novel, and how the usage of one word can establish class and gender markers. Burrows' analysis does not take place in the mathematical realm alone; he uses his statistics in conjunction with literary theory. One instance of this occurs when he applies Roman Jakobson's theory that language functions along two axes (the syntagmatic and paradigmatic) to analyze how meaning arises from the choice of particular words at a particular moment (p. 29ff). Efforts such as Burrows's show how theoretical and statistical results support and complement one another.

Studies such as Burrows's have paved the way for others, developing techniques and showing preliminary results that prompt subsequent research. However, over the last fifteen years, persistent voices have noted how these studies have not appeared in the mainstream literary journals, and so in that respect we may be tempted to conclude that Humanities Computing has failed to influence literary criticism. In "Literary Criticism and Literary Computing: The Difficulties of a Synthesis," Roseanne Potter candidly observes that "most [literary] critics are about as likely to quote a computer study as a biochemical one" (91). Potter sees two factors that stand in the way of literary critics who may be interested in computer studies: "(1) the utter lack of training in, or appreciation of, scientific methods among mainstream literary critics, and (2) the almost universal tendency of computer analysts to get lost in the jargons of programming and statistics" (91). Five years after Potter's remarks, Mark Olsen's article "Signs, Symbols, Discourses" ascribes blame not to computers nor to technical inadequacies, but "on theoretical and methodological issues" (4) and suggests: "a shift in the theoretical orientations of computer-assisted textual analysis may lead to a more prominent role in the mainstream of literature" (2). He recommends that the computer be used only for specific processes; indeed, he refers to the computer as "an ideal semiotic machine" (9). He goes on to suggest that the current models, based on stylistics and reader-response theory, would best be replaced by models based on semiotics and intertextuality.

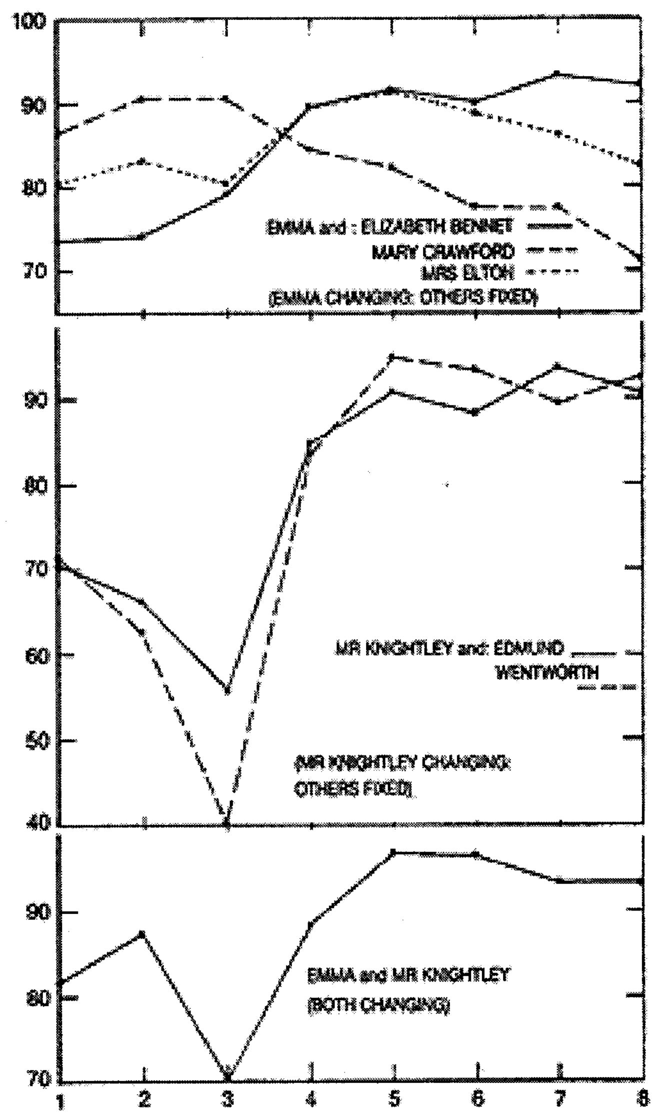
Still, little seems to have changed. Potter's and Olsen's lament is echoed up to the present day in the humanities computing literature: in 2003 Stephen Ramsay's essay "Towards an Algorithmic Criticism" notes that "our [computing humanists'] failure to transform technical achievement into interesting literary critical discourse is among the most baffling features of our discipline" (173). Ramsay strongly criticizes some studies, saying that they do not carry their results into the area of literary criticism. He states:

> Burrows and Craig (1994) use Principle Component Analysis (PCA) to show us patterns in the word frequencies of Romantic and Renaissance drama that are simply astonishing, but rather than using those patterns to do literary criticism, they simply note that their results do not contradict the impressions of earlier critics—as if there had been no net gain to their work at all. Paul Fortier deftly locates an amazing series of statistical convergences running through several modern French novels, but ends by noting that "The results correspond to known and documented literary phenomena"—as if critical insights were like species of butterflies in need of Latin names (Fortier, 1989). Eric Johnson writes a program that computes the minimum number of actors necessary to mount a production of a play, but ends the paper in which he describes this marvellous tool by saying that "the program can probably be used to document a character's role in ways its creator never imagined" (Johnson, 1995). (173)

Ramsay's remarks are illuminating, for they position quantitative studies outside the realm of literary criticism. Ramsay sees these studies as creating "patterns" that one can then use "to do literary criticism": humanities computing is thus envisioned as a feeder program that creates results in order for others to do their jobs.

Quantitative studies rely on being able to isolate some element of the text in order to count that textual element, to classify it, separate it from other elements. In this respect, the text is viewed as a data source. The data that are isolated are processed by a variety of numerical methods, producing results that are themselves data. This is, of course, the information processing model: input-process-output. Yet a text is not simply data. As we have seen, Burrows does interpret his results, and he is by no means unique in doing so. Researchers using quantitative methods respect the text: they know that their methods and results must be analyzed. We cannot expect a researcher using quantitative methods to perform an exhaustive analysis, even with the help of computers. As in traditional literary criticism, the results, insights, and methods used must be continually questioned. If ideolects can be distinguished based on a few simple words, what does this mean? What does it say about Austen's writing, about language itself, about how we make meaning?

Quantitative studies of literature use visualizations that are similar to those used in the sciences. Both are focused on representing numeric data. Burrows presents his results in tables and graphs. The tables and graphs present, at times, a great deal of information. They also confuse, and are at times misleading. For example, his graphs of "'Development' in the Ideolects of Emma and Mr Knightley" (Graph 1, p.5) all cut off the lower portions of the scale, magnifying the differences between ideolects that he is illustrating.

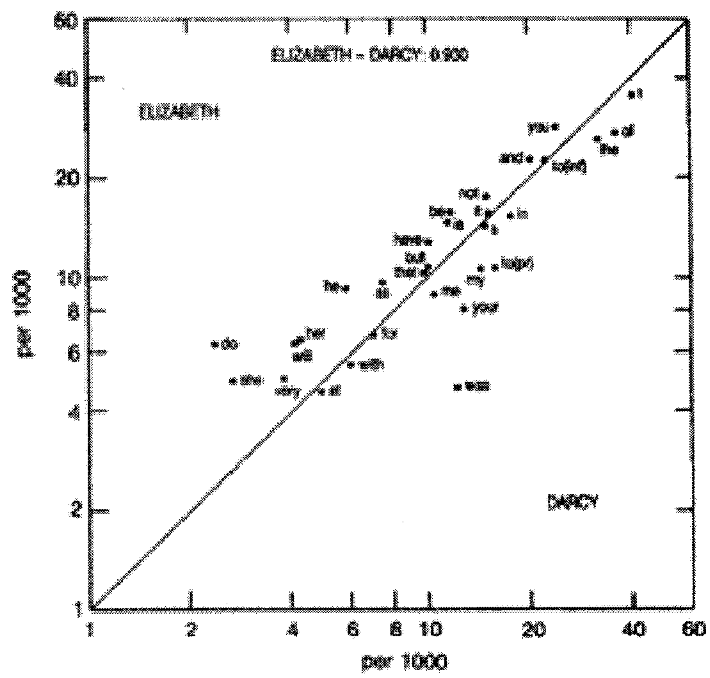


GRAPH 1. 'Development' in the Idiolects of Emma and Mr Knightley

Though slightly misleading, this technique does serve to point out the differences in ideolects. It is not apparent, however, just what is being graphed: both x- and y-axes are unlabelled. The explanation in the text does not account for the y-axis, but alludes to 'stages' in the novel, though we are not told what these stages are.

This graph appears in the introduction, and so can be imagined as a 'teaser' that makes the reader want to continue, to find out just what is being graphed and what these results mean. To the scholar/researcher, however, this graph conveys little information. This may be a rhetorical strategy on Burrows's part, for as the book continues, the graphs become increasingly informative. His graph of "Elizabeth and Darcy: Correlation of Word-types 1-30" (Graph 11, p. 83) is a good example: the axes are clearly labelled, we see immediately that logarithmic scales are used, and most importantly, the points on the graph are each labelled with the word they correspond to.

Internal Character Relationships 83



GRAPH 11. Elizabeth and Darcy: Correlation of Word-types 1-30

In this case, the researcher does not have to consult a table to discover what a point on the graph means. This labelling not only saves time, but it presents information to the researcher in a manner that aids him in doing his task. This graph is supported by a table in the body of the text on the facing page, and it is also compared to a graph on the following page. This layout unfortunately makes the reader flip back and forth between the two graphs. Simply placing them on facing pages would act as a better means of presentation. Another way this could be achieved is by using overlays. In her book Geometry of Design, Kimberley Elam uses transparent overlays to show how geometric structures are used in the composition of graphic presentations and the design of objects. The overlays give the reader a means of seeing the objects with and without the geometric proportions. This physical means of presentation can be accomplished easily on the computer, and it is curious that it is not used more often.

Burrows's results are compelling, but at times they are less accessible than they could be. Presenting such results on a computer would give the researcher facilities to explore his results and investigate them in depth. Of course, the computing facilities available at the time of Burrows's writing (the 1980s) precluded this sort of presentation, but graphical facilities to accomplish this are now available. We can look at what the computer can offer for the presentation of his data. Presenting a graph such Burrows's Graph 11 is easily accomplished with the computers and software now available. But the computer can offer the possibility to extend this graph. We can overlay it with other graphs so we can make direct comparisons; we can make each of the data points hyperlinks to tables of detailed data, so the researcher can 'drill down' into greater detail, or return to the larger view. These are just two of the possibilities that come to mind.

As mentioned above, Roseanne Potter notes that the results must be made "accessible and compelling" (93). Another category that could be added to these criteria is appealing. Results that are obfuscated or presented poorly do not attract readers. At the IEEE InfoVis 2003 conference in Seattle, Bradford Paley, the designer of TextArc, observed that "people may be throwing away good ideas just because of bad graphic arts issues." Researchers work hard for results, but when these results are poorly presented, they go unnoticed. On the other hand, presentations that have been well thought out and designed can offer the researcher a chance to be compelling and accessible. Presentation is an integral part of communicating those ideas to others. Furthermore, good presentation design can organize the data, which can lead to insights and help the researcher make connections that may have been missed. In *Visual Explanations*, Edward R. Tufte notes that "clarity and excellence in thinking is very much clarity and excellence in the display of data" (9).

Graphs can show many different concepts simultaneously, such as the correlation between multiple variables. Clusters and regions can be located, differences can be revealed; regions and classes can be seen. Graphical axes do not have to be strictly numerical, but can use qualitative concepts such as love/hate or light/dark. The graphs developed by one person can be compared with those of others. Patterns and periodic events can be detected, and changes over time may be seen.

On first glance, it may seem that quantitative information readily lends itself to visualization. However, we often forget that we are taught many of these visualizations. The number line that is now commonly used is one such example. We are taught to visualize numbers as if they occur on a continuous infinite line, something that is so familiar to us that we take the concepts behind it for granted. Mathematician Luigi Borzacchini writes:

the development of the 'real number line' was a process of interaction, I should say between four traditions: the ancient algebraic tradition, from Babylonian to arab and italian algebraists, which employed geometrical representation to solve the equations, the ancient geometrical tradition, from Euclid to Pappus, which developed the analytical/synthetical geometry, the numerical practical tradition, from the arab to the european algorisths, which introduced the symbol-based algorithms, and the new physical tradition, from the calculatores to Galileo that developed the role of the measuring and metaphorized the quantities with the geometrical line. This process is by and large the birth certificate of modern science, and the emergence of the 'number line' is its core.

The conception of numbers as continuous, with an origin and stretching infinitely backward and forward from that origin, gave mathematicians a visual metaphor that enabled thinking past the medieval models of discrete, positive, integral quantities only. The number line has an origin (zero) that allows us to think of numbers as positive or negative as well as a direction (assumed to be straight and linear). The concept of the number line illustrates the idea of inclusion and exclusion, allowing us to think about numbers which are not on the line, such as imaginary numbers.

Visualizations are not part of the current practice of most literary criticism, and attempts at visualization are often seen as pseudo-scientific. One of the reasons that humanities computing articles aren't appearing in the mainstream of literary criticism may be that such studies are attempting to establish a scientificity that is not well received in the humanities. Writing in 1978, John B. Smith declares in "Computer Criticism" that "the mainstream of critical thought has moved steadily, inexorably, toward greater formality and toward the notion of a "science" or "sciences" of criticism" (14). Smith notes that Structuralism is one such movement, especially when viewing the text as a semiotic structure (15). However, he also notes that "in spite of statements that Structuralism is really only a method, it is not methodical enough; Structuralists have never codified a set of methods or techniques that is adequate and general enough to accommodate close, sophisticated analyses of specific literary works" (15). This statement is often typical of the approach to literary computing. Put another, perhaps less generous way, it is saying that the methods of criticism must be adapted to the machine. Obviously, this won't work. Forcing literary criticism to become "scientific" will not accomplish anything other than annoying everyone involved. Instead, we must adopt procedures and develop tools that will position the computer as an aid to research. Most of the essays in Potter's collection take a 'scientific' approach to literary criticism, yet, as Potter herself notes in "Literary Criticism and Literary Computing: The Difficulties of a Synthesis," literary study does not follow a scientific method (for there is rarely replication of studies), but is more akin to law, where previous authoritative positions are cited to establish or dispute interpretations (93).

This failure to cross from science into literature is not a surprise. Potter laments that "we have bought the verbal-versus-quantitative division of human brains and have, as a result, incapacitated ourselves for an entire range of possible understanding through our studied ignorance of basic intellectual skills and experimental methods" (92). These words were written in 1988 along with her advice that those involved in computer studies must make their results "accessible and compelling" (93) before non-specialists will take these results seriously. All too often, the 'two cultures' model of the humanities and the sciences has been uncritically accepted, promulgating a view that these two approaches to knowledge are irreconcilable and have no points of intersection, or that empirical studies are not at the same level as the interpretative work of literary criticism.

Unfortunately, a hierarchy of literary criticism has already been established. In *A New Computer-Assisted Criticism*, Raymond Siemens describes William Machan's division of literary studies into Higher Criticism, characterized by interpretative studies, and Lower Criticism, which is "chiefly textual and bibliographical in nature" (260). Machan asserts that Lower Criticism is based on the factual, and provides "numerical, analytical, and categorical information which is used to define . . . realities" (260). In other words, empirical and quantitative studies do not have the same status as interpretative ones. Siemens notes, however, that both Higher and Lower criticism are mutually influential, and each "assists in the definition and development of the other" (261). Despite this mutual influence, such dichotomization can be dangerous; it may presuppose a division of text and idea, that the signifying and meaningfulness of a text arise from the ideas presented, without consideration of the presentation (including the actual words of the text itself). Issues of presentation will be discussed in more detail below.

In A History of the Modern Fact, Mary Poovey relates how she "noticed that early nineteenth-century surveys of the newly crowded cities in Britain tended to combine interpretive accounts of neighborhoods with numerical tables that purported to describe more or less the same circumstances, apparently without analytic commentary" (xi). From this observation, she embarked on a quest to discover how knowledge arose from both the interpretive accounts and the noninterpretive, that is, numeric, data. Her analysis echoes Machan's division of high and low, then extends it to show how the high and low are not inevitable categories, but that both are constructed:

> focusing on this epistemological unit [the modern fact] has enabled me to expose the connections between knowledge projects as different as rhetoric, natural philosophy, moral philosophy, and early versions of the modern social sciences.

> By revealing that what connects these projects is a problematic (but symptomatic) assumption about epistemology—the assumption that systematic knowledge must draw on but also be superior to noninterpretive data collected about observed particulars—I have been able to show how a range of practices that were undeniably developed to serve different agendas also helped elaborate this assumption about knowledge. (xiv-xv)

Poovey's analysis of fact-making shows that facts are not discovered, but instead they are constructed in a context that includes the researcher. There can be no separation of 'facts' from the social and cultural milieu in which the facts are presented. In a similar manner, the presentation of data always occurs within a context. The methods of science and those of literary criticism are not separate but continually inform one another. The disciplines are not separate but rather they are different ways of investigating and producing knowledge, of making meaning. As we have seen, the 'facts' that text analysis deals with can meld with the interpretations of literary criticism in mutually beneficial ways.

Despite their lack of 'mainstream' acceptance, text analysis studies offer much to literary criticism. They bring issues of the text into sharp focus. They require a praxis, which in turn requires that ideas be articulated clearly. Before embarking on any quantitative study, we must ask: What exactly do we mean by a "text"? What is it that we wish to quantify, and how will we go about it? In order to construct a concordance, or in order to test an hypothesis, what text will be used? Such studies also invoke a bibliographic approach to texts: What edition or version of the text has been used? How much editorial interference/collaboration has there been? We question both authorship and text, we examine its reception, all because a numerical study has produced results that call these very items into question. This in turn leads to an examination of the conditions under which knowledge is produced and recognized.

Current text analysis tools allow researchers to spend their efforts on such questions rather than on the preparation of the texts. In his book, Burrows notes almost casually, "the five years that have gone in the preparation of the texts" (10). Obviously, such a project required a great deal of effort and funding. It is considerably faster than the 33 years of Busa's project, but such a long-term study is one that would only be undertaken given sufficient reason to do so. Advances in computational hardware and software today shorten the study period, but more important, with the availability of electronic texts and concordance tools and high-level programming languages, a preliminary pilot study may show results in weeks or even days, and thus could have a great influence on the direction of research. The availability and low cost of computer resources mean that we can now run computer studies that previously would not have been feasible. Software and hardware are much more affordable and continue to provide more processing power as time goes on. The Open Source movement has resulted in free software for a variety of applications. As well, software is easier to use: graphical user interfaces have changed the way we use computers. The technical knowledge requirements and expensive machinery that characterized early computer projects is now a thing of the past. As of April 2004, eight of Austen's texts were available from Project Gutenberg. Though these texts may not meet stringent scholarly standards, they can provide the basis for preliminary studies.

Criticisms of the failure of humanities computing to break into mainstream literary computing are valid if one situates humanities computing as a service to the humanities. However, if we see humanities computing as a discipline in its own right, with its own practices and theories, we need to take another look into how humanities computing interacts with established disciplines such as literary criticism. One example is the University of Newcastle's Shakespeare Computational Stylistics Facility, which offers texts and tools to perform Principle Component Analysis (PCA). The site follows Burrows's methods in using the most common words of a text to probe the text, and, for the newcomer to computational stylistics, it "presents a set of Shakespeare play texts with a ready-made apparatus for computational-stylistics exploration". To help the beginner get started in PCA, they offer several "walk-throughs" (see below for more details). The titles of these walkthroughs are indicative of what PCA can achieve: "Exploring broad differences between the three genres;" "Exploring differences between the three Falstaffs of Henry IV Part 1, Henry IV Part 2 and The Merry Wives of Windsor;" "Exploring larger characters' use of the various forms of the second person pronoun;" and "Exploring the consistency in the contrast between some representative tragedies and comedies of Shakespeare's middle period." These walkthroughs show what PCA is capable of doing, and offer both new and experienced users tools and texts for further investigation.

The Newcastle PCA site allows us, for example, to compare characters based on their use of common words (Figure 2-5). Any of the characters shown on this graph can be selected for a detailed analysis of individual word use (Figure 2-6). If the user desires, she can see the data behind the graph (Figure 2-7), and for each word, she can return to the context(s) (Figure 2-8) in which the word is spoken.

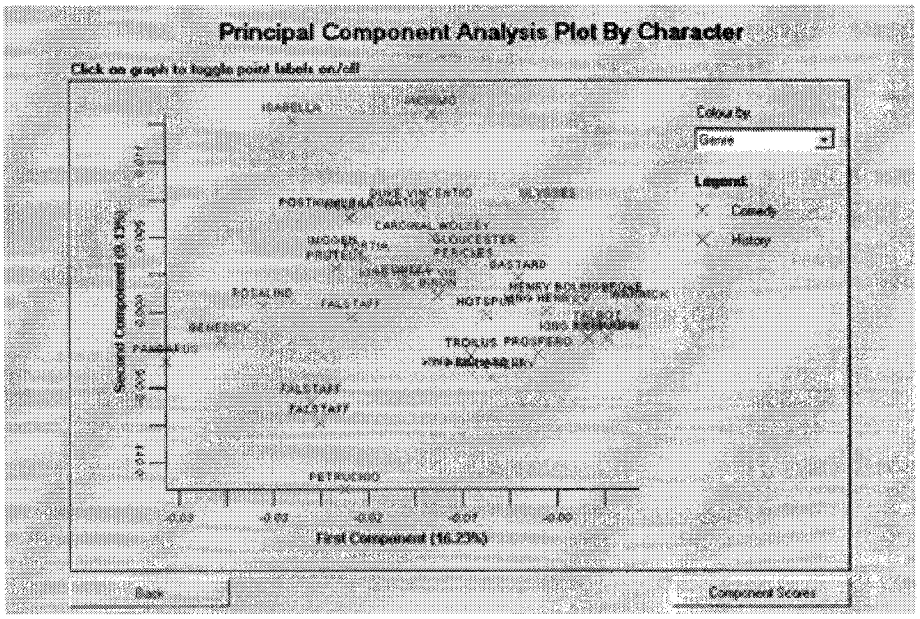


Figure 2-5. PCA Plot Analysis by Character.

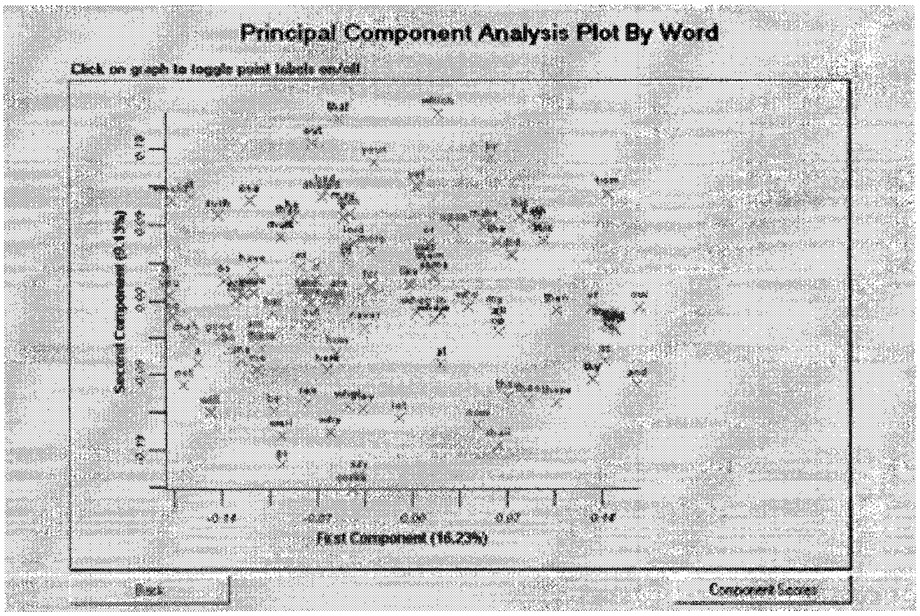


Figure 2-6. PCA Plot Analysis by Word

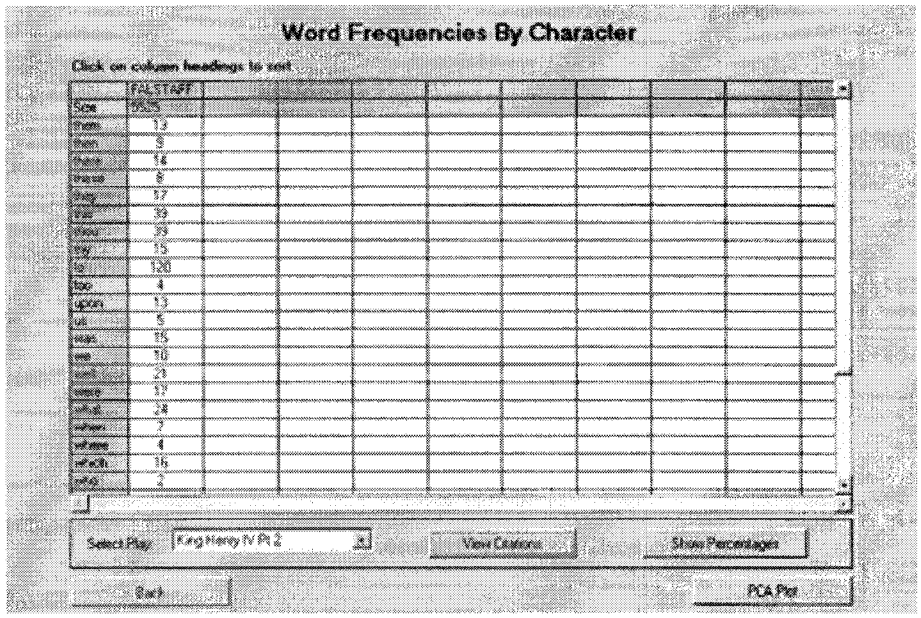


Figure 2-7. Frequencies by Word

The PCA site uses visualizations to help the user accomplish their task. Instead of rigorously explaining the task before it is begun (as would have to be done in a command language), screens are presented based on the choices made up to that point. Once the choices are made, a graph is presented with the information. The graph can be dynamically colour-coded by genre, gender, number of words, or by the social role of the character. The graphs presented by this software allow the user to see how characters differ in their word use, and how an individual character uses specific words. Again, rather than specifying an hypothesis at the beginning and proceeding through a long set of analysis, the user can *see* how characters differ, and how they use individual words. Hypotheses can be formed on the fly, and immediately tested. The PCA software links the text to the presentation of information, so that the user can return to the source (i.e., the play itself), to investigate the context.

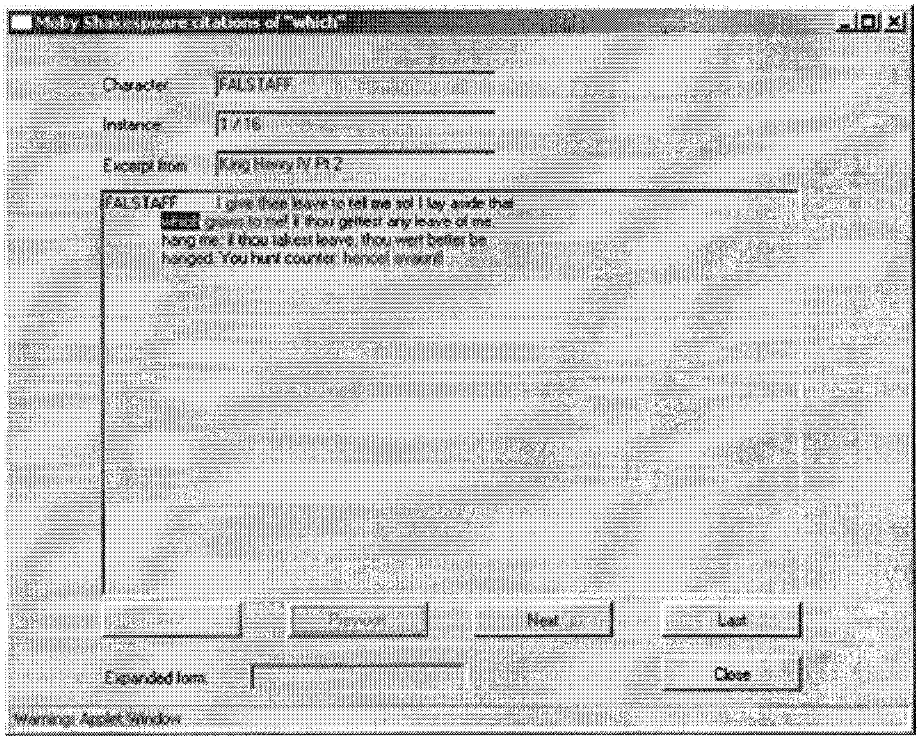


Figure 2-8. Context.

The PCA site will undoubtedly prove a valuable tool for text analysis, especially since it incorporates a visual presentation of the results. However, users still navigate through the information in a relatively primitive way. If the points on the graphs were hyperlinks, the users could make immediate investigations rather that going through screen by screen. This idea, however needed a context before it could be voiced, and this context requires a working model of the PCA software. This is a point that I wish to stress: had the tool not been made, we would have great difficulty imagining other ways of navigating this information. Until we see how something operates, it is difficult to conceive of alternate methods. Having a prototype (though the PCA is not merely a prototype but a full application) elicits response.

A program that does use hyperlinks to help navigate through the information is Stéfan Sinclair's HyperPo, a "user-friendly text exploration and analysis program." It allows the scholar to run (amongst other features) cooccurence lists, frequency lists and keyword-in-context searches, on thousands of texts already available online with absolutely no setup required. A tool such as this makes possible investigations that, a couple of decades ago, would have taken months or years, or more likely, would not have been feasible. And because HyperPo processes text immediately, it allows researchers to explore the text in ways that static text analysis tools do not. Results from a search can immediately be used to generate subsequent searches.

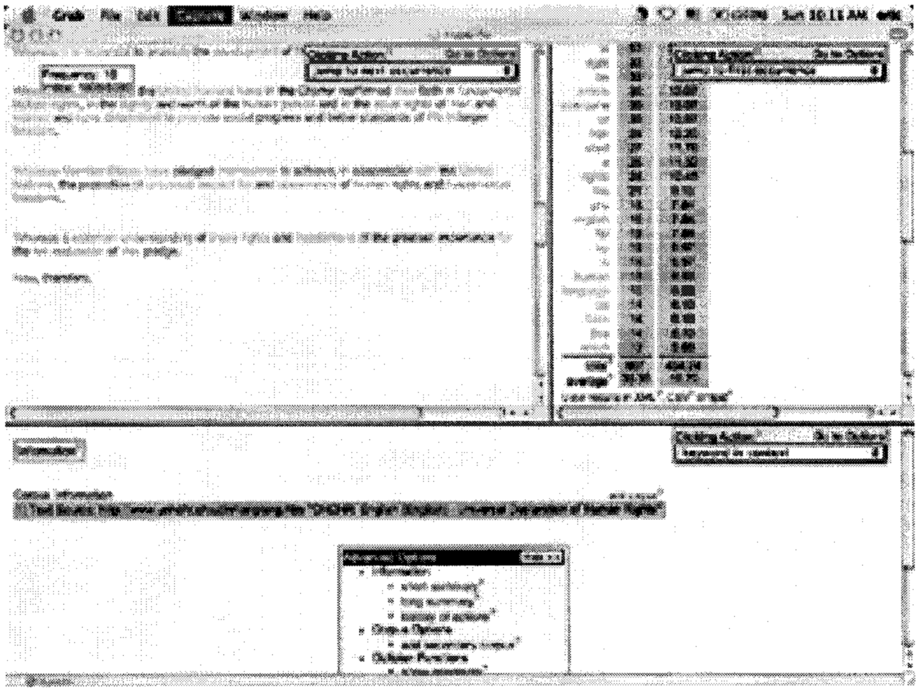


Figure 2-9. HyperPo.

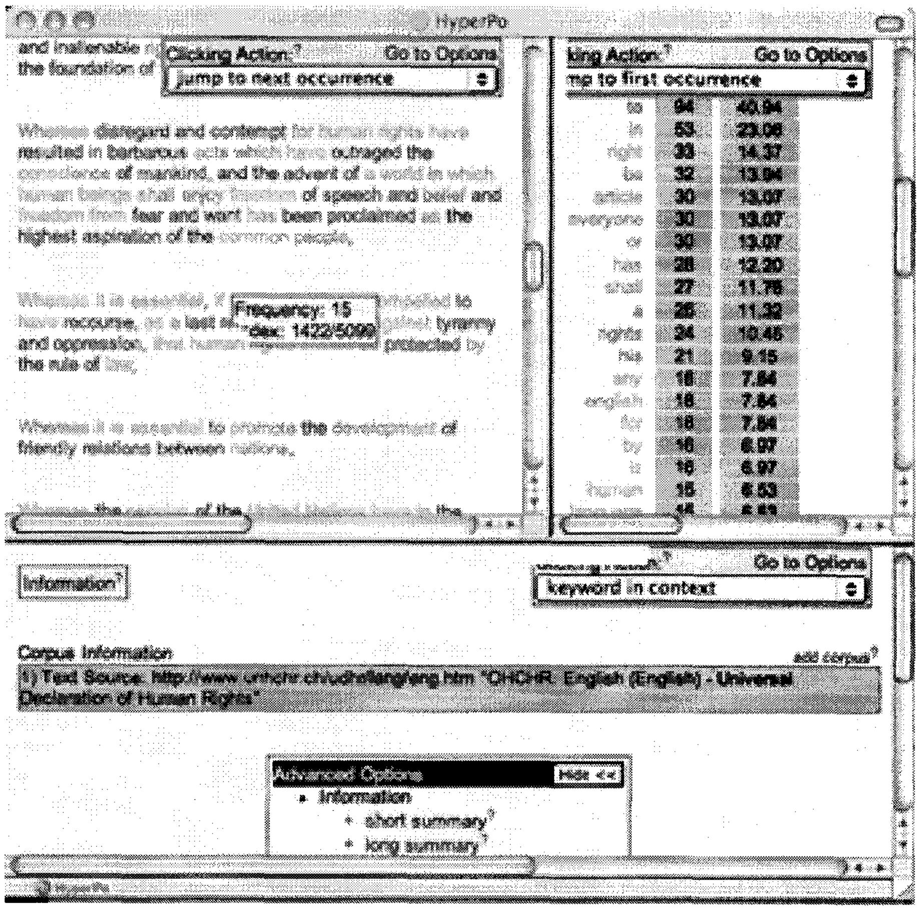


Figure 2-10. HyperPo detail.

HyperPo is one of the tools available for text analysis from the Text Analysis Portal for Research (TAPoR), a national project based at McMaster University and connected to five other centres across the country. The project is described by Geoffrey Rockwell in "What is Text Analysis, Really?" as "a virtual laboratory that makes available a variety of server-based tools properly supported, documented, and adapted for use in the study of electronic texts" (215). Stéfan Sinclair, in "Computer-Assisted Reading: Reconceiving Text Analysis" notes: "rather than to extol the computer as a scientific tool that can supposedly help prove particular facts about a text, we would do better to focus on its ability to help read, explore, experiment, and play with a text" (176). Both Rockwell and Sinclair recommend a move from the direct analysis of text to other applications. They do not preclude the use of quantitative analyses, but instead see such studies as part of a larger, more encompassing suite of tools for research.

Text analysis tools are being combined with search engines to give more options for searching the Web. One of these is WebCorp, created and operated by the Research and Development Unit for English Studies at the University of Liverpool. WebCorp is a "suite of tools which allows access to the World Wide Web as a corpus". It has advanced features that allow a user to specify complex search criteria. Wildcards and pattern matching criteria can help the researcher search for lemmatizations; thus "use of r[u|a]n[ning|s|] to match *running, runs, run, ranning, rans, ran"*. The user can search particular domains and give specific dates. The use of such a tool gives researchers the ability to filter search results and save a great deal of time when searching the Web. The approach taken by WebCorp is that the Web itself is an entire corpus, so the tools that have already been developed for research into corpora are applied to the Web itself. This strategy—to use tools developed for one application in another—is one of the strongest features of computer-based tools.

There is another approach to looking at the history of computers in literary criticism. If we look from a slightly different angle, we can't help but conclude that computers have had a resounding success in humanities, including literary studies.

When the blackbird flew out of sight,
It marked the edge
Of one of many circles.

As Wallace Stevens alludes to in "Thirteen Ways of Looking at a Blackbird," perhaps one cannot look directly at the issue; one must approach it liminally. Tools that use quantitative results in ways that are not immediately apparent have become ubiquitous. Consider a literature search: on-line databases make searches near-instantaneous where they once may have taken days or even months. Consider the word processor: a scholar is able to edit her own text in sophisticated ways that was simply not possible a few decades ago. Those who claim no progress in the field of computer-aided literary studies are overlooking resources such as these in their arguments. Computer searches now form such a basic part of the scholar's toolkit that they are taken for granted, as is word processing, e-mailing, requesting library materials, and browsing on-line archives on another continent. Literary studies gain greatly from these applications.

The name McCarty gives to the text-analytic studies examined in this chapter is *algorithmic*. This term is instructive, for it reveals an assumption that texts can be analyzed according to particular patterns, that patterns can be found by applying an algorithm to detect them. The algorithms used must at some point specify a unit of text—usually the individual word—that is to be used. As we have seen, these algorithms can reveal surprising results. The processing capabilities of the computer allow the researcher to iterate through cycles of questions that probe the text according to the choice of unit that is being investigated. There remains, however, the basic assumption of an 'atomic' model of text, that texts can be divided into units of significance that occur within the text itself. If we wish to investigate how meaning can arise from sources other that the literal words of the text, other methods need to be used. These methods will be discussed below.

In this section I have argued that algorithmic methods, which focus on counting some aspect of texts (usually words) have used visualization. I've mentioned how these methods have not been accepted as part of "mainstream" literary criticism, but have formed a discipline of their own. I've noted how as hardware and software become increasingly sophisticated and easy to use, visualizations have been increasingly incorporated into the presentation of results. These visualizations enable researchers to form new questions and new hypotheses that may not have been apparent otherwise, opening new spaces of interpretation. Researchers are no longer simply presenting results, but are developing tools that allow others to form hypotheses and immediately test them. These are participatory spaces where exploration and play can take place. Again, visualization plays an important part in these tools.

3. Linking

But to the postmodern writer, confusion is not a bug but a feature.
—Janet Murray, Hamlet on the Holodeck

The following section deals with hypertext and hypermedia. I will present, very briefly, the development of hypertext, look at the early hypertext theorists' predictions for hypermedia and end with a look at the current state of hypertext and what we have learned in the past fifteen years of hypertext implementations. This look at the predictions and the outcomes of hypertext will serve as a cautionary tale to temper our expectations of visualizations. More importantly, we will see the importance of taking into account our strategies for implementation, and the importance of paying attention to the restrictions imposed by technology.

The terms hypertext and hypermedia were introduced by Ted Nelson in 1965. There is a distinction to be made between hypertext and hypermedia—the inclusion in the latter of visual and audio media as well as text—but the use of the term hypertext to include hypermedia has become the norm and unless specified otherwise, this is the sense in which I will use it. Hypertext—the ability to link passages in one text with those in another—is not a new conception. In Hamlet on the Holodeck, Janet Murray points out that "hypertext formats are not new intellectual structures" (56), citing the Talmud as one instance. To this I would add that neither are multimedia documents new: artist's books, for instance, incorporate visual, sculptural, and tactile features. The notion of hypertextual implementations is credited to Vannevar Bush. In his article "As We May Think," first published in 1945, Bush describes a machine he calls the memex, which provided a means for the user to make connections between documents. The familiar hypertext that allows us to jump among web pages was first demonstrated by Doug Englebart in 1968 as part of the NLS (oNLine System) developed at the Stanford Research Center. This presentation also included the first public display of the mouse. The demonstration was so innovative that some thought it a hoax. Hypertextual systems did not see wide-scale implementations however, until the advent of the World Wide Web and HTML.

The development of HTML prompted widespread use of hypertext. Several writers saw hypertext as the implementation of forms of writing that literary theorists had been discussing since the 1960s. Along with the literary theory came a rhetoric of freedom and democracy. One of the early prognosticators of hypertext was Stuart Moulthrop, who saw hypertext as an implementation of the theories of the "writerly text" put forth by Roland Barthes in The Pleasure of the Text. Moulthrop begins his 1989 article "In the Zones: Hypertext and the Politics of Interpretation," with an epigraph from Ted Nelson: "Tomorrow's hypertext systems have immense political ramifications, and there are many struggles to come." This epigraph sets the stage for Moulthrop's prose. His first sentence declares: "For the last twenty years the technology of writing has been overdue for a paradigm shift". He then proceeds to set up a binary between what he sees as the democracy and freedom of hypertext versus the authority and constraints of print: "In electronic writing systems, the allusive and elliptical forces inherent in prose were no longer constrained by pagination and binding." He notes that "the hypertext concept owes much to the critique and dissent that came out of the sixties and seventies", and later lapses into sixties rhetoric, noting "one might very well envision . . . a kind of 'Democracy Wall,' a huge library-cum-bulletin board whose users would be free to forge connections and publish theses, where ten thousand flowers could happily bloom," undoubtedly a reference to Richard Brautigan's "All Watched Over by Machines of Loving Grace"

(1967): "where deer stroll peacefully / past computers / as if they were flowers /with spinning blossoms."

George Landow is another theorist who has written extensively about hypertext. In his article "Hypertext and Critical Theory." published in 1992, Landow declares that

> In S/Z, Roland Barthes describes an ideal textuality that precisely matches that which has come to be called computer hypertext—text composed of blocks of words (or images) linked electronically by multiple paths, chains, or trails in an open-ended, perpetually unfinished textuality described by the terms *link, node, network, web,* and *path.* (3-4. Page numbers refer to the electronic edition.)

Landow quotes Barthes's description of this ideal textuality: "this text is a galaxy of signifiers, not a structure of signifieds; it has no beginning; it is reversible; we gain access to it by several entrances, none of which can be authoritatively declared to be the main one." Again, we see the anti-authoritarian rhetoric that so much hypertext theory seems to attract. Landow claims hypertext as the instrument of democracy, as we see in statements such as: "hypertext does not permit a tyrannical, univocal voice" (11), and the declaration that "all hypertext systems permit the individual reader to choose his or her own center of investigation and experience. What this principle means in practice is that the reader is not locked into any kind of particular organization or hierarchy" (11-13). He asserts that hypertext is the implementation of postmodern literary theory, citing specifically Barthes's notions of the writerly text, Michel Foucault's ideas of networks and links, Mikhail Baktin's uses of dialogism and polyvocality, and Jacques Derrida's decentred text. Some of Landow's claims seem to come from the retroactive imposition of hypertext on to literary theory: "The analogy, model, or paradigm of the network so central to hypertext appears throughout structuralist and poststructuralist theoretical writings."

(23-26). Espen Aarseth, in Cybertext, calls this "the reification fallacy" (78)—the claim that hypertext manifests previous literary theory.

Statements about the democratization of hypertext fail to take a variety of factors into account, particularly the implementation of the hypertext. Other factors such as accessibility are ignored. Jerome McGann, in the digital version of "Radiant Textuality" exhorts us to "look at the back issues of *Postmodern Culture*, especially the last couple," and provides links to do so. However, the full contents of the issue are available only through subscription. This is a far cry from the predictions of democratic and open access to information prophesized by the early hypertext theorists. Landow's declaration that "hypertext blurs the boundary between reader and writer and therefore instantiates another quality of Barthes's ideal text" (5-6) is a voicing of an ideal world that is not fully thought out and consequently fails in the implementation. Even in an ideal world, the text does not simply exist between reader and writer. As Robert Darnton shows in "What is the History of Books?", the text (as codex), follows a communications circuit that governs its reception by the reader. This circuit includes the author, the publisher, printers and compositors and their suppliers, shippers and wholesalers, and, of course, the reader. All of these are influenced by intellectual interests, economic and social factors, and political and legal sanctions. These factors influencing the publication of printed materials have analogous components in the electronic publishing world. Issues of access, editorialism, and the problems of technical implementation all come to bear on an electronic text. Landow's claims for a reader-centred text ignore the requirement that hypertextual links must be created by someone, that links are one-way and only link to a single document. The end result is that the hypertext is a strictly structured document. Susan Schreibman, in "The Text Ported," observes that hypertext, once thought of as the realization of post-structuralist literary theory, is in its implementation, "extremely rigid" (285), that "while giving the appearance of embodying post-structuralist theory, [hypertexts] force readers into tightly controlled hyperlink paths created by the editor" (285). The dreams of decentring the text and the banishing of authority have not been realized. In the realm of theory, ideal texts and ideal readers may exist, but in reality, neither does. If we are looking for realizations of Postmodern literary theory, magnetic poetry kits for refrigerator doors come much closer than do hypertexts. Aarseth points out that "the reader's freedom from linear sequence, which is often held up as the political and cognitive strength of hypertext, is a promise easily retracted and wholly dependent on the hypertext in question" (77).

I suggest that an informational democracy is not what a researcher wants. When the landscape is flat, that is, when all links have equal value, then how do we distinguish one place from another? One of the first tasks a researcher performs is to categorize and list. Links, references, and information are classified and prioritized, and the information landscape becomes contoured. In theory, all links may be equal, but in practice, some links are more equal than others.

Schreibman notes how in the early 1990s, the ease of use of web publishing with HTML "gave a false sense of hope to humanities scholars who felt that the new medium would provide an environment that would foster new interpretative models" (77-8). This utopian realm of text representation did not come to pass: hypertexts, once thought of as democratic and uncentred, proved instead to be strict guidance systems determined by their creator. As well, many texts are simply ported to electronic versions without any attention paid to the differences in media, resulting in texts which are difficult to read. Schreibman deplores both the difficulty of finding good sites as well as the disappointment the researcher feels on finding sites that are "editorially and artistically unimaginative" (79-80). She laments: "many of these sites simply port codex norms into a Web environment" (80). This is not unexpected, since codex norms are familiar. Skeuomorphic implementations, such as the inclusion of tables of contents and running heads in the electronic text, give the reader a sense of familiarity. In other respects, new methods of displaying and navigating the text have yet to be developed; the field of computing is still immature in many respects.

In his 1999 article, "Trivializing or Liberating? The Limitations of Hypertext Theorizing," David Miall looks at some of the lessons that have been learned over the previous decade of hypertext implementations, and makes a succinct summation of the limitations of hypertext:

> A part of the work of interpretation is to make connections across a text, from parallels between plot elements to extended metaphors, as well as beyond the text to other works of literature and beyond that again to the world of the author and history. . . . The reading process, however, also depends upon the personal resonances of the reader. To attempt to model such connections explicitly in a network for all readers represents a premature formulation of the reading process; in effect, the network displaces the reader's own response (169-170).

This is nearly the opposite effect of the predictions of Landow and Moulthrop. Miall argues that literary reading is "rendered incomprehensible by the model of reading put forward in hypertext theory" (158). He points out that the spatial properties of hypertext have been falsely interpreted as giving a sense of freedom to the reader, that hypertext undermines the stability required for an "affective engagement" with the text (158):

> The linking of one text node to another tends to promote superordinate

> connections and to elicit an analytical response more appropriate to expository prose than to literary texts. The mechanical invocation of nodes through links will rarely correspond to the process of anticipation that a reader of a novel or poem experiences, since the need to choose from an array of multiple pathways at each step is unlikely to sustain the progressive unfolding of the reader's affective engagement with the text. This suggests, paradoxically, that the fixed form of the printed text may be more liberating for the reader than the constrained process of linking imposed by a hypertext, where the requirement to decide every few sentences which link to follow seems likely to prevent the immersion characteristic of literary reading. (166)

Johanna Drucker, in "The Virtual Codex from Page Space to E-space," notes that "the alternative reading practices of hypertext story structures have not found large followings. The one area where branching narratives and experimental pathways have taken off is in the design of games."

I have gone into some detail over the failure of hypertext implementations to achieve the predictions of theorists because this is a lesson to be learned. Hypertext speculation has been the result of decontextualization. The failures of hypertext to live up to the predictions of theorists is not the fault of technology, but the result of an ignorance of the context in which reading occurs. It is the result of the lack of building prototypes and of testing hypotheses. As Winograd and Flores and Frascara have mentioned, context and participation are integral for the development of a technology that includes human elements. Hypertext theorists have shown a remarkable ignorance of the human factors involved in the development of this technology (and of the history of technological predictions), as well as a myriad of other factors including politics, economics, sociology, and psychology. The predictions of hypertext concentrated on the "features" of hypertextual connections rather than on the task at hand, which is providing information. The relevant domain here is not a hypertextual one but rather an informational one.

Good theory is useful and purposive; it guides our thinking, challenges our views and preconceptions. However, it is all too easy (and, alas, too common) for theory to glide into unreasonable extrapolation, or worse, prescriptive speculation. Periodic reality checks are necessary. If the decentred, writerly text is to be implemented in hypertext, we must ask: How? What are the constraints we must work under? What does the machine impose on us, and how can we work around it? Who will pay for the effort? These are not unidirectional queries. Addressing such questions can provide valuable feedback for theory. In "Radiant Textuality," Jerome McGann points out that "the creation of networked archives holding vast bodies of electronic and digitized materials — has been exerting enormous pressure upon scholars to become intimately involved in the design and creation of those archives". The task of the scholar does not end once the archive is brought into existence, but continues through the life of the archive, for the archive is not a static object, and it exists in a dynamic world. The relationship between the archive and the 'outside' is continually morphing. McGann realizes the need for continuing maintenance: "Because the Rossetti Archive will outlive its makers, provision has to be made for a continuity of authority over all aspects of the Archive and other works of that kind". It is informative that he uses the word "authority": this real-world example of a hypertext *does* have a centre. McGann continues, noting that "we must begin experimenting with the critical opportunities that these new media hold out to us". Such experimentation is necessary to discover what we can do; it will generate new theory, it will result in new practices, but only if we *do* it. Speculating does not produce results.

Doing shows us that electronic texts offer the author even less control over the appearance of the text than she has with printed text. Servers running at different speeds and capacities will influence the availability of the text to the reader/user. The rendering of the electronic text is determined by a number of factors beyond the author's control: different browsers (and different versions of these browsers), render the text in different ways. The author has no control over the browser being used. Users can resize their browsing window and change the font size and style. This lack of control does not create a readerly text out of a writerly one. Most of the factors listed above are technological ones that exist outside the text. Surrounding the text on the computer are navigation aids that are both visible and invisible. The browser interface can be seen as analogous to both codex and scroll, where the text "window" becomes a function of both the implementation of the text and the text itself. The text may already have some formatting elements in it: it may be broken down into lexical pages with links between them or it may be seen as one long text that must be scrolled in the browser window. Navigational aids present in the codex, such as chapter and section breakdowns, a table of contents, page numbers and running heads may no longer be present on the browser page but instead are replaced by a browser history list, or by links that take one to specific places in the document, or other techniques.

The claims for hypertext also ignore the effects of paratext. Richard Macksey, in his introduction to Gérard Genette's Paratexts, defines paratext as:

> those liminal devices and conventions, both within the book *(peritext)* and outside it *(epitext)*, that mediate the book to the reader: titles and subtitles, pseudonyms, forewords, dedications, epigraphs, prefaces, intertitles, notes, epilogues, and

afterwords . . . also the elements in the public and private history of the book (xvii).

Paratextual apparatus present in the codex is missing in the electronic form and consequently the reader of the electronic text misses some of the information that this apparatus conveys. For instance, the quality of a book conveys information about the intended audience: high-quality hardbacks for the connoisseur and collector, trade paperbacks for the discerning reader, mass market paperbacks for inexpensive entertainment. While the electronic text lacks the physical paratext of the codex, the reader experiences a new digital paratext that is not taken into account in hypertext theory. The presentation of the electronic text to the reader mediates its reception by the reader, and needs to be accounted for in theories of electronic texts.

We are still in the early years of hypertextual implementations. Bieber et al. in "Fourth Generation Hypermedia: Some Missing Links for the World Wide Web" note that current web authors must "cope in a hypermedia environment analogous to second-generation computing languages (i.e. assembler language) in that they only have relatively low-level functionalities available" (32). They compare these second-level languages to "Fourth-generation packages . . . [which allow the user to] concentrate on *what* they want to achieve instead of the process of *how* the underlying program actually produces it" (32). They point out that two major dangers are associated with using hypermedia: disorientation (analogous to disorientation in a physical environment) and cognitive overhead (the additional mental effort required to track one's progress through the hypermedia environment) (33-34). In too many implementations, hypertext is like riding the London Underground without a map—you only know what stations you can get to from this one, never the larger picture that tells you where all of the stations are, and the relationships between them. There is also the skeuomorph factor to contend with: any new medium needs a period of time in which to adapt to it; initial forays into the medium are typically characterized by the adoption of familiar practices in unfamiliar territory. Thus the first attempts will be characterized by the artifactual—the first hyperlink documents will resemble those of the codex, where they simply implement footnotes and other references by using a hyperlink.

Perhaps the most important elements missing in hypertext implementations are perspective and prospective views. Bieber et al. observe that

> Web browsers have no inherent way of presenting the structure and interrelationships of data of any sort. For example, there is no way to visualize even the simple interrelationships of web documents, such as "Where can I go from here? or "Which documents point to this document?" The reader has no idea of the position of a given document within the corpora unless an author explicitly embeds such details. Yet such information is very important, as indicated by the prediliction of web page authors to provide tables of contents, explicitly stating document interrelationships (34).

Steve Krug, in Don't Make Me Think, lists what he terms the "oddities of Web space": "No sense of scale. No sense of direction. No sense of location." (57). Hyperlinked web spaces could benefit greatly from visualization. A map could give the user a sense of place, it could make use of gestalt 'laws' such as proximity and similarity to indicate relatedness, or use trends in a set of elements to indicate continuation. Without such maps, the user is forced to follow links, not really knowing anything about where they lead. Disorientation results. Hubert Dreyfus, in On the Internet, notes that when searching the web, the sheer number of documents being searched will nearly always result in some relevant documents being returned, but what the searcher does not know is how many *better* documents were not returned in the result set. Dreyfus credits Don Swanson as the originator of the term *fallacy of abundance* for this phenomenon. The list of hyperlinks that most search engines present are occasionally accompanied by bar graphs of "relevancy" (to what? one asks?), but there is no way of telling just how all of these list items are related to the search and to each other. Were the results presented in a graphic form, one could infer groupings and relevance; one could have a sense of direction; if the links toward the upper right do not prove fruitful, the research could then take a different tack. Instead, the list items must be linked to one at a time, in sequence, a time-consuming, or rather, a time-wasting activity when a simple map could facilitate the researcher's task.

When we look at a map or a diagram, we are usually paying attention to the information that we can get from it. We usually aren't thinking that this is a *designed* object. What it presents to us is not an objective reality—a straightforward one-to-one correspondence with things in the world, but rather an interpretation of the things that the designer feels are important. It is the result of selection and classification. The London Underground map is one famous example. Designed by Harry Beck, an electrician, it reduces the information presented to a schematic. It bears only a marginal resemblance to the geography of the city, because to a user of the Underground system, geography is unimportant. What is important is knowing how to get from one stop to the next. What lies around and between the stops is irrelevant to someone riding the train, since they cannot get off between stops. As soon as one returns to the surface, however, geography once again becomes of prime importance.

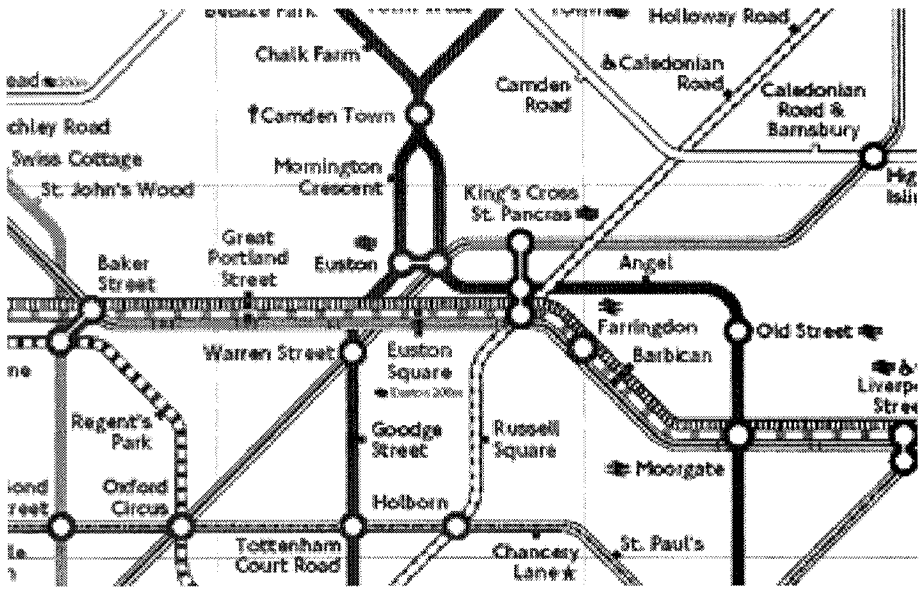
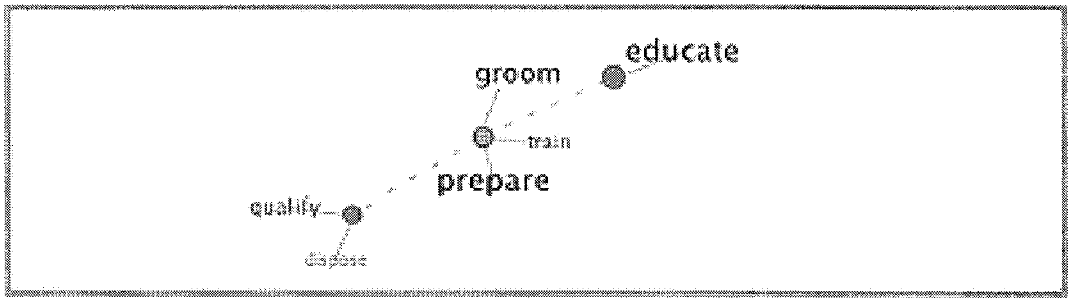


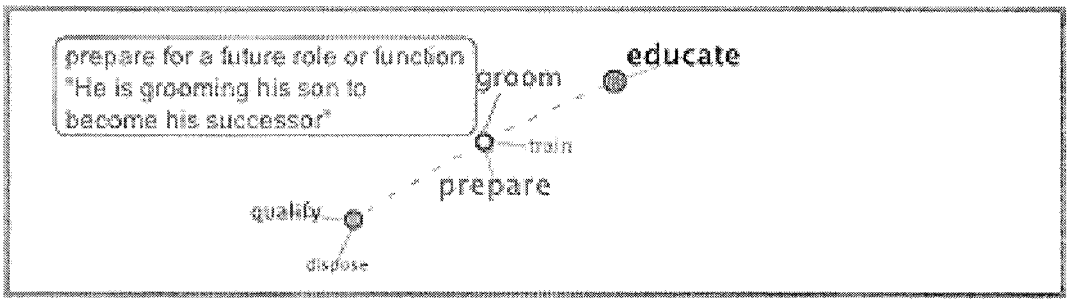
Figure 3-1. London Underground map (detail).

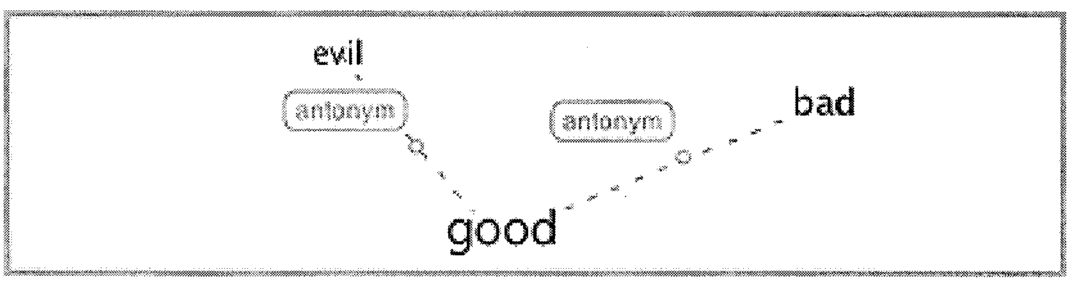
Hyperlinks present us with a similar situation except that we can only see one stop in any direction. We have no sense of the whole. And while the whole of the Internet is too much to comprehend, for someone searching for specific information, to know what lies beyond the next page, and beyond that, can be extremely important information. Visualizations can quickly and accurately convey the layout of the information landscape, or even the immediate vicinity. In order to move from one information space—a web page, or a web site—to another, we need to know what the connections between the two are. When we are browsing through the library stacks, we are aware of books that are immediately relevant to any particular book, since the classification system uses physical proximity to locate similar topics together. Computers have the advantage of being able to dynamically change a classification system (for instance, sorting by publication date or author name), but it is only recently that systems are being developed to visually duplicate the relatedness-by-proximity that library classification systems have done for centuries.

A good example of hypertext used with visualization (and vision) is Thinkmap's Visual Thesaurus. The Visual Thesaurus presents an animated display of words. The word of interest is centred in the display, with lines connecting it to synonyms. These synonyms are colour-coded to represent parts of speech. Clicking on a synonym re-centers the display on that word, and the display then presents its synonyms. The original word is still visible, so the user can see where he came from (a history list is also maintained). Rolling over a word results in a pop-up box with the meaning of the word. Clicking on a connection between words gives the nature of the relationship between them. The display is customizable, and the graphic features of the display make it easy to read and understand. The Visual Thesaurus includes many other features that make use of both hyperlinking and visualization to offer the user a space in which to explore.

(Next page.) Figures 3-2, 3-3, and 3-4. Three views of the Visual Thesaurus.


educate
groom
train
prepare
qualify
dispose


prepare for a future role or function
"He is grooming his son to
become his successor"
groom
educate
train
prepare
qualify
dispose


evil
antonym
antonym
bad
good

In this section, I have argued that the failures of hypertext theory provide an example of theory that runs amok without a solid basis in experience. I have noted how the "failure" of hypertext to live up to the hype of the theorists is the result of ignorance of human factors and a failure to realize that the relevant domain is one of providing access to information, not the properties of the linking itself. I have also noted how potential features of hyperlinks have not yet been physically implemented, and I have concluded with a look at the Visual Thesaurus, an application that is a highly successful combination of hyperlinking and visualization.

4. Marking

. . . it is reckoned that there is not at this present a sufficient quantity of new matter left in Nature to furnish and adorn any one particular subject to the extent of a volume. This I am told by a very skilful computer, who hath given a full demonstration of it from rules of arithmetic.
—Jonathan Swift, A Tale of a Tub, 1710

The following section deals with markup languages. I will discuss how the issues facing markup are similar to those we face when making visualizations. I will focus on what markup can offer literary studies, and use the Orlando Project as an example of how computing can be integrated into literary study. I will go into some detail here on the issues of markup, since there is a correspondence between these and the issues facing visualization. In both cases, encoding and structuring are involved. The decisions that must be made in both cases strongly affect the end result.

Markup languages incorporate special characters or strings of characters into a document. These strings, called tags, provide information about the processing of the document, and allow the tagger to specify semantic information about the document itself. Tags surround the text they apply to. HTML (HyperText Markup Language) is the most familiar markup language currently in use. It uses tags to direct the display of files in a browser. For instance, using the 'bold' tag directs the browser to render text between the start and end of that tag as bold: **this text will appear in bold**. HTML is, in effect, a tool for visualization since it controls the appearance of information on the computer screen. Other, more general languages, allow the user to specify their own tags.

Markup languages have existed for decades. An example of an early markup language is Waterloo SCRIPT, which began in the mid-1970s as a set of text-markup specifications that later incorporated the Generalized Markup Language. Waterloo SCRIPT was used for formatting a text document as well as other functions such as producing a table of contents and an index. Early versions of it ran in batch mode, so any change to a document required that the entire file be processed. Obviously, such a method of processing is not suited for visualization, but the idea of controlling the presentation of a document through tags incorporated into the document was present. Standard Generalized Markup Language (SGML) began as a project at IBM in 1969, with the publication of the first working draft in 1980, and subsequent publication as an ISO standard in 1986. SGML has been used by the United States government and Department of Defense, but it is not widely used among non-technical areas, because, despite its power, it is exceedingly complex.

The power and utility of markup languages comes from their open-ended approach to document description. The person marking up a document can define tags to mean whatever is important. Unlike HTML, where tags are predefined, languages like XML (eXtensible Markup Language) allow users to create their own tags. Consequently, the tagger can mark the document depending on their own interests. If, for instance, we are interested in the political affiliation of an author, we could create a tag for it. However, unlike HTML, where a browser has the capability to process a predefined set of tags, SGML and XML require that the user define the processing on those tags. Languages like XSL (eXtensible Stylesheet Language Transformations) allow the user to control the processing of XML documents.

One of the advantages in using a markup language is that each document can be custom-tagged. This can also prove to be a disadvantage when documents are shared. Using a standard set of tags across projects or disciplines allows for document sharing. It is for this reason that the Text Encoding Initiative (TEI) was formed in 1987. The TEI home page describes the project as: "an international and interdisciplinary standard that helps libraries, museums, publishers, and individual scholars represent all kinds of literary and linguistic texts for online research and teaching, using an encoding scheme that is maximally expressive and minimally obsolescent." One of the founding principles of the TEI is that the software should not force users to commit to it. This is an idea which has already proven itself in the computer industry, where, for example, the adoption of the ASCII format for representing text files meant that such files could be shared among many applications. In "The Text Ported," Susan Schreibman describes the TEI project as "a framework . . . from which to create textual resources that were not dependent upon specific platforms and software to function," one which "was designed to facilitate the editing, storage, search, and retrieval of large textual documents" (81). The TEI guidelines have adopted SGML as the basis for its encoding scheme, and have created a number of base tag sets, each aimed at particular types of work. There are, for example, TEI tag sets for drama, prose, speech, and dictionaries, each one providing the tagger with a core set of tags useful for marking up those particular types of documents. The TEI was developed by scholars from several institutions, and it attempts to cover a wide range of disciplines and researchers. It also provides tags for semantic and physical description of documents, and for bibliographic and editorial information.

Markup also allows multiple versions of a text to be encoded into a single document, a capability that is used to represent scholarly editions of texts electronically. Once the variations among texts are marked, the computer can be directed to display any one of the editions that have been encoded. This capability of markup means that the scholarly apparatus that surrounds a literary text can (ideally) be encoded into a single electronic document that can then be dynamically customized by the researcher. In his article "Textual Criticism and the Text Encoding Initiative," C.M. Sperberg-McQueen, one of the founding members of the TEI, lists three fundamental needs for electronic editions of texts: "accessibility without needless technical barriers to use, longevity, and intellectual integrity." He notes that some of the traditional conventions of printed texts have resulted from both economic pressures and from the nature of the medium of print to convey complex information. In an ideal situation, such pressures would not be brought to bear on electronic texts, but in actuality, electronic texts must submit to a great variety of constraints.

Sperberg-McQueen articulates the concern that:

> any notation carries with it the danger that it must favor certain habits of thought—in the TEI's case, certain approaches to text—at the expense of others. No one should use TEI markup without being aware of this danger—any more than we should use the English language, or any other, without realizing that it favors the expression of certain kinds of ideas, and discourages the expression, and even the conception, of others.

This statement invokes a degree of linguistic determinism, but is nevertheless a fair warning. Markup languages, though powerful and now widely used, do not offer the best of all possible worlds in representing text. Some of the issues raised in creating electronic editions arise from the electronic/computing medium itself, others from editorial and bibliographic issues that have traditionally plagued editors, and still others from aspects of the text that, until recently, have gone largely ignored by literary critics. The problems of representing a text electronically brings these issues to the fore: they must be explicitly addressed in creating an electronic scholarly edition.

In "Computer-mediated Texts and Textuality: Theory and Practice," Susan Schreibman notes several problems with electronic texts, among them that markup languages conceive texts as OHCOs (ordered Hierarchy of Content Objects), and also that encoding ignores the physical aspects of the text. She points out that in electronic editions, the text becomes "bound up with its critical apparatus" (291). This problem is not unique to the electronic medium; it has faced editors for years. Electronic editions are simply new presentations of the problem, but in order for an electronic edition to be at all satisfactory as a scholarly resource, these problems must be addressed. Simply putting the texts themselves online is not the answer: Sperberg-McQueen rejects the Project Gutenberg texts as scholarly editions because of their lack of scholarly apparatus and the lack of control over transcriptions. This does not, however, mean that these texts cannot be useful—as mentioned above, they can form a basis for pilot studies in stylometrics.

One of the restrictions of XML is that the tags must be nested hierarchically. This requires that any tagging scheme that is conceptualized must conform to a hierarchy, where one "object" is contained within another. At the highest level, the document falls under a single tag. Within that tag are the details. For instance, a book might have the structure:

```
book
        table of contents
        chapter 1
                section 1
                        subsection 1
                        subsection 2
                section 2
                . . .
        chapter 2
        . . .
        index
```

Here, 'book' consists of a table of contents, one or more chapters, and an index. Within each chapter are sections, and within each section are subsections. While this may seem a 'natural' structure for representing a book, it is nevertheless an arbitrary one that forces the tagger into using a specific mental and physical model of the text that is being tagged. Other methods of representation, such as relational databases, allow greater freedom for specification and are based on a solid mathematical foundation. A great deal has been written about both hierarchical and relational data structures and their limitations, but I will not address these issues since space does not permit. It is important to note, however, that a hierarchical *representation* of the data does not force the user into a hierarchical *presentation* of the data. Transformation software can dynamically re-order the hierarchies of an encoded text. Sophisticated query languages such as XPath allow the user to search by content regardless of the hierarchical structure of the document, and to duplicate many of the advantages of relational querying. This does not mean that all problems are solved; basic issues concerning how and what to encode still remain at the root. These questions, however, are less a matter of addressing the technological limitations than addressing the properties inherent in the texts themselves and in the problems of representation. Still, the underlying structure of the representation requires that the document conform to that model. As we will see below, the design of these data structures are intrinsic to the success of any markup project.

A different sort of problem lies with the physical structure of the text. Schreibman refers to the work of Jerome McGann and Johanna Drucker, noting that McGann points out that in the OHCO thesis "the graphic format of text does not participate in the production of textual signification" (286). Robert Darnton, in "What is the History of Books," notes that "typography as well as style and syntax determine the ways in which texts convey meanings" (21). Darnton refers to D.F. McKenzie's demonstration that "the bawdy, unruly Congreve of the early quarto editions settled down into the decorous neoclassicist of the *Works* of 1709 as a consequence of book design rather than bowlderization" (21).

The TEI does not have a formal language for typographic description. Sperberg-McQueen notes one of the reasons for this is that "it is not at all obvious how best to describe the layout of a page in an electronic transcription of that page". This is not simply laziness on the part of the TEI committee but arises from the lack, as Sperberg-McQueen points out, of "agreement about what constitutes a significant difference" when distinguishing the set of signs that constitute the layout of the page. This includes all aspects of the typography of the page: the particulars of the font, including size, leading, and the foundry that made the font. To properly encode such differences requires a theory of semiotics and typography that is not currently available.

What we get from addressing the problems of encoding is an interrogation of our concept of text. We must address our notions of text as a product of social and cultural factors that change through time, which in turn affect the signification of the text. Encoding an electronic scholarly edition requires not only that the critical apparatus be made explicit, but also the editorial and bibliographical decisions. Schreibman points out that "models will be needed which not only address the behavior of lexia (as hypertext theory does), theories of encoding discrete textual objects (such as OHCO does), but which address the principles which govern the reconfiguration of objects" (287). Along with these models, we need theories about how to interpret and understand them, and how modelling impacts on signification.

Most theories of electronic textuality, and the literary theories that inform them, pay little attention to the electronic paratext that surrounds the text in electronic form. How does the electronic apparatus surrounding the text "furnish" the text? How do the scroll bars, navigational buttons, the frame around the text, contribute to the presentation and to the meaning of the text? These issues will be addressed in detail in the next chapter.

The Orlando project, currently ongoing at the Universities of Alberta and Guelph, illustrates many of the issues facing markup projects. It is exemplary in some of the approaches it takes to using the computer in a literary project. The aims of the project are ambitious, and two-fold. In "SGML and the Orlando Project" Brown et al. declare: "we aim to produce a five-volume history of women's writing, in English, in the British Isles, . . . as well as one or more electronic research tools" (272). It is significant that the project aims to produce both printed material and electronic tools, and that neither is subordinated to the other. Brown et al. announce that the project deals:

> with a vast range of issues, seeking to account for how the writer is shaped by her society and experiences; how writing has existed as a practice and an institution, from when the first press was invented and print culture initiated to the role that particular periodical editors have played in shaping literary reception; how all these are intertwined with such factors as political events, wars, birth control knowledge and practices, religious beliefs, or educational and legal institutions (272).

I quote at length here to show that the project addresses issues that are in no way attenuated by the decision to use electronic tools; this project is not one of merely computerizing existing documents, but is one of building a new knowledge base. Brown et al. point this out: "rather than planning and conducting the research and writing first, . . . we are designing our data structure as part of the process of research and writing, which means that the research process and the computing practices of the project are indistinguishable and indeed thoroughly integrated" (274). The project takes an approach that is very aware of the limitations tagging imposes upon the documents being tagged, but at the same time, it does not see those tags as merely constraints. Brown et al. remark that "we are tagging the material in part so that we can get at insights we wouldn't normally have, develop our material in directions we couldn't otherwise, and see what emerges from the structuring of information within and across the different historical periods and different areas of analysis." (274). This approach makes the process of markup one of potentiation: the semantic and structural information coded by the tags is there to enable further research. Again, this is addressed by the project: "we want the SGML to allow us both to tag various kinds of materials to make it accessible to analysis and retrieval, and, as far as possible, to allow users to shape the information according to their own interests" (274).

The approach taken by the Orlando project is exemplary in that it addresses computing from the very start of the project and situates computing as an integral element of the project. The project team undertook to create DTDs (Document Type Definitions—a description of the tag set used) that could encode both structural and semantic features of the documents. They note that there were overlaps in such definitions, and also that such definitions were arbitrary. The DTDs they used were also restricted by their goal of using a tag set that was both structurally and semantically rich enough to encode the documents, and also was simple enough that it could be learned and used by researchers in a short time. They credit the TEI with establishing basic structural principles that they then modified. Instead of seeing the hierarchical structure imposed by SGML as a straitjacket, they used it to their benefit, creating hierarchies of tags that would guide the researcher in their tagging by establishing a context: "taggers knew that they should only use the *cause* element in the context of *death*, not *wealth* or *childlessness*" (279).

Through the practice of markup, our notions of text are deeply interrogated. The challenges of representing text electronically become opportunities to make explicit our theories of text. This brings scholars together to establish new areas and new collaborations for research. Brown et al note that:

> instead of a single researcher needing to communicate effectively and clearly with one or more research assistants, we have a research collective that together has had to develop a shared view of the project's research aims. . . . We are continually forced, in ways both frustrating and beneficial, to articulate our various assumptions about our purpose, our methods, our theoretical frameworks (283).

Mylonas and Renear, in "The Text Encoding Initiative at 10: Not Just an Interchange Format Anymore—But a New Research Community" point out that "an entire research community is flourishing now that did not exist at all before 1987. . . . The subject matter of this new community is textual communication, with the principal goal of improving our general theoretical understanding of textual representation" (7). They describe the TEI's goal of "the development of an interchange language for textual data" as "completely successful" and note that "the TEI Guidelines are now widely accepted as the standard interchange format for textual data" (1). They point out how developments for one discipline can affect others: "it seems likely that in a year or so, when anyone follows a link—whether to look at medical x-rays, buy an appliance, or watch a rock video— they will be using protocols, namely XML's XPointer and XLink, based directly on techniques developed by the TEI" (7). XML is becoming enormously popular, and may become a de facto standard of data representation.

Part of the success of the TEI is that it has proceeded both on the basis of theory and practice, along the lines of what Willard McCarty describes as "experimental knowledge-making." In "Humanities Computing: Essential Problems, Experimental Practice", McCarty argues that humanities computing "does not wait on a theoretical formulation of what humanists do, [but] rather should look to the tradition of experimental knowledge-making" that has been described in recent years by philosophers and historians of science such as Hacking and Galison. McCarty notes that "when humanities research is computerized the source materials become *data*" (104). This reconception of the source files requires that choices be made which will determine what is represented on the computer, and how it will be represented. Such choices interrogate our notions of both source materials and scholarly apparatus. The choice of what does not get represented is as informative as what does. We can ask why it does not: is such-and-such not important to the text? Does it not constitute a part of it that we wish to study? If not, why not? The other consideration in what gets represented is a technical one: how can we represent such-and-such on a computer? Such a representation always involves a translation of some sort—a translation of the physical to the digital. Different means of representation privilege different readings of the text.

I have developed two applications that illustrate the potential of markup. The first, called BiblioX, is a bibliographic cross-reference tool. It reads a file of XML-encoded bibliographic entries, and allows the user to locate other entries that are written by the same author, or that have keywords in common with the entry selected. The user can also choose to view a list of other entries that have all or any keywords in common with the selected entries.

Figure 4-1. BiblioX screen.

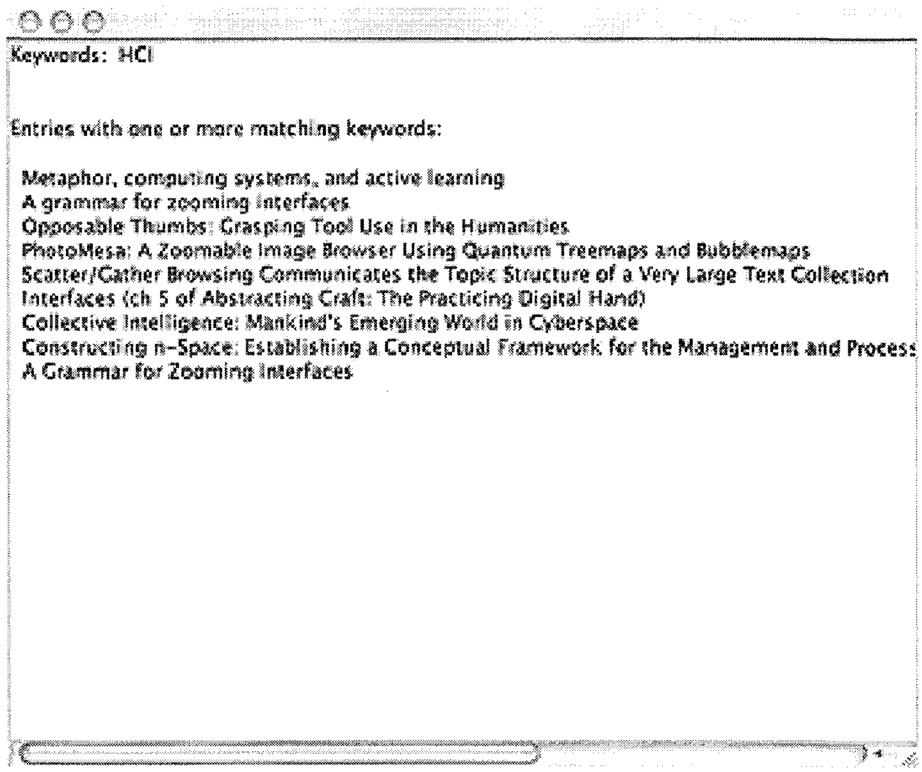
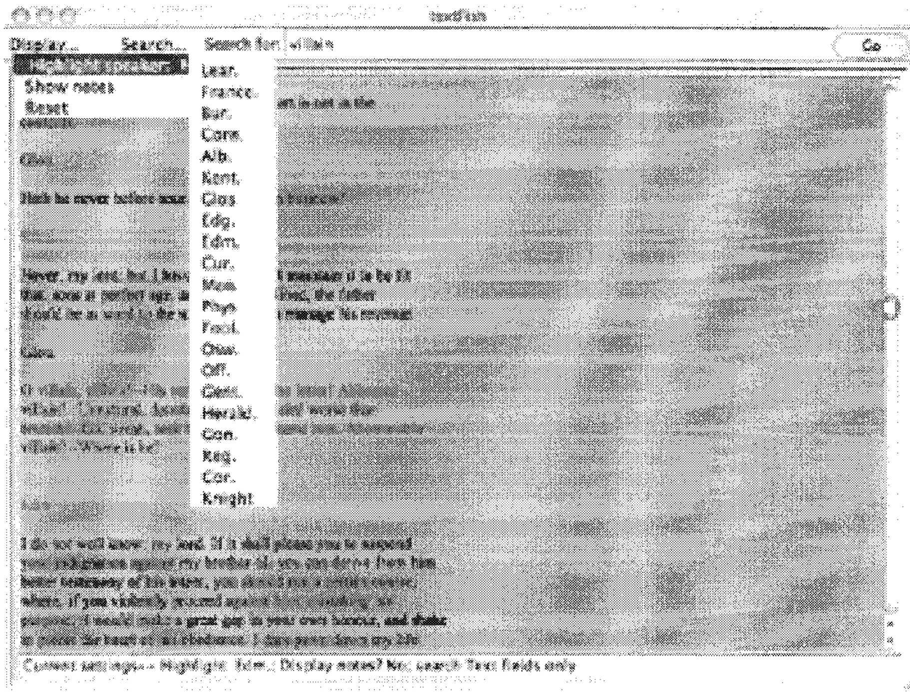


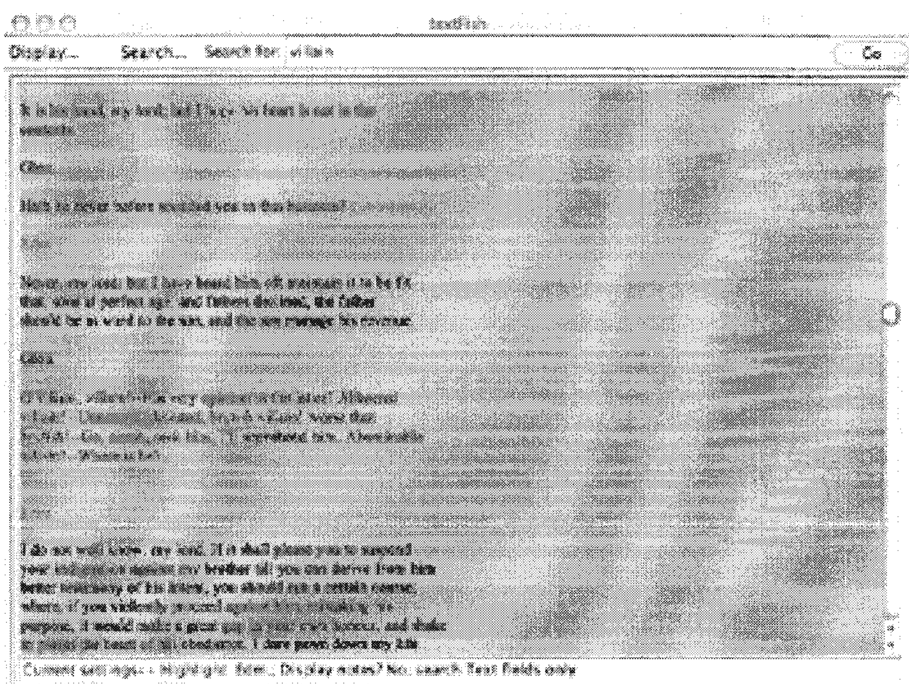
Figure 4-2. BiblioX search results screen.

Because the entries are coded in XML, the display can be dynamically changed based on the encoded data.

The second application is called TextFish. It reads an XML-coded document of a drama, and uses XSLT to dynamically transform the display. The user can choose to highlight any character's speeches from a list of characters that is dynamically generated from the text itself. Notes can be viewed as well, and searches done on either the text or the notes (or both) for text strings. A status line on the bottom of the display shows the current status of parameters such as whether notes are shown and what character's speeches are outlined.



Figures 4-3 (above) and 4-4 (below). TextFish .



Both BilioX and TextFish offer a glimpse of the potential that representational methods can give us. Once a document is encoded, a variety of applications can be written and used to explore that document. The search capability is one such example: in the case of TextFish, searches can be limited to search only the actual text of the play, or only the notes, or both. It is possible to extend this capability without a great deal of work: searches could be limited to only certain characters, or scenes or acts. BiblioX and TextFish both use very simple, menu-driven interfaces. These interfaces have some advantages in that most users are familiar with them and they can be very explicit as to the operations they show.

Text markup has had remarkable success as a method of encoding semantic data that can be dynamically presented. Its success has brought about other challenges: as more and more texts are available electronically, the researcher is faced with the problem of sifting through this material. Given the vast amount of material available electronically, how does one make one's way through it? To navigate this sea of information without drowning in it is the challenge facing the researcher.

Visualization offers great potential for navigating these vast amounts of information. However, the problems and issues mentioned above are also applicable in the case of visualization. To make a document, a web page, or a database "visible" means that it must be presented in such a way that a researcher will come across it. All of this information needs to be both marked (for content) and presented.

Groxis's Grokker is a visualization tool that groups search engine results visually. Search results are presented as a map where geometric shapes (the user can choose squares or circles) indicate categories. Each category is further subdivided into subcategories.

Grokker shows all results on one screen, and the user can zoom in, choosing categories of interest. Unwanted results can be filtered out. Grokker uses XML as the source for its maps, and allows the user to feed their own XML source into the Grokker engine to create a visual display. However, Grokker groups its results into exclusive categories. Essentially, it is a hierarchical structure imposed on the search results. While the visualization it offers us can be a valuable tool, we need to pay attention to the way that categorization is done, and how groups do not overlap. The challenge to such tools is to present results in ways that allow categories to overlap, and results to appear in multiple categories simultaneously.

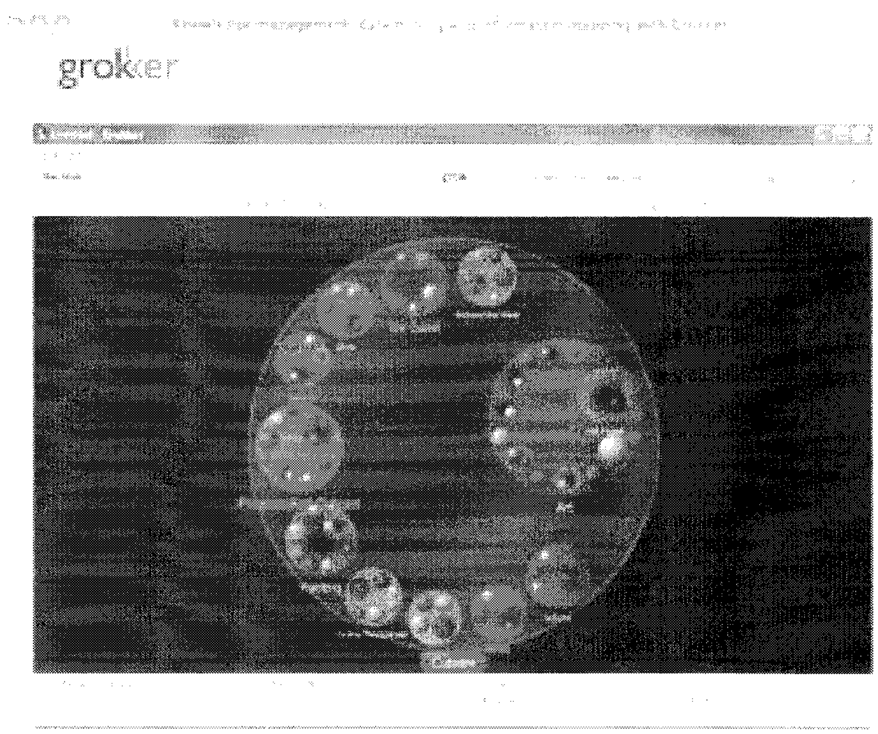
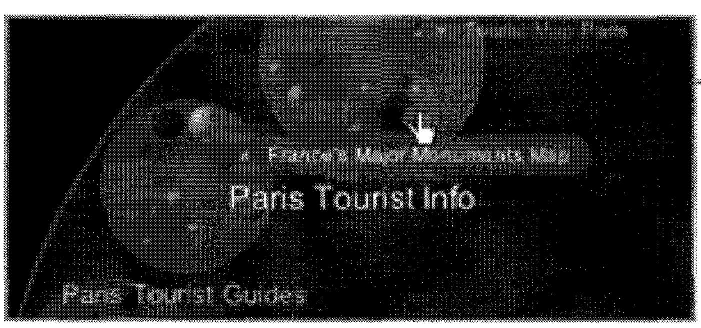


Figure 4-5. Grokker search results screen.

Figures 4-6 (above) and 4-7 (below). Grokker search details.



^ The Grokker2 application.
< A slice of the Grokker map.

In this section, I have noted how markup faces issues of encoding that are similar to those faced by visualization. I have looked at how the Orlando project has addressed these issues. I have noted how these issues arise from the physical and semantic representations that we wish to encode, and how structure plays a large part in the presentation of results. In the next section, I will explore structure and physicality in further detail.

5. Doing

To be is to do - Sartre
To do is to be - Descartes
Do be do be do - Sinatra
—graffito

In this section, I will look at how the practice of visualization involves us in the world.

In his paper "Literary and Mechanical Thinking," Willard McCarty distinguishes between what he calls *textual engineering* and *textual science*. Textual engineering, in his terms, is aimed at producing a practical device, such as a database of textual information. Textual science aims at producing knowledge. He notes that:

> although the practical goal of commanding more textual detail is important, the primary contribution of the computer to literary studies is not so much to amass new facts as to reveal the difference between facts and knowledge. The more a text relies on our imaginative involvement, the wider the gulf between the data as such and what we have in our minds once we have read the text through. . . . Mental recall, even perception of the text on re-reading it, are thus crucially different from engineered retrieval, which relentlessly yields only the data.

Computers offer us near-instantaneous retrieval, indexing, and searching of text, yet as McCarty has stated, computer-based text does not give us knowledge. One means by which computers may help us gain new knowledge of texts is through the building of visualizations.

In The Real World of Technology, Ursula M. Franklin observes that "from the invention of writing to the use of the Internet, the way in which knowledge is kept, transmitted, or shared has structured the perception of what is real, as well as what is possible or desirable" (viii). Through visualization, we can literally see the structure of that reality. As Franklin notes, "the technology of doing something defines the activity itself, and, by doing so, precludes the emergence of other ways of doing 'it,' whatever 'it' might be" (9). If we limit the way we use our technology (and writing is certainly one of those technologies), we limit our realities. Visualization can extend the possibilities for interpretation and study, and it can aid the researcher in making connections as well as distinctions.

Franklin distinguishes between two types of technologies: prescriptive and holistic (10). Prescriptive technologies are associated with a division of labour, of an alienation from the whole, and particularly with political compliance. Franklin notes how prescriptive technologies "eliminate the occasions for decision-making and judgement in general and especially for the making of *principled* decisions. Any goal of the technology is incorporated *a priori* in the design and is not negotiable" (18). As we have seen, such technologies are manifestly with us, from word processors, to hyperlinked web sites, to text markup schemes. However, by being aware of the prescriptive nature of such technologies, we can compensate for their limits.

Holistic technologies are associated with craft, where a person working with technology is typically involved with the entire work from start to finish. Interpretation as a function of literary study is typically done holistically; even though the task may be composed of many subtasks, it is done by a single person who controls the process from start to finish, continually making decisions along the way. Research is a craft that shapes interpretation and knowledge.

A researcher wishing to maintain an holistic approach is faced with the problem of being able to analyze and synthesize simultaneously. Analytical operations seize upon individual elements within the whole, often isolating them for analysis, and the researcher is then faced with the task of considering the interrelationships between the elements, for each of these operates within a context, is part of that context, and affects the entire system. The experienced researcher knows the dangers of isolating single elements without considering the context. And part of that context is the researcher's own experience, their own knowledge of their craft.

Craft is the conscious shaping of an object. It requires an awareness of one's self, of the object at hand, and of the possibilities presented by the world at large. Craft is wide ranging, from carving wood to writing an essay. It is both concrete and abstract. It requires an assessment of the environment, an ability to project forward in time, a keen sense of the practical and the possible. It requires a knowledge of self and object and the steps that must be taken to get to the imagined outcome from the present situation. It is a process of interaction with the world that is ever-changing because the act of perception depends on the observer, and the observer is part of the environment. Craft is one of the ways that we come to a deeper understanding of our world. It is an involved, participatory method of investigation and interpretation.

By paying attention to the visual aspects of objects we can see them in new light, and become involved with them in new ways. We discover new possibilities for the object at hand. In the following, I will focus my attention on objects that are so familiar in literary studies that they are overlooked: books. This return to the physical form of the text will show how technology shapes and forms our experience with the world. Above, I discussed ways that the computer can aid literary studies through incorporating visualization into the presentation of texts and information. By paying attention to the visual aspects of books, the various physical, graphic, and typographic components of the book become apparent, and we see how our interaction with those elements helps us to create meaning from the experience of reading.

In Critique of Information, Scott Lash writes that "phenomenological enquiry makes sense of the world less though 'intellection', but through what Husserl and Bergson called 'intuition'. We have knowledge, not through the abstraction of judgement, but through the immediacy of experience" (14). Every text, document, or corpus is a thing that we come to know through interaction. It may be possible to memorize a text, to think about it without a physical instantiation, but even such a 'version' of the text still requires the body. Such a text exists through the person who 'carries' it, and subsequently, ceases to exist when he dies. Even the conveyance of the text—if it is spoken—involves the person. The corpus is intimately involved with the body. We incorporate texts, transform them into something that is a part of ourselves. Lash writes: "intuition is more bodily and organic than intellection; experience more life-like ... than judgement. ... One knows, one imposes an order on things, not through judging and classifying from above. Knowledge instead comes through experience, 'below', in the same life-world with people and things" (14). It is through participation that we make meaning and come to knowledge. Too often, technology forces us into the procrustean bed where experience is denied us, where all choices have already been made, as we have seen in the case of strict hyperlinked spaces.

Franklin implicates technology in the separation of knowledge from experience to the degree that "the downgrading of [personal] experience ... is a very significant feature of the real world of technology" (32). Franklin counters that "it should be the experience that leads to a modification of knowledge, rather than abstract knowledge forcing people to perceive their experience as being unreal or wrong" (32).

Reading is a hands-on experience. The critical reader 'knows' her text with a familiarity that is born of the activity of reading, making notes, and looking up references. The practice of annotating a text is part of that experience. The reader is continually moving back and forth through the text and relating it to other texts she has read. The well-read book will have annotations throughout, ranging from pencilled notes, bits of paper serving as bookmarks, and the colourful bristling of stickies that decorate some readers' texts. We give life to the text in the process of reading, and each note we make, each reference, serves to make that text our own in the sense that it is our own reading of the text. Reading, whether in the narrow sense of reading a book or in the broadest sense that we are continually reading the world around us, is a highly conscious engagement with our world.

In A History of Reading, Alberto Manguel relates a story of anthropologist Claude Levi-Strauss among the Nambikwara Indians of Brazil:

> his hosts, seeing him write, took his pencil and drew squiggly lines in imitation of his letters and demanded that he "read" what they had written. The Nambikwara expected their scribbles to be as immediately significant to Levi-Strauss as those he drew himself. (67)

Over years of learning, we've come to interpret our own scribbles in certain ways. We "read" in many different senses; whether it is traffic lights, a play in a theatre, or the weather as we gaze out the window. All are learned. In our reading however, we read the words but not their form, forgetting that the presentation of a work—the typographic marks on the page—is already a visualization. We separate the message from the medium.

Book design and typography, historically ignored in interpretations of literature, need to be taken into account in approaches to literary interpretation, and become important elements in any consideration of visualization. However, we are often unaware of the graphic elements that work to bring a text to life. Lupton and Miller, in Design Writing Research, write that "spacing, framing, punctuation, type style, layout, and other nonphonetic structures of difference constitute the material interface of writing. Traditional literary and linguistic research overlooks such graphic forms, focusing instead on the Word as the center of communication" (23).

Texts are presented through typography. The graphic elements already present in our reading have, through convention, acquired certain properties. Italics are used for emphasis, indentation indicates the start of a paragraph. Blank lines or wingdings are used to create sections. Other devices give the reader cues as to the navigation of the document. The graphic devices that present a text form a visual context in which reading takes place.

Like metaphors and other figures of speech, typographic conventions are so common that we lose sight of the fact that they are conventions. In The Elements of Typographic Style, Robert Bringhurst remarks that "typography must often draw attention to itself before it will be read. Yet in order to be read, it must relinquish the attention it has drawn" (17). The elements which constitute a book or journal itself, such as running heads, tables of contents, and page numbers, are all graphic elements. These parts of the document enable us to navigate the object that we have in our hands. Such elements are so common that they become invisible. As Bringhurst so aptly puts it, they "aspire to a kind of statuesque transparency" (17). It is only in the case of their absence, or their misuse, that we notice them.

Johanna Drucker, in her essay "The Virtual Codex from Page Space to E-space" sees the book—the codex form—not as a static structure, but instead as a formal structure that makes possible dynamic relations. She makes a distinction between "the literal book—that familiar icon of bound pages in finite, fixed sequence—and the phenomenal book—the complex production of meaning that arises from dynamic interaction with the literal work". This distinction between the literal and the phenomenal book informs Drucker's approach to books: "[t]hus, in thinking of a book, whether literal or virtual, we should paraphrase Heinz von Foerster, one of the founding figures of cognitive science, and ask 'how' a book 'does' its particular actions, rather than 'what' a book 'is'".

How a book does its particular actions is intimately related to the physical construction of the book. By becoming aware of the many graphic elements that make up a text, we become aware of how a text is a designed document. As Drucker notes: "the visual hierarchy and use of space and color don't simply reference or reflect the existing hierarchy in a text, they make it, producing the structure through the graphical performance" The design of the text (both the document and the words and marks that comprise it) affects our interpretation of that text. Design also affects the interpenetration of text and reader. If we bring a text into the electronic realm, that is, put our text on a computer, we find we can quickly and easily change its visual presentation. Word processors and browsers make apparent the graphic elements that present the text to us. Working with a text on a computer, we become the typesetter, the printer, and the designer. We become acutely aware of the restrictions that a computer places on the ways in which we represent the text.

The many physical aspects of books are often ignored when texts are remediated into electronic versions. We need to re-examine the book in light of this knowledge so we can determine how the physical form of the book affects our reading of it. We must limit and filter certain aspects of our text in order to present it. We must impose a structure on it. We need at times to make the structure invisible, but more important is that we always keep in mind that the structure has within it certain presumptions, biases, and preconceptions. We are in effect constructing a model of the text on the computer. Goodman reminds us that models are not copies of an object or of an interpretation, but are representations that we *achieve* (9). By being aware of what we model, and how we construct/achieve it, we can make structure work *for* us. In Figuring the Word, Johanna Drucker argues that

> Structure can work as instruction, as program, as transformation. . . . The visual IS a performative dimension: it makes the text, makes meaning in its embodiments, as form/expression/enunciation. Ultimately it's not only that the visual/image/icon/event performs on the stage/theatre/arena of the page but that it makes/is made/be's/becomes through the graphic and visual means. (108)

We can use structure to make visible the transformations that we are doing in order to perform the act of representation.

It is to be emphasized that visualization is a *process*, and that it is the *activity* of visualization that is the main generative element. The visual itself is not meant to stand in for the text, rather, it is the making of the visual that is the goal. In "Literary and Mechanical Thinking," Willard McCarty suggests:

> that we adopt what American physicists charmingly call "tinkertoy modeling". Typically, like us, they are faced with a reality they can neither observe nor manipulate directly. . . . To learn more about this reality, to harness it, they work with current theory to construct a working idea, or

> model, of what the reality might be like. The model is not assumed to be true; quite the contrary, it is known in an absolute sense to be false. . . . A crude model knowingly used in this way is called, then, a "tinkertoy" model . . . Tinkertoy modeling is a useful notion for computer-assisted literary study because it names the recognition of how crude our tools are, identifies the experimental nature of our work, and points to its essential reliance on externalized ideas and methods. Furthermore, the term suggests the ludic quality often characteristic of pure research, which relies crucially on insight from beyond the walls of what we think we know.

McCarty's points on the rough, experimental, externalized nature of modeling are well taken, as is the ludic aspect of modeling. Out of such crude play may emerge unforeseen insights. Visualization is also a hands-on approach and as such encourages the modeler to engage with the text in new ways, to 'see' the text from new perspectives. Mary Keeler, in "The Place of Images in a World of Text," suggests that "pragmatic methodology could be the truly humanist approach to computing needed to advance beyond the current text-based, technology-driven mode of development" (76).

TextEye is a computer application that I have written to explore text visualization. It presents multiple views of a dramatic text, giving the user views that range from a prospect view of the entire text on a single screen to a detail view of a passage from a scene. The prospect view is presented in microtext, but allows the user to see the "shape" of the drama. The user can choose to colour-code one or more character's speeches. This allows viewing of just where in the play a character is appearing, and where two characters interact. From the prospect view, the user can zoom into a view of an entire act (again in microtext), and from there, the user can choose a scene. The entire scene is shown in microtext along the left-hand side of the screen, and a detailed view of part of the screen is presented in the centre of the screen. The user can use the prospect views to locate characters and then zoom in to see the context of particular scenes.

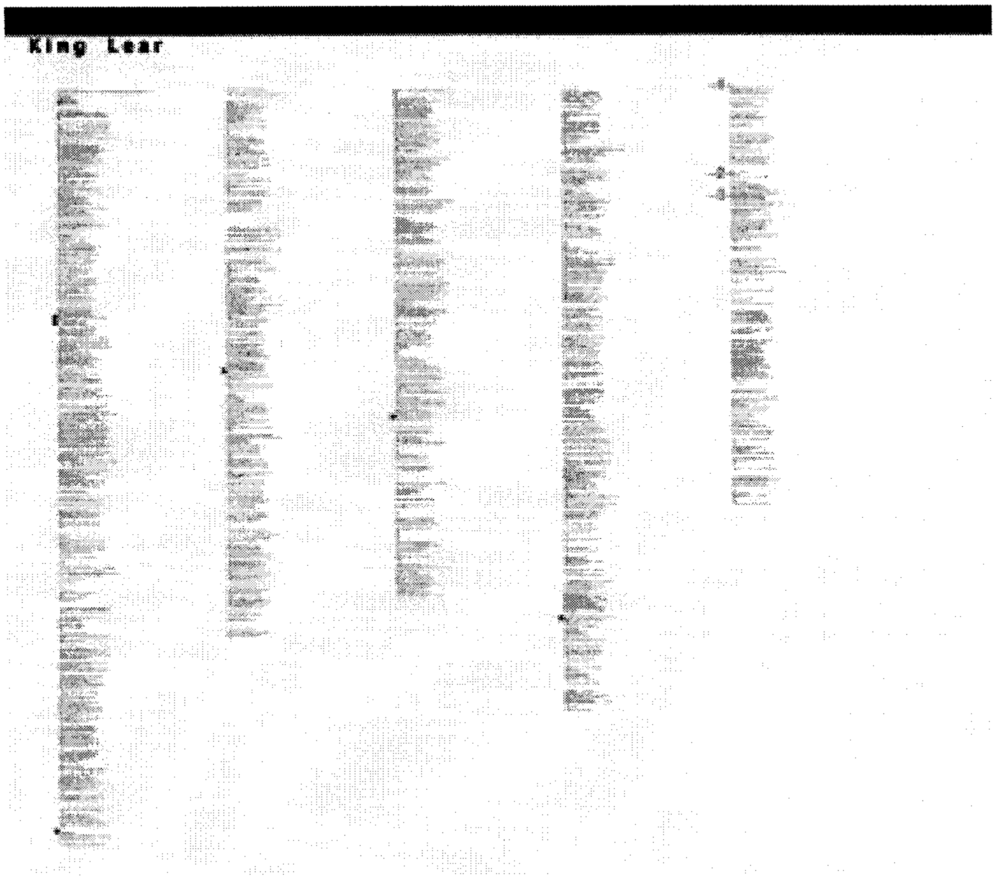


Figure 5-1: TextEye prospect screen (shown in inverse)

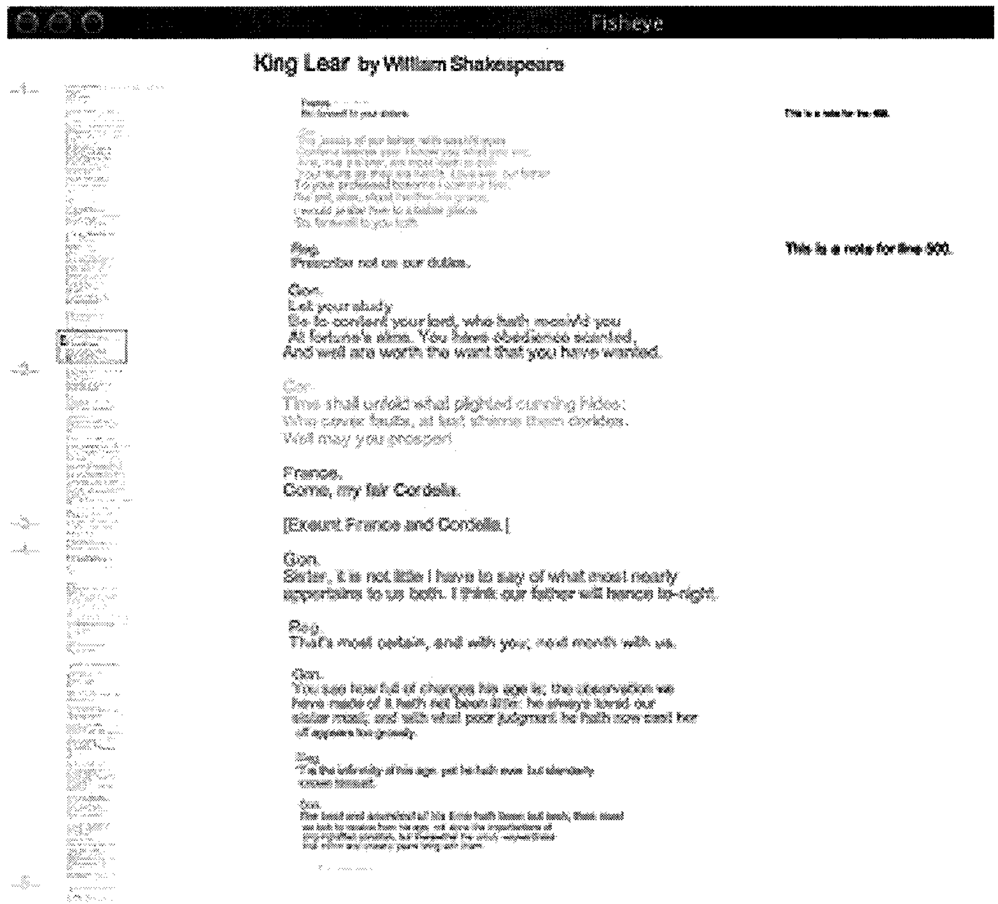


Figure 5-2. TextEye detail view, with microtext, scene numbers, and the selected scene on the left.

Microtext, such as that used in the TextEye application, changes our view of the text. It immediately calls our attention to the *image* of the text. It cannot be read as text and so we see it in a different way. It takes a shape, a form on the screen or page, that represents the text proper. It reminds us that the readable text is an image, has shape and other attributes that determine the form it will take. When we read a book, we remember that a certain passage was "on the right hand side near the top, about a quarter of the way through." Text *is* image. To present text, we must represent it.

The computer provides an electronic printing press, a typographic canvas for us to present and represent our text. That space allows us to present the text while at the same time restricts the ways in which we do so. With the computer, we can do marvellous things with texts and documents that would be time-consuming and painstaking to do otherwise. We are offered a space of vast potential, a place where mistakes can be rectified with the touch of a key, a space that invites us to play. In her essay "Design and the Play Instinct," Jessica Helfand describes the designer's interaction with the computer: "We make mistakes. We experiment. We play. We take the sorts of risks we might not take were we not in the presence of a computer" (9). We can take this idea of a play-space and extend it: as well as manipulating text, what else might we manipulate in such a space? Why not manipulate ideas, connections, notes, even our physical view of the text itself? We can envision this space as a blackboard, a sandbox, a tinkertoy set; a tool for experimentation, for modelling ideas, a place where we can make mistakes, experiment, and play. We can make connections and model relationships. We can sort and group and colour-code. Not only with text, but with our annotations and interpretations. The computer offers a medium to make such a space possible. However, it is not without drawbacks. As much as it seems to offer us, the computer still imposes limitations that we must fit into. Helfand describes both the pleasure and the risks of designing on the computer: "In the best of circumstances, the play instinct leads us toward improvisation. . . . In the worst of circumstances, we stop thinking" (10). This trade-off between promise and limitation is always present when working with technology. We shouldn't forget that the printing press is a technology as well, as is writing itself. As McLuhan has said, "We shape our tools, thereafter our tools shape us."

Tools are a part of us and our world. Each tool has its functions and limits. There are a myriad of tools that we have developed, including the computer. The computer is a tool, just as a knife is. More complex, but still a tool. One of the fundamental ways in which our use of tools changes our being-in-the-world is through affordances. Having a tool to hand changes our view; we now see our environment as something that can be manipulated with the use of our tools. As Franklin notes, "any task tends to be structured by the available tools" (49). This not-so-subtle change is accompanied by the subtler but profound idea that our world can be changed. Our environment is now refracted through technology and we see it as a place of possibilities. Our knowledge of the environment is intimately tied to the activities we can perform in that environment. Keeler notes that "Gibson says the information to specify an affordance points in two ways: 'to the environment and the observer ... information to specify the utilities of the environment is accompanied by information to specify the observer himself'" (83). The computer tools for textual representation, manipulation, and analysis invite an awareness of the physical aspects of text and of how representations afford interpretations.

In her essay "Against Interpretation," Susan Sontag notes how Western interpretations of art as representation have given rise to "the odd vision by which something we have learned to call 'form' is separated off from something we have learned to call 'content,' and to the well-intentioned move which makes content essential and form accessory" (4). The conception of form as accessory is unfortunately present in many visualizations. It has also been present historically in many computer application designs, where the majority of effort is spent on simply "making it work," and once this task is accomplished, the efforts of the application developers are directed elsewhere. Efforts to design an elegant or a simply usable interface to the application are seen as low-priority tasks to do if the schedule permits (which it usually doesn't).

The division between humans and technology is another false dichotomy. It misleads us into viewing technology as something apart from us, when technology is instead integral to our lives, part of what makes us human. If instead of dichotomizing, we embrace the technology—perhaps a better term might be 'admit' the technology—we can examine how our relationship with technology shapes our view of the world. Franklin notes that "technology defined as *practice* shows us the deep cultural link of technology, and it saves us from thinking that technology is the icing on the cake. Technology is part of the cake itself" (9). The tools and technologies we use include language and the technologies that are associated with communication, including e-mail, word processing, web sites, and databases. Most of these tools are text-based. Visual tools can help to restructure the task, opening up new possibilities that are simply not available with text-based tools. The introduction of Graphical User Interfaces (GUIs) opened personal computing up to millions of people. Without the point-and-click convenience of the mouse, personal computing would not exist to the extent it does today. The GUI frees the user from the explicit language formulations of the command line. It takes the burden off of the mental task of formulating the command and instead lets the hand guide the task.

What a visualization can offer, then, is both components and processes, and the way they interact. Their interaction will make for another important part of the process of visualization, the phenomenon of emergence. The basic concept of emergence is that simple objects and rules give rise to unpredictable degrees of complexity. In his book Emergence, John Holland states that "If the model is well conceived, it makes possible prediction and planning and it reveals new possibilities" (5). Working with a visualization tool offers great potential for emergence. A particular feature of emergent behavior is that it does not occur based on a predefined directive. Surprise is often its hallmark. An example of such a system is chess, where a bounded playing space and a small number of objects and rules give rise to very complex games. The phenomenon of complexity arises quickly in the study of literature. Words give rise to metaphors, irony and other tropes. Relationships between characters in the texts quickly become complicated.

Emergence happens in systems where the interactions between parts are as important as the parts themselves. It is a recursive phenomenon: as parts interact with one another to create emergent behavior, so those newly created 'systems' now interact to again create more complex systems that in turn interact to create ever more complex behavior. However, emergence does not mean continual surprise. Holland claims that "models, above all, make anticipation and prediction possible" (11).

There is a good degree of anticipation in the visualization process: building means thinking ahead. Prediction is a very important part of the process. If our visualization appears to radically depart from our expectations, we must ask ourselves why. Such divergence may be the result of emergence, and if so, it can open new areas of research. If not, we re-examine both our anticipations and the model itself to find an explanation for the divergence. This activity requires us to further articulate our assumptions.

The continual reconception of the visualization process engages the researcher with the text. Pauline E. Head, in Representation and Design, notes that "the process and product of interpretation reflect each other and then merge in their signification, so that neither can have a separate existence; this circularity perplexes a logic of binarism" (3). Although she is writing about the interpretation of Old English poetry, Head's words speak also to the process of visualization: "The interpreter of these poems must identify *with* the objects in order to identify them. . . . The reader is never offered a distant, stable position from which to observe the object of her or his perception" (3). Making a visualization requires *participation*: the modeler cannot stand back and observe, but must engage with the visual, engage *in* the visual. Walter Benjamin notes that "art demands concentration from the spectator . . . A man who concentrates before a work of art is absorbed by it" (239).

Bradford Paley's TextArc is a superb example of visualization. It represents a text by drawing it in microtext on a concentric spiral on the screen. Each word of the text is also drawn in the center, with brightness indicating more frequently used words. TextArc incorporates concordance features such as keyword in context and collocations. Most of all, TextArc is visually appealing. It invites users into a realm where exploration is encouraged, and supports exploration with tried and true text analysis tools. It is an academic tool as well as a work of art.

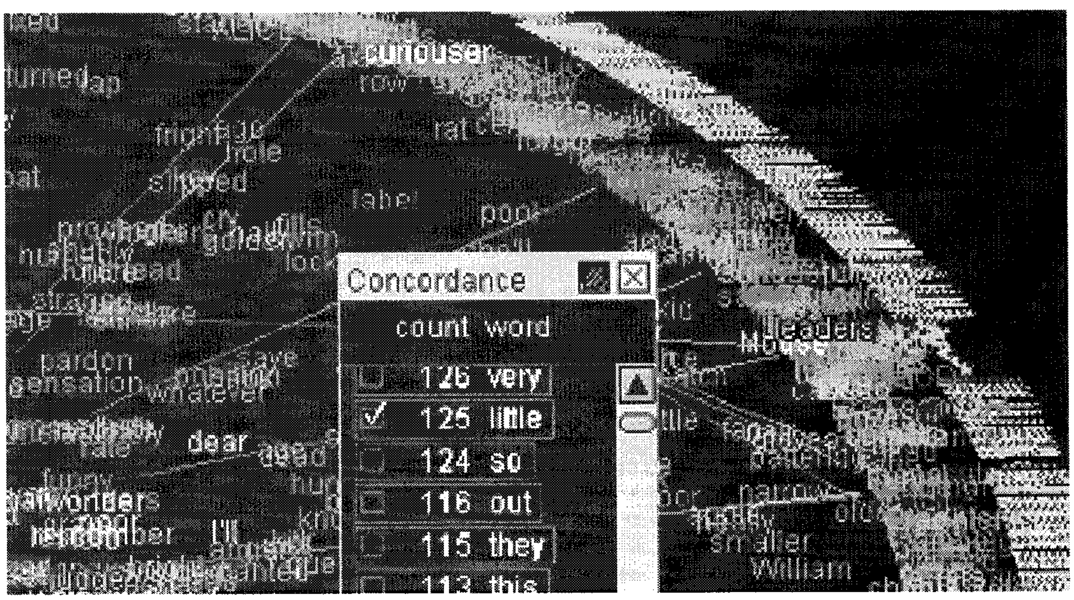


Figure 5-3. TextArc (detail).

Visualization is playful. To make a visualization with destination(s) in mind is to effect closure, to shut down the meaning-making process. The effort of visualization is not one of telos. Rather, it is the activity itself—the ludic process that I wish to stress. It is the continual play of reconception, and the activity itself, a jouissance, indeed, a *j'ouïs sens* of model– and meaning-making. The visual itself is fluid—it is the continual reconception of space, relationships, and of itself. This is space, time, relationship, folded back on itself while it simultaneously and continually redefines itself.

Two applications I have written are meant to engage the user with a playful reconception of text. Poemscape presents the text of a poem as a cityscape. It literally shows the shape of the poem, and also lets the user interact with the shape. FontFun presents the text of a poem where each word is presented in a random font size. The user can change the font and re-present the poem at the click of the mouse. Both of these applications are meant to engage the user with the text, to see how the physical aspects of text can affect meaning.

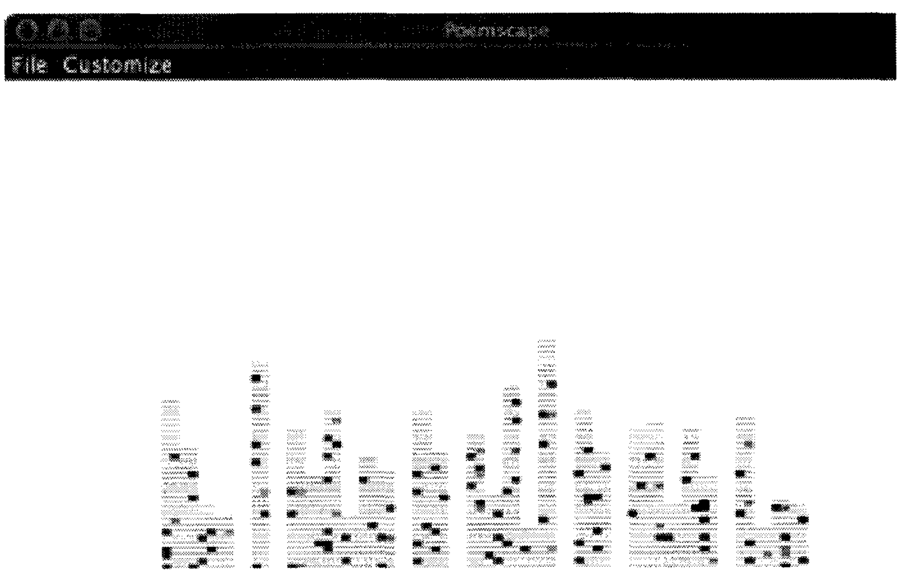
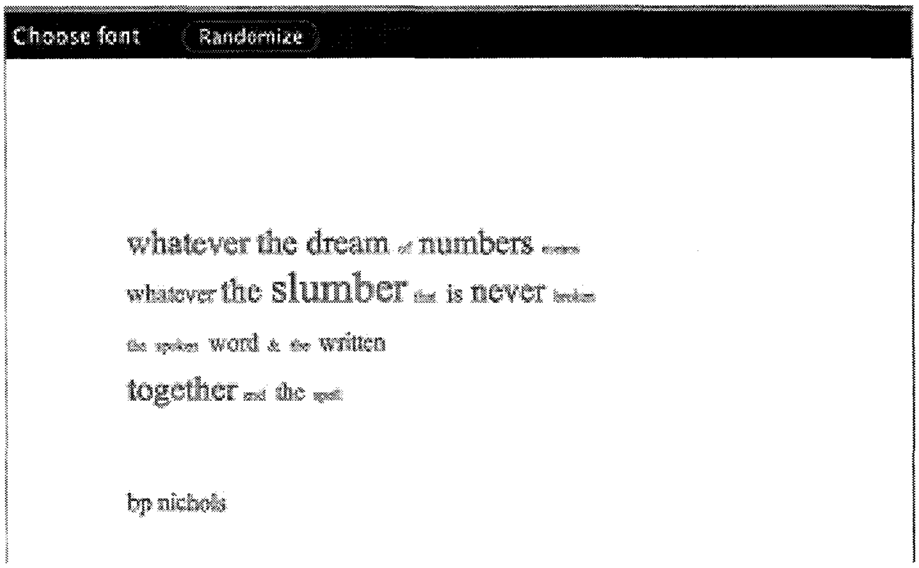
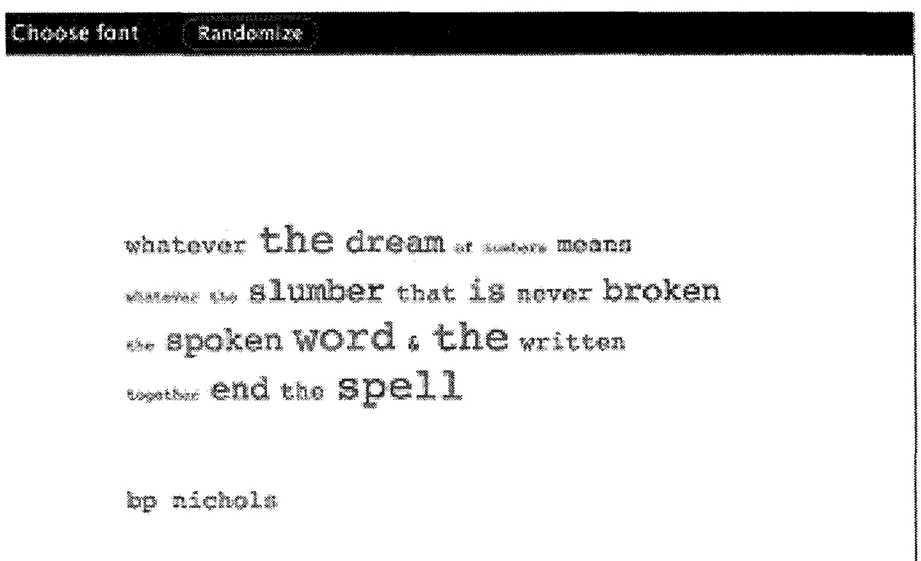


Figure 5-4. A Poemscape screen (shown in inverse).





Figures 5-5 and 5-6. Two FontFun screens.

In this section I have argued that craft involves us in the world, and that our technologies of representation are a form of craft and hence are a form of involvement with the world. I've noted how the separation of form from content discounts the visual aspects of forms such as the book, but to represent texts on computer, we must address these visual aspects and see the book as a designed object. I've noted how the tools we use give us affordances that change our view of our environment. This environment is shaped by our tools, but by being aware of how we use tools, we can shape an environment that offers opportunities to play and explore.

6. Conclusion

Always the more beautiful answer who asks the more beautiful question.
- e.e. cummings

In a recent talk given at the University of Alberta, Mary Louise Pratt spoke of Columbus's third voyage to what we now call the Americas. As he sailed between two land masses, a sample of the water his ship was in showed it to be fresh. He was miles out to sea; the presence of fresh water at his location meant that there must be a vast river that was producing it. Columbus, already very interested in seeking the Biblical Garden of Eden, convinced himself that he had come across one of the four rivers that purportedly flowed from it. By extrapolation, he reasoned that there must be a vast land mass that drained into to the river. However, he was so interested in discovering Eden that his reasoning excluded other possibilities. He came to the conclusion that the world was pear-shaped, with Eden at the top.

Columbus arrived at the correct answer; he just didn't choose it. As Pratt so aptly put it: "sometimes you look obvious truths and colossal error in the face and pick colossal error." Instead, he continued on with the paradigm that he was entrenched in, and set about explaining his discovery in terms of Ptolemaic and Biblical geographies and cosmologies. A few years later, Amerigo Vespucci made a similar voyage, but he sailed under a new paradigm, which, as it turns out, was the correct one. And which explains why we now live in the Americas and not the Columbias.

Pratt used this example to emphasize that many of the discoveries in the humanities are both inevitable and unpredictable, and that we can and still do get it dead wrong, just as in the days of Columbus and Vespucci. And today, as then, we must shift our contexts to see what has been apparent all along. Staying entrenched in a set of beliefs will not produce new knowledge. In his essay "The Validation of Continental Drift." Steven Jay Gould writes "new facts, collected in old ways under the guidance of old theories, rarely lead to any substantial revision of thought" (161). Hanging onto a set of convictions will not generate new knowledge.

The world is continually changing around us and insularity often means stagnation. By taking an interdisciplinary approach to research, we are continually offered fresh ideas and new perspectives. These perspectives (and the ideas that come with them) do not simply stream into our passive minds. We are continually incorporating, synthesizing, testing, and filtering ideas. An interdisciplinary approach to research offers a plethora of connections, new perspectives on them, and new ways of testing them.

Humanities computing is a fertile ground for the seeds of interdisciplinarity. The computer is a tool that may be used in a variety of ways. The computer's roots lie in science and mathematics, but humanities computing is open to whatever uses we can imagine. However, our imagination should not be confined to already proven uses of the computer, as calculator and symbol processor, but rather to how we want it to be. We should not have to fit the computer, but have it adapted to our uses.

Visual tools will help promote the use of computers to study literature. At a time when literature departments are shrinking, it is becoming urgent that the history, culture, morals, and ethics that are adjunct to the study of literature do not disappear as more students turn to short-term skills that promise employment. Ursula Franklin notes: "the logic of technology begins to overpower and displace other types of social logic, such as the logic of compassion or the logic of obligation, the logic of ecological survival or the logic of linkages into nature" (92). Computer literacy should not come at the expense of community and morality, but should instead be a way to embrace the values of a culture. Technology is a part our culture and our lives. We have the choice in how we use technology, and the choices we make will affect others. Promoting a variety of methods of approaching problems—including both linguistic and visual approaches—will promote both computer and cultural literacy.

I will conclude with a return to Janet Cardiff's *40-Part Motet*. In the installation, listeners can move physically through the space, and navigate the piece itself by their choice of where they stand, of how far away from a particular speaker or set of speakers they wish to be; of whose voice they wish to hear. The complexities of the piece are far more apparent than listening to it through headphones; one can physically separate the voices while at the same time never losing the effect of the whole. Cardiff's installation offers both a prospect "view" and a detailed view at the same time. If offers affordances that are not available on a stereo recording or even in a live performance. The effect is breathtaking. It is the intersection of art and information, of aesthetics and analysis. One is never sacrificed for the other.

Cardiff shows us how technology can be used to enhance a work; we can literally hear how the work is structured, we can separate components from one another without losing the impact of the whole. Cardiff presents the space for interpretation; the choices to be made are left to the listener. The installation is also an *experience*: the listener wanders throughout the space of the installation, exploring, playing, becoming part of the music itself. I witnessed tears running down cheeks at the sheer beauty of this piece, people standing in the center of the room, head thrown back and arms outstretched, lost in the music. The installation engaged the listener, opened them, gave them the opportunity to experience this music in a deeply personal way. All through technology.

Critics accuse technology of alienating us, but it need not do so. By addressing the human factor, by affording opportunities rather than restricting actions, technology can engage us, and offer experiences we could not otherwise have. Visualizations are one way of doing this.

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Figs. 1-1 & 1.2. Population by Country and Energy Use by Country from Smith, Dan. The State of the World Atlas: New Revised Sixth Edition. London: Penguin 1999. p. 14-15 & 96-97.

Fig 1-3. Magritte's "The Treason of Images" (1928-29), from "Ouevres de Magritte" <http://dubhe.free.fr/gpeint/magritte6.html> 2004 June 15.

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Figs. 2-3 & 2-4 Burrows's Graph 1 & 11 from Burrows, J.F. Computation Into Criticism: A Study of Jane Austen's Novels and an Experiment in Method. Oxford: Clarendon Press, 1987. p. 5 & 83.

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Fig. 4-5 Grokker search results screen and 4-6 & 4-7 Grokker search details from Grokker. 2004 June 22. <http://www.grokker.com/>.

Fig. 5-3 TextArc (detail) from TextArc. 2004 July 3. <http://www.textarc.org/>.

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