Seeing the Trees in the Forest: Teaching Literature with Data Visualization Techniques

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Abstract

While recent scholarship examined the use of hypertext and other technologies for the teaching of writing, it has rarely taken up the study of conventional linear textual modes—the kind of literature still most frequently studied in college classrooms across the globe. Literary texts are often seen by students as complex, overwhelming, and emphatically closed systems. What practical methods exist for generating the kind of close, self-aware, deliberate literary analysis we want to see from our students? How can we help students see the trees, as it were, within the forest? This essay draws on a variety of freely available electronic tools for data visualization, a set of methods using computers visually to represent abstract data, to model an approach to teaching a sample survey text, Eliza Haywood's Fantomina; or, Love in a Maze (1725). By providing a skills-based handhold on complex textual systems, such technologies can help students attend more closely to the details of the text, its nuances, and its patterns of imagery, motif, symbol, and discourse.

As an instructor of college literature, primarily teaching in the early modern and eighteenth-century periods, I struggle with the typical classroom dilemmas of inspiring engagement and enabling analysis. Part of the difficulty of teaching much literature, particularly early texts, is the obstacle of relevance, the assumption that, because this text is so old, it has no relevance for one's life. A companion obstacle involves analytical engagement, and this is a hurdle that instructors of all forms of literature routinely encounter—how do I say something original,

accurate, challenging, and analytically provocative about a text that is already hard to understand on the basic levels of discourse and plot? Each instructor provides the necessary historical and cultural context to help students see the relevance of the piece, but the question of individual analysis is always before us; often, the two questions are intertwined. The curse of perceived irrelevance, that is, is a function of analytical ability. How do we enable students with little previous exposure to literary analysis, much less analysis of old texts, long texts, or texts exempted from the Shakespearean Aura, to feel as though they can not only see something in a text on their own but also say something original about it? What practical methods exist for generating the kind of close, self-aware, deliberate literary analysis we want to see from our students? How can we help students see the trees, as it were, within the forest?

Data Visualization and the Study of Literature

After Marshall McLuhan and Walter Ong, it is difficult for scholars to think of written expression without at least a glance toward its technological nature, its function as a complex instrument both enabling and extending our control over the world around us. Much recent scholarship examining the use of hypertext and other technologies for the teaching of writing emerges from the changing nature of text itself in a world that is increasingly aware of the material constructedness of culture (Anson 1999; Stroupe 2000; Smith 1986; Hawisher and Selfe 1991). This work, however, has rarely taken up the study of conventional linear textual modes—the kind of literature still most frequently studied in college classrooms across the globe. George Landow (2006) would term this form of literature a single "lexia" or block of text, as opposed to a hypertext, which is a structure composed of multiple lexias linked together in nonlinear ways (Landow 1997).

Most recently, work in the digital humanities and humanities computing provide an important starting place. According to Tito Orlandi (2002), the digital humanities are a set of theories and practices "centered on the mediation of thought by the machine." However, as David Hoover points out in "The End of the Irrelevant Text: Electronic Texts, Linguistics, and Literary Theory" (2007), the upsurge in accessible electronic

texts, a fact that bodes well for the readers and scholars of all forms, has sadly occurred simultaneously with an emphasis on theory in linguistics and literary study. This coincidence Hoover sees as "unfortunat[e]" for humanities computing because modern linguistics and literary theory both "tend to deny the legitimacy of text-analysis and stylistics. They de-emphasize the close study of texts and cast doubt on its significance and centrality" (p. 1). If we do not want literary study to become increasingly disengaged from the concrete, then we must find ways to enable students' ability to see, understand, analyze, and ultimately control the concrete. We still, after all, require that evidence be given in support of a thesis, regardless of the discipline. Ultimately, close literary study fosters logical thought through the perception and analysis of patterns. Humanities computing can introduce literature to students either wary of or uninterested in it by providing a skills-based handhold on complex texts as systems. Technology can help students attend more closely to the details of the text, its nuances, and its patterns of imagery, motif, symbol, and discourse.

Today, one of the most powerful sets of tools for this kind of enabled analysis works within a medium our students are already intimately familiar with—the Internet. Building on this existing facility and familiarity, teachers with virtually any amount of technological skill, even minimal skill, can enhance students' level of textual analysis with some accessible techniques of data visualization. Also known as information imaging; scientific, educational, or knowledge visualization; data mapping; and informational aesthetics, data visualization refers to the selection, transformation, and representation of "abstract data in a form that facilitates human interaction for exploration and understanding" ("Data Visualization"). Charts and models are familiar tools of data visualization, examples of which have been updated for post-modern media. Recent web projects based on data visualization technologies include static and dynamic news and web aggregators, reference and linking visualizations, and a variety of other specific data source visualizations like tag and text clouds (Howe 2008). While such technologies are traditionally used in mathematics and other "hard science" disciplines, web-based visualizations are becoming increasingly accessible to users interested in traditional text analysis; we

might speculate that this interest derives from the dynamic, hypertextual nature of the web and its lexia, the fundamental intertextual nature of the digital environment. If we believe that literary texts are complex structures that contain patterns, and that it is the job of the literary critic to apprehend and interpret those patterns as they illuminate larger contextual, textual, or cultural systems, then the utility of data visualization tools becomes immediately clear. After all, emphasizing the systematicity of any given text is a primary role of the instructor of literature: when we define plot, we identify a system; when we articulate theme, we identify a system; when we trace motifs and images, we identify systems. Let us take the example of Eliza Haywood's prose fiction, Fantomina; or, Love in a Maze. While I take Fantomina as a point of entry, these techniques are highly portable and can be used effectively on long poems, novels, and other electronic texts.

Over the past thirty years, partially as a result of revisionist approaches to the canon and the concept of canonicity, scholars have been increasingly interested in teaching the vast repository of texts that lost the wars of cultural and literary authority (Flannery 2005). Haywood's work suggests not only a popular "other" to the conventional narrative of Augustan literature, but also a distinctly gendered "other." By teaching Haywood alongside Alexander Pope, Jonathan Swift, Henry Fielding, and other canonical authors, we can present students with a clearly different perspective—one that may, in fact, seem more contemporary to many students, or at least more accessible. Haywood participated extensively in the theater, which informed her work in prose, and she also wrote essays and fiction that are invested in making visible the varieties of female experience in the early modern world. On a practical level, Haywood's text is comparable to a short story, a prose fiction brief enough to cover in one class meeting; this renders it formally more accessible to students, as well. The techniques described below, however, are applicable to virtually any text that might be taught in college literature classrooms.

Haywood's fiction tells the story of a young woman of noble birth and means who is left much to her own devices in London, her mother being abroad for the duration. The young woman is nameless, though she adopts a variety of different

names to suit the disguises she takes—the name "Fantomina" is one of several in the story, and it suits the character's protean, phantasmic identity. Her curiosity about physical, embodied experience leads her repeatedly to seduce and be seduced by a man named Beauplaisir; in one sense, her experimentation is a clear reworking of masculine codes of conduct, both social and scientific (Craft 1991). The story is at once a narrative of her sexual experimentation and the learning curve that comes with it. But it is also a story about the fluidity of gender roles and the performative quality of identity. Beauplaisir proves a fickle lover, and Fantomina takes on a number of different identities to maintain his sexual interest—ultimately learning that, while she can act on her desire, it must be masked in a variety of ways and the act of desiring, like the act of masquerading, has consequences (Croskery 2000). When her mother appears, Fantomina's growing pregnancy is revealed; she goes into labor, fittingly, at a masquerade ball. Beauplaisir is named the father of the child, but learning that the many young women he encountered were in fact iterations of one, he refuses to acknowledge his fatherhood. Fantomina, caught in a web of double standards, is packed off to a monastery after giving birth in disgrace, where "thus ended an Intreague, which, considering the Time it lasted, was as full of Variety as any, perhaps, that many Ages has produced" (p. 71).

Fantomina; or, Love in a Maze, is a useful text to teach in a survey class for a number of reasons. Not only does it present students with a much different picture of female sexual desire in the early modern period, but it also illuminates the period's popular tastes. Further, it gives students a point of reference when reading the works of other, more traditionally canonical authors. In a survey class, it is often impossible to teach the "rise of the novel" by reading an actual novel, so shorter amatory fiction like that of Aphra Behn or Haywood becomes necessary—while also exemplifying the biases inherent in that master narrative. Finally, Fantomina works with clearly definable questions, images, and textual patterns, and it is—perhaps most significantly—interesting to a good cross-section of students.

Seeing the Trees in the Forest: Text and Tag Clouds

A useful, accessible tool for simple data visualization is the text or tag cloud. Most students will be familiar with the related concept of tag clouds if they browse the web with any regularity. Tags—also called labels—are short, usually one-word personalized descriptions of any given resource, which can then be used as an index to the site or a method for organizing quantities of material. An example of this is the social bookmarking site del.icio.us, which allows users to share their tagged bookmarks with Internet users the world over. A browser interested in one link described with an interesting tag can search for other links described with the same or similar tags, leading to new information; as del.icio.us notes, "[t]his is great for organizing and finding personal data, but it goes even further when someone else posts related content using the same tags. You begin building a collaborative repository of related information, driven by personal interests and creative organization" ("What are Tags?"). The process is flexible and intuitive, creating an elastic, renewable system as tags are made, revised, and deleted. What we're looking at here are intuitive research tools and investigative strategies for the new millennium. Often, sites will dynamically generate a collection of the tags most frequently in use, ordering them not alphabetically but visually—by proportionate weight and brightness, as it were. These dynamically generated collections are called "tag clouds." Tag clouds visualize the number of times a tag is used, clicked, or searched. A related form of clouding especially useful for the analysis of static systems like literary texts is called "text clouding," though sometimes the terms are used interchangeably—particularly when the words in use become the tags themselves. For our purposes, "text clouding" is a more accurate term, given that we're searching for the relative frequency of use for each word. Users interested in these tools should experience Chirag Mehta's "US Presidential Speeches Tag Cloud," which draws on over 365 freely available electronic documents to "[show] the popularity, frequency, and trends in the usages of words within speeches, official documents, declarations, and letters written by the Presidents of the US between 1776 - 2007" (2001).

A variety of currently available websites will allow a user to cloud a webpage, to cloud a lexia that has been pasted into a text box, or to cloud an uploaded file. These tools visually weight tags, labels, or individual words or word strings as they appear in a given file or group of files—one commentator on the subject has described the way such clouds allow readers to "watch ideas bloom" (Lamantia 2007). On the simple, accessible, and user-friendly site TagCrowd.com, for example, one has the option to cloud words in a webpage or electronic text, upload a file for clouding, or past text to cloud from an existing document. Suggesting its utility for teaching and learning, TagCrowd was developed by a Stanford doctoral student in Design and Education, Daniel Steinbock ("What Is TagCrowd?"). A few simple options—how many tags to show, whether the cloud should count word frequencies, whether to exclude certain common words from a stoplist, whether similar words should be grouped together, and, like the stoplist, whether you want the algorithm to exclude common English words—make the tool more powerful. Other tools, also freely available on the web though requiring perhaps slightly more preliminary work on the part of the instructor, include the cache of data visualization techniques at IBM's Many Eyes project, part of the company's Collaborative User Experience research group and a direct result of work by the Visual Communication Lab. Many Eyes, which describes itself as "a bet on the power of human visual intelligence to find patterns," the goal of which is "to 'democratize' visualization and to enable a new social kind of data analysis," offers a variety of visualizations that readers may use to organize or visualize any existing or newly created data sets, including literary texts (VCL, "About Many Eyes"). The project seeks ultimately to "help people collectively make sense of data"—and if that is not what we as literature professors seek to do, as well, I have missed my calling. Among the visualizations that can be created by manipulating uploaded data sets are the tag/text clouds we've been discussing, word trees, treemaps, and a variety of graphing and charting tools. While the simple text cloud generated by TagCrowd is a good starting place, the Many Eyes project offers a much higher degree of customizability, archival capability for later access, and a stronger sense of contextualization for each text clouded. When

we create a text cloud of Eliza Haywood's Fantomina, we can begin to see how useful such tools are.

As we can see, this image is useful for the study of Haywood's tale of masquerade and amorous intrigue in a number of ways. Excluding the common English words and their archaic expressions, like "'till" and "'tis," and perhaps controlling for terms like character names, we can begin to see several trees emerging from the forest. One of the largest and boldest words is "manner." When we look that word up in a good historical dictionary like the Oxford English Dictionary, we understand that is a term that expresses not only practices of social behavior, but also—and by extension—morality, habit, deportment, and "characteristic style." Important companion senses of the word relate to "the way an action is performed" (Manner). In class, we might look for all the places where the

Figure 1: Many Eyes *Text Cloud of Haywood's* Fantomina *with "manner" highlighted (detail).*

word "manner" is used and consider how Haywood is adopting, adapting, and otherwise employing those ideas to her own ends. To expand on this theme, we might take a second look at the text cloud and consider other terms that are related to manner, given the historical picture sketched out by the OED; some related terms include "behavior," "reputation," "character," "design," "counterfeit," "seem[e]d," and "expected," each of which

suggest the networked, perceptual, and performative quality of social behavior.

Once these ideas have been themselves sketched out and perhaps traced throughout the text, we might begin to think about how—and to what end—some words appear more often. For instance, "character" is an important idea in the areas of ethics, theater, and literature (Anderson 2005, Freeman 2002, Lynch 1998). While Fantomina repeatedly describes her secrecy and her disguise as a means to secure her reputation, the word "reputation" itself is underrepresented when juxtaposed with the language of seeming and representation. This might lead us to question the goals of the story—is it a moral lesson showing young ladies why they should always maintain their chastity, or is it a story that explores alternative, even oppositional forms of gendered expression? Perhaps it is a story that excavates the performance of character? How are we to read Fantomina's character, especially when we take into consideration the fact that, throughout the tale, she has no name and no identity other than that which she constructs? What about the conclusion of the story? While Fantomina does seem to be punished for her escapades at the end of the text—with an illegitimate daughter and life in a monastery—it appears there may be more evidence to suggest a real ambiguity in that reading. To engage these kinds of questions more fully, students can return to the text cloud and examine, for instance, the language of passion, desire, and physical pleasure.

Based on this tag cloud, we can generate entry points into the text, questions that will lead to analysis and interpretation. Once we have a general sense of what's important in the text—and this is something that students can do on their own, or even in class the period before assigning the reading—students can direct their analysis in a much more focused manner. One of the things that interests me in this text, and one of its most teachable points, is the rationale behind what Fantomina calls her "Frolick" (p. 42), the "Whim" of repeatedly disguising herself—first as a courtesan, then as a young maid, then as a distressed widow, then as an unknown masked woman, Incognita—to maintain the sexual interest of Beauplaisir. If we look at the very first sentences in the text, we learn something crucial about this rationale that can provide a

framework for the rest of our reading. Fantomina—here, only a "young Lady of distinguished Birth, Beauty, Wit, and Spirit" (p. 41)—is doing a bit of sociological research while at the theater, and she notices that men in the pit interact with women there very freely, much differently than she is addressed in polite society. This observation "excited a Curiosity in her to know in what manner these Creatures were addressed" (p. 41). Indeed, Barbara Benedict explicitly addresses the powerful image of female inquiry in work by early women writers like Cavendish, Behn, and Haywood, taking Fantomina as an exemplum in "The Curious Genre" (1998) of amatory fiction; however, as students often learn best when able to put the pieces together for themselves, we might reserve these critical authorities for the very skeptical in the classroom—or use them to inform our teaching.

How can we help students grapple with the text in a way that enables them not only to see the significance of an image, but also to generate the questions that lead into the kinds of critical arguments that scholars make? As we know, the status of knowledge was changing rapidly in the early modern world, particularly at the end of the seventeenth and beginning of the eighteenth centuries, creating what Roy Porter (2000) has called a "culture of science." Under the influence of empiricism and the scientific revolution, curiosity and experiment took on new significance as agents for knowledge, though these techniques were often bounded within the gendered pale of masculine inquiry (Sutton 1995; Benedict 2001). "Since," as Benedict writes, "early-modern scientific institutions excluded women, print became the only public venue for women's questions" (Benedict 1998, p. 194). How is Haywood—a popular writer, a woman writer—interacting with these developments? What is the full significance of curiosity in Fantomina?

When we examine the text cloud for Fantomina, we see that the word "curiosity" is used quite frequently in a rather short prose fiction. Users of Many Eyes' tag cloud visualization can interact more fully with the text; by positioning the cursor over the word "curiosity," users can see a note about total uses in the text and a brief contextualization of each use. In Fantomina, the word "curiosity" is used seven times—perhaps there is something here to look more closely at? The tag cloud tool at Many Eyes allows

you to see up to six instances of the word in a brief context; when we position the cursor over the word "curiosity," we note that it appears seven times throughout the text. What we might want to do now is focus our attention on those moments in the text where the word "curiosity" is used, and see if we can locate a pattern, perhaps the beginning of a hypothesis. At the very least, we might want to learn about how curiosity seems to function in Fantomina.

Branches of Reading: Word Trees

To engage the specific instances of the word "curiosity" in Haywood's text more fully, we can turn to another visualization tool, the word tree. According to the Many Eyes visualization guide, "A word tree is a visual search tool for unstructured text, such as a book, article, speech or poem. It lets you pick a word or phrase and shows you all the different contexts in which it appears. The contexts are arranged in a tree-like branching
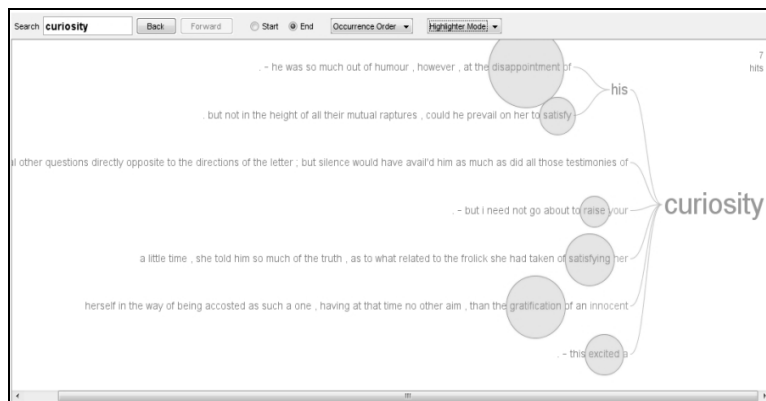

Figure 2: *Many Eyes Word Tree for* Fantomina*, search term at end of hit context, highlighting used to emphasize key contextual language (see below and next page).*

structure to reveal recurrent themes and phrases" (VCL, "Word Tree Guide"). An electronic version of a concordance, word trees allow you to search for a string and observe the variety of its contextual appearances; a benefit of this is that you can see at a glance the different—or similar—ways the word functions in a

given text. Using Many Eyes, we can generate word trees that situate the search term at the beginning of its context or at the end of its context, providing a more substantial overview of the term's use.

The contexts in which the word "curiosity" appears are suggestive, allowing us to make several observations. Focusing on the patterns emerging when we map the search term at the end of the hit context (Figure 2), we note a consistency in the verbs frequently appearing in close proximity to "curiosity." In Fantomina, curiosity is something that is "disappointed," "satisfied," "gratified," "excited," and "raised," clearly associating it with action. While "curiosity" is a noun, it is rarely treated in a passive, static manner, but becomes a vehicle for agency. Significantly, it is Fantomina's desire to satisfy her curiosity about the manner in which the women in the playhouse pit are treated that spurs her "Frolick," the series of masquerades and intrigues she initiates. We can shift the contextualization to the language immediately following the word "curiosity" by situating the search term at the start of the tree. By manipulating the word tree in these ways, we can use the context to establish whose curiosity is being discussed at any moment, which might lead us to some interesting questions about the differences between Beauplaisir's mode of inquiry and that of Fantomina. Because the Many Eyes word tree is highly interactive, we can enable critical engagement further by focusing attention on the language through which curiosity takes shape. By highlighting a selection of words for contemplation (Figure 2), we can continue to interpret the quality of curiosity in Haywood's text—in Fantomina, curiosity is somehow closely bound up with language connoting sexual desire. Finally, the word tree's unique ability to rebranch and zero in on proximal language not only narrows the field of text to a manageable size for students overwhelmed by unfamiliar language, but in doing so, it also models an approach to close reading invested in uncovering nuance and discovering networks of meaning. These networks of meaning can also, themselves, be informed by tools like WordNet, below, providing the reader with a variety of related terms to organize and direct re-branching.

According to Benedict, writers of amatory fiction, like Haywood, often draw creatively on the two senses of curiosity—

curiosity as "the desire to find something out" and curiosity as the "desire to be aroused" (1998 p. 194). As richly detailed prose providing vividly imagined scenarios of the gratification of such curiosity, amatory fiction "represent[s] these impulses visually," through the gaze. The act of inquiring, of looking where one isn't necessarily supposed to look, or in a way one isn't necessarily supposed to look, is itself dramatized in the text. The techniques of data visualization we're employing here may also model a kind of non-traditional looking that can drive home the appeal of these texts to early readers, while simultaneously encouraging students' own desire for critical inquiry.

An Aside: Discovering Networks of Meaning

To grasp connotations, students should have recourse to a good thesaurus or historical dictionary. Students should be prepared to look up terms that figure centrally in their interpretations, but beneath this is a methodology that, clarified, can empower students significantly. We all expect—or at least hope—that our students will look up unfamiliar words as they're reading; while we cannot always count on that, we can make it more interesting for them to do so. Once we've clouded the text to determine what seems important, and once we've selected one term in particular for further study, we want to uncover associated language and imagery that can help us understand the whole system in which a central idea figures. Fortunately, even without a library subscription to the electronic OED, a variety of good online tools that continue the methodologies of data visualization are freely available. Two that are most useful are Princeton University's WordNet and VisuWords, a resource that is built on Princeton's open source database. VisuWords is more graphic, while WordNet is text-based and interactive. Students tend to react more positively to the graphical dictionary, but WordNet provides more precise descriptions of the relationships among affiliated terms. While neither of these tools incorporate a strong historical dimension, such contextualization is easily provided by other resources, and for the purposes of enabling student-generated analysis, VisuWords affords an excellent entry point.

Looking up some of the important recurrent words discovered through the text cloud in these resources, students

can quickly grasp a linguistic network that will then help generate more interpretive entry points. When used in conjunction with the re-branching feature of the Many Eyes word tree, this kind of tool can prove invaluable. VisuWords, for instance, presents the reader with a graphical representation of a linguistic network that illustrates the relationships between synonyms, hyponyms, and other associated language; it includes a legend clearly defining each relationship. From the entry on the word "gratify"—a word often used in conjunction with "curiosity"—we can quickly get a sense of the networks of meaning that underpin and give shape to the kind of curiosity at work in Fantomina. Of particular interest are the secondary denotations of wild, excessive indulgence, pleasure, and delight, which ultimately help clarify the sexual connotations of curiosity—and, not coincidentally, give us more terms to keep in mind as we continue to read the text.

WordNet, unlike VisuWords, is hypertextual in nature, grouping "[n]ouns, verbs, adjectives and adverbs" into "sets of cognitive synonyms (synsets), each expressing a distinct concept" (Miller et al 2006). Each sysnet, as the WordNet introduction describes, is hypertextually "interlinked" through a field of "conceptual-semantic and lexical relations," allowing the user to expand the sense with examples or to re-search the database for a primary related term. When we ask students to read closely, and when we ask students to interpret a text, one of the fundamental skills we seek to exercise is the ability to trace a whole image out of the individual parts of the text; a tool like WordNet gives students purchase on a concrete set of related ideas, expressed in single words, that can powerfully inform reading.

Using WordNet to generate a stronger understanding of the possible senses of Haywood's curiosity, we can see quick glosses of the different meanings of the word as well as a variety of lexical and semantic relationships that expand our analysis of the text. "Curiosity" is semantically related to both "wonder" and "rarity," which are relevant to Haywood's Fantomina. As Barbara Benedict argues in Curiosity: A Cultural History of Early Modern Inquiry (2001), the relationship between the curious inquirerer and the curious object of inquiry links the observer with the observed in potentially dangerous, overly ambitious ways. Curiosity, in short, renders the observer him- or her-self also a

curiosity, a rarity, something odd and potentially out of place. Exploring these relationships gives us more avenues for inquiry—we can return to the word tree or the tag cloud and look for other related terms, for instance. By clicking on the links, users of WordNet can expand the entry or shift the primary focus to a related sysnet like "wonder," which can then itself be explored.

This kind of research encourages students to see relationships among not only words, but the ideas they represent. Curiosity is related to inquiry, knowledge, questions and questioning—but also to doubt and objects and ideas that are understood as odd or even bizarre by comparison. In Haywood's text, Fantomina is clearly represented as an oddity, as an experimenter, one who tests the boundaries of her world; she does so by varying—by shaping, by making, by designing— her manner and appearance. By shaping and re-shaping her manner, Fantomina is also shaping and re-shaping the way others perceive her. Her experimentation, however, has consequences, the precise nature of which is also material for analysis. If we go back to the tag cloud or the word tree with this new knowledge, we can begin to see more patterns for analysis, and especially more ways that individual portions of the text become less isolated, more part of a larger system.

Conclusion

In 1986, D. B. Smith published an essay in College English calling for a concerted, institutional awareness of the technological nature of language. A real understanding of language in this sense has important practical ramifications, one of which is Smith's further call for pedagogical practices designed to overthrow the "hegemony of literary studies over English" and return to "technical students" a "constructive relationship with their native language" (p. 578). While Smith's essay is largely concerned with the damage potentially caused by the study of literature over and against the study of language and the technologies of information storage and retrieval—and while today, we might question either the fact of such a "hegemony" at all or the validity of the distinction between "technical" and other students—his argumentation makes sense for those of us on the ground. Smith's axioms center on and

derive from a fundamental concept of language as technology and thus of crucial importance to society. Following Marshall McLuhan, Smith argues that technology, far from being "the enemy" of traditional literary studies, should instead be recognized as "the enabling essence of homo faber's evolution as a species" (p. 569). As we create, we recreate the world— much, it should be noted, like Fantomina herself. We are, in Smith's phrase, "homo faber because we are homo symbolicus, and vice versa" (p. 570-1). To the extent that technology can improve us, used with purpose, so too can language. Perhaps the most human of human technologies, language—the ability to write, to speak, to read, to categorize, to understand—"enables other technologies" (p. 573) like the ability to "modify," "control," "analyze," and "articulate" a practice (p. 574). Ultimately, the goal of such technological expertise should be the continuing improvement of communication, including access to information. From there, Smith argues, we can achieve improved control over our environments, instead of being trapped within an incomprehensible system. By using a combination of the data visualization tools I've described in this essay, students can become not only more familiar with the text but also more adept at close reading, more in control of the complex representational systems encountered inside and outside the classroom—they can begin to become effective makers of the world.

In addition to democratizing access to information, as the creators of Many Eyes suggest, these are tools that can be used, for the most part, on the fly, with relatively little knowledge of the technology, providing students with a necessarily level of independence that builds confidence. Students can do much of this on their own, with a few modeling sessions, and projected in class, the visualizations can stimulate discussions informed by concrete textual elements. Using these tools to acquire real purchase on literary lexia, students to do not need to know what they're looking for in a text before they begin to engage analytically with it; instead, these tools provide a visual framework that enables inquiry, logical thought, and critical analysis. They rely less on pre-existing knowledge or memorized lecture points than the individual's ability to put data into a general historical context, to identify patterns, and to make logical connections—to embrace the relationship between homo

faber and homo symbolicus. Such tools spark inquiry-based topics for further research, acknowledges and builds on students' existing critical toolbox, stimulates synthetic reasoning skills, and emblematizes the act of close reading within a complex representational network, such as the one our students will be living in for the remainder of their lives.

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