

Why have we not heard more about materiality? Granted, there have been some promising beginnings and a host of materially-based studies in the emerging field of science studies. But within the humanities and especially in literary studies, there has traditionally been a sharp line between representation and the technologies producing them. Whereas art history has long been attentive to the material production of the art object, literary studies has generally been content to treat fictional and narrative worlds as if they were entirely products of the imagination. Significant exceptions include the tradition of artists' books and the exuberant experiments of such materially-based practices as concrete poetry. A few theorists attentive to these developments have argued eloquently for the importance of the book as a physical object and for criticism as material practice. Yet they remain the exception rather than the rule. By and large literary critics have been content to see literature as immaterial verbal constructions, relegating to the specialized fields of bibliography, manuscript culture, and book production the rigorous study of the materiality of literary artifacts. Even cultural studies, refreshingly alert to the importance of materiality in cultural productions, has made only an incremental difference, largely because it usually considers artifacts outside the literary text rather than the text itself as a material object.

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. Not only electronic literature but virtually all historical periods and genres are affected as print works are increasingly re-produced as electronic documents.

The loyal opposition has been insisting for some time now that literary studies must expand to include images. The respected critic, W. J. T. Mitchell, has forcefully made this point, urging that we think not only about words but what he calls the textimage, words and images together. In the digital age, however, image is the tip of the iceberg. In a stimulating exchange I had with Mitchell, I was surprised to find him defending the position that although image was of course important, the expansion of literary attention should stop there. Once image has been introduced into the picture (so to speak), literary critics have everything they need to deal adequately with literary texts. This print-centric view fails to account for all the other signifying components of electronic texts, including sound, animation, motion, video, kinesthetic involvement, and software functionality, among others. Moreover, it does not do justice even to print books, as the vibrant tradition of artists' books testifies with the innovative use of cutouts, textures, colors, movable parts, and page order, to name only a few.

MATERIAL METAPHORS

What would it mean to talk about materiality in an era in which simulations are everywhere around us?

I found a clue in Greg Egan's brilliant novel *Permutation City*, a book I love to hate because it challenges almost everything I thought I knew about materiality. The novel begins by enacting the scenario that technofabulist Hans Moravec proposes in *Mind Children: The Future of Robotic Intelligence*—downloading human consciousness into a computer. Unlike Moravec, Egan does not find it necessary to destroy the original in creating the **SIMULACRUM**. Moreover, the Copy does not find himself identical with his biological progenitor as Moravec supposes. Depressed

at becoming an artificial intelligence without a body, Copy after Copy commits suicide. Those that reconcile themselves to living inside the computer often create INTERFACES that allow them to preserve the illusion of ordinary human existence. For example, a CEO creates a boardroom with video screens through which he can interface with the far-flung business empire legally transferred to the Copy upon the original's biological death. In a sense the interface is a metaphor, for the character is not actually in a boardroom but merely interacting with the world through functionalities similar to a boardroom's operation. Nevertheless, this metaphor has power to make things happen in the real world, for it is connected to a complex material apparatus that operates machinery as well as such socio-material constructions as economic transactions.

Traditionally metaphor has been defined as a verbal figure. Derived from a root meaning bearing across, it denotes the transfer of sense associated with one word to another. In Egan's fictional scenario, the transfer takes place not between one word and another but rather between a symbol (more properly, a network of symbols) and material apparatus. This kind of traffic, as old as the human species, is becoming increasingly important as the symbol-processing machines we call computers are hooked into networks in which they are seamlessly integrated with apparatus that can actually do things in the world, from the sensors and actuators of mobile robots to the semiotic-material machinery that changes the numbers in bank accounts. To account for this traffic I propose *material metaphor*, a term that foregrounds the traffic between words and physical artifacts.

We are not generally accustomed to think of a book as a material metaphor, but in fact it is an artifact whose physical properties and historical usages structure our interactions with it in ways obvious and subtle. In addition to defining the page as a unit of reading, and binding pages sequentially to indicate an order of reading, are less obvious conventions such the opacity of paper, a physical property that defines the page as having two sides whose relationship is linear and sequen-

Reading Eye Dog. Photo: D. Horvath



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tial rather than interpenetrating and simultaneous. To change the physical form of the artifact is not merely to change the act of reading (although that too has consequences the importance of which we are only beginning to recognize) but profoundly to transform the metaphoric network structuring the relation of word to world.

This was the informing realization of "The Future of Reading" at San Jose's Tech Museum of Innovation (2001) mounted by the Research in Experimental Documents (RED) team at Xerox PARC, which included such pioneering thinkers as Richard Gold and Anne Balsamo. To understand the power of material metaphors, let us consider one of the reading machines the RED group built for the exhibit, the Reading Eye Dog. Designed to look like a large robotic upright dog, this mechanism scans printed material placed on its reading stand and uses a text-to-speech program to speak the words aloud. The metaphoric associations put into play by the device's physical form include traffic between machine and biological organism, companion animal and parent, printed marks and oral production, static book and dynamic text-to-speech generation, artificial intelligence and human cognition, reading text without understanding it and (for young children listening to the Reading Eye Dog), understanding what is said without being able to read it. All these associations are structured by the materiality of the artifact and differ significantly from the structuring associations called forth by the print book. To change the material artifact is to transform the context and circumstances for interacting with the words, which inevitably changes

the meanings of the words as well. This transformation of meaning is especially potent when the words reflexively interact with the inscription technologies that produce them.

Here I should specify what I mean by INSCRIPTION TECHNOLOGIES. In print books words are obviously inscriptions because they take the form of ink marks impressed on paper. The computer also counts as an inscription technology, because it changes electric polarities and correlates these changes with binary code, higher-level languages such as C++ and Java, and the phosphor gleams of the cathode ray tube. *To count as an inscription technology, a device must initiate material changes that can be read as marks.* Telegraphy thus counts; it sends structured electronic pulses through a wire (material changes that can be read as marks) and connects these pulses with acoustic sound (or some other analogue signal) associated with marks on paper. Additional examples include film, video, and the images produced by medical devices such as X-rays, CAT scans, and MRI. Even nanotechnology slouched its way toward inscription when scientists arranged molecules to form their company's logo, IBM.

TECHNOTEXTS

When a literary work interrogates the inscription technology that produces it, it mobilizes reflexive loops between its imaginative world and the material apparatus embodying that creation as a physical presence.

Not all literary works make this move, of course, but even for those that do not, my claim is that *the physical form of the literary artifact always affects what the words (and other semiotic components) mean.* Literary works that strengthen, foreground, and thematize the connections between themselves as material artifacts and the imaginative realm of verbal/semiotic signifiers they instantiate open a window on the larger connections that unite literature as a verbal art to its material forms. To name such works, I propose "technotexts," a term that

connects the technology that produces texts to the texts' verbal constructions. Technotexts play a special role in transforming literary criticism into a material practice, for they make vividly clear that the issue at stake is nothing less than a full-bodied understanding of literature.

My title, *Writing Machines*, plays with the multiple ways in which writing and materiality come together. "Writing machines" names the inscription technologies that produce literary texts, including printing presses, computers, and other devices. "Writing machines" is also what technotexts do when they bring into view the machinery that gives their verbal constructions physical reality. As a literary term, technotext can be understood through its similarities and differences to related concepts. All of the technotexts I discuss in this book could also be called hypertexts. Hypertext has at a minimum the three characteristics of MULTIPLE READING PATHS, CHUNKED TEXT, and some kind of LINKING MECHANISM to connect the chunks. The World Wide Web, with its links, millions of pages and multiple reading paths, is a vast hypertext of global proportions. From the definition, it will be immediately apparent that hypertext can be instantiated in print as well as electronic media. A print encyclopedia qualifies as a hypertext because it has multiple reading paths, a system of cross-references that serve as linking mechanisms, and chunked text in entries separated typographically from one another. These hypertextual characteristics of the encyclopedia form the basis for Milorad Pavić's brilliant print work *Dictionary of the Khazars: A Lexicon Novel*. Other examples of print hypertexts include Ursula LeGuin's *Always Coming Home*, which includes audio tapes to document a richly imagined science fiction world; Paul Zimmerman's artist's book *High Tension*, which creates a multiplicity of reading paths through an unusual physical form that allows the reader to fold diagonally cut leaves to obtain different combinations of text and image; and Robert Coover's "The Babysitter," a short story that pushes toward hypertext by juxtaposing contradictory and nonsequential events suggesting many simultaneously existing time lines and narrative unfoldings.

As hypertext theory developed during the late 1980s and early to mid-1990s, theorists such as George Landow, Jay Bolter, Michael Joyce, and others emphasized the importance of the link, which tended to loom larger than hypertext's other characteristics. This orientation was consistent with first-generation electronic hypertexts such as Joyce's *Afternoon, a story*, an almost exclusively verbal work that employs Storyspace software to link one screen of text (or LEXIA) with another through "hot words" the reader can activate by clicking. Although this structure departs from print in providing multiple reading paths, it preserves the basic print convention of moving through a text by going from one page/screen to another. In retrospect the revolutionary claims made for these early hypertexts appear inflated, for they were only beginning to tap into the extraordinary resources offered by electronic environments.

As the technology changed, and especially as the Web grew in size, scope, and functionality, writers began to move away from the Storyspace interface to explore the rich diversity of interfaces available in such commercial software packages as Flash, Shockwave, and Dreamweaver and also HTML, VRML, DIRECTX, and other web-oriented languages. A new breed of SECOND-GENERATION ELECTRONIC LITERATURE began to appear that looked very different from its predecessors, experimenting with ways to incorporate narrative with sound, motion, animation, and other software functionalities. Riding on the crest of these developments, Espen Aarseth's pioneering *Cybertext: Perspectives on Ergodic Literature* argued for a perspective fundamentally computational in nature. To this end he proposed the category CYBERTEXT and defined it to include a wide variety of texts that used combinatorial strategies, including print works such as Raymond Queneau's *Cent Mille Millions*, electronic fictions like *Afternoon, a story*, computer games, and even the *I Ching*. He gave substance to the idea by developing a typology of semiotic variables, including in addition to links such concepts as perspective, access, determinability, transience, dynamics, and user function. Combinations of these variables yield 576 different

variations, which can be plotted on a grid to locate a particular text's strategies within the cybertext domain. This schema is undoubtedly more appropriate to second-generation electronic literature than earlier hypertext theory, which now began to appear dated and provincial compared to Aarseth's flexible and theoretically powerful approach. Meanwhile, other critics and writers who continue to be interested in linking have developed theoretically sophisticated ways to talk about hypertext that move considerably beyond the first generation of hypertext theorists.

These developments have invested hypertext and cybertext with connotations that make them useful relatives to technotext but also significantly different from what I have in mind when I use that term. Hypertext connotes an emphasis on links, a brand of criticism derived from traditional literary approaches, and a polemic that seeks to convince the literary community of the value and importance of electronic hypertext for pedagogy, criticism, and theory. Cybertext connotes a functional and semiotic approach that emphasizes a computational perspective, a polemic that wants, as Stuart Moulthrop put it (echoing James Joyce), to "kill the literary priest," and an emphasis on computer games as paradigmatic examples of ERGODIC texts, which Aarseth defines as those literary systems that require "nontrivial effort" to allow the user to traverse them. To use one term or the other is not only to invoke a particular approach but to position oneself in a highly contested field where allies and enemies sometimes count more than arguments. Neither term pays particular attention to interactions between the materiality of inscription technologies and the inscriptions they produce. As a consequence, neither term is completely appropriate to my project, although I will use both on occasions when their connotations are appropriate to the point at hand.

MEDIA-SPECIFIC ANALYSIS

Complementing the foundational concepts of material metaphors, inscription technologies and technotexts is a kind of criticism that pays attention to the material apparatus producing the literary work as physical artifact.

Although material criticism is highly developed in specialized fields such as bibliographic criticism and textual studies, I think its value is much more general and widespread. Accordingly, I want to call it media-specific analysis (MSA), as a way to invite theorists and critics to think more broadly about the connections between strands of criticism that have not yet made common cause with one another.

Lulled into somnolence by five hundred years of print, literary studies have been slow to wake up to the importance of MSA. Literary

criticism and theory are shot through with unrecognized assumptions specific to print. Only now, as the new medium of electronic textuality vibrantly asserts its presence, are these assumptions clearly coming into view. In his influential essay "From Work to Text," Roland Barthes uncannily anticipated electronic hypertext by associating text with dispersion, multiple authorship, and RHIZOMATIC structure. In positioning text against work, Barthes was among those who initiated semiotic and performative approaches to discourse, arguably one of the most important developments in literary studies in the last century. But this shift has entailed loss as well as gain. Useful as the vocabulary of text was in expanding textuality beyond the printed page, it also had the effect, in treating everything from fashion to fascism as a semiotic system, of eliding differences in materiality. Perhaps now, after the linguistic turn has yielded so many important insights, it is time to turn again to a careful consideration of what difference the materiality of the medium makes.

In calling for MSA, I do not mean to advocate that media should be considered in isolation from one another. On the contrary, media constantly engage in a RECURSIVE dynamic of imitating each other, incorporating aspects of competing media into themselves while simultaneously flaunting the advantages their own forms of mediation offer. Voyager's now-defunct line of "Expanded Books," for example, offered readers the opportunity to dog-ear electronic pages. Another option inserted a paper clip on the screenic page, itself programmed to look as much as possible like print. On the other side of the screen, many print texts are now imitating electronic hypertexts. These range from John Barth's *Coming Soon!* and Don DeLillo's *Underworld* to Bolter and Grusin's *Remediation*, which self-consciously pushes toward hypertext through arrows that serve as visual indications of hypertextual links. MSA attends both to the specificity of the form—the fact that the Voyager paper clip is an image rather than a piece of bent metal—and to citations and imitations of one medium in another. MSA moves from the language of text to a more precise vocabulary of screen and page, digital program and analogue interface, code and ink, mutable image

and durable mark, computer and book.

One area where MSA can pay especially rich dividends is in hypertext theory. Some theorists working in the area of electronic literature argue that hypertext ought to be reserved for digital works. In my view, this is a mistake (and not one that cybertext theory makes). When Vannevar Bush, widely credited with the invention of the form, imagined a hypertextual system more than fifty years ago, it was not electronic but mechanical. His 1945 article, "As We May Think," testifies that it is possible to implement hypertext in a variety of ways, not only through the "go to" commands that comprise the hypertext link in digital computers. If we restrict the term hypertext to digital media, we lose the opportunity to understand how a rhetorical form mutates when it is instantiated in different media. The power of MSA comes from holding one term constant across media (in this case, technotexts) and varying the media to explore how medium-specific possibilities and constraints shape texts. Understanding literature as the interplay between form, content, and medium, MSA insists that texts must always be embodied to exist in the world. The materiality of those EMBODIMENTS interacts dynamically with linguistic, rhetorical, and literary practices to create the effects we call literature.

In attending to the materiality of the medium, MSA explicitly refutes the concept of the literary work that emerged from eighteenth-century debates over copyright and that has held considerable sway since then, although not without contestations. As Mark Rose has shown in his important book *Authors and Owners: The Invention of Copyright*, legal theorists such as Blackstone defined a literary work as consisting solely of its "style and sentiment." "These alone constitute its identity," Blackstone wrote. "The paper and print are merely accidents, which serve as vehicles to convey that style and sentiment to a distance." Subsequent commentators realized it was not practical to copy-right "sentiment," for some ideas are so general they cannot be attributed to any single author: that men are mortal, for example. Rather, it was the ways in which ideas were expressed that could be secured as

literary property and hence copyrighted. This judicial history, played out in a contentious environment where conflicting economic, political, and class interests fought for priority, had important consequences for literature that went beyond purely legal considerations, for it helped to solidify the literary author as a man of original genius (the author's assumed gender in these discourses was invariably male) who created literary property by mixing his intellectual labor with the materials afforded him by nature—much as Locke had argued men created private property by mixing their labor with the land. Consistently in these discourses, material and economic considerations, although they had force in the real world, were elided or erased in favor of an emphasis on literary property as an intellectual construction that owed nothing to the medium in which it was embodied. Although this conclusion was repeatedly challenged in court and in such literary movements as futurism and imagism (“No ideas but in things,” William Carlos Williams declared), the long reign of print made it easy for literary criticism to ignore the specificities of the *CODEX* book when discussing literary texts. With significant exceptions, print literature was widely regarded as not having a body, only a speaking mind.

MSA aims to electrify the neocortex of literary criticism into recognizing that strands traditionally emphasizing materiality (such as criticism on the illuminated manuscript, on writers such as William Blake and Emily Dickinson, where embodiment is everything, and on the rich tradition of artists' books) are not exceptions but instances of MSA. Like all literature, technotext has a body (or rather many bodies), and the rich connections between its material properties and its content create it as a literary work in the full sense of the term.

Here I want to clarify what I mean by materiality. The physical attributes constituting any artifact are potentially infinite; in a digital computer, for example, they include the polymers used to fabricate the case, the rare earth elements used to make the phosphors in the CRT screen, the palladium used for the power cord prongs, and so forth. From this infinite array a technotext will select a few to foreground and

work into its thematic concerns. Materiality thus emerges from interactions between physical properties and a work's artistic strategies. For this reason, materiality cannot be specified in advance, as if it preexisted the specificity of the work. An emergent property, materiality depends on how the work mobilizes its resources as a physical artifact as well as on the user's interactions with the work and the interpretive strategies she develops—strategies that include physical manipulations as well as conceptual frameworks. In the broadest sense, materiality emerges from the dynamic interplay between the richness of a physically robust world and human intelligence as it crafts this physicality to create meaning.

In urging increased attention to materiality, I hope it is clear that I do not mean to argue for the superiority of electronic media. With both print and screen, the specificity of the medium comes into play as its characteristics are flaunted, suppressed, subverted, or re-imagined. Many critics see the electronic age as heralding the end of books. I think this view is mistaken. Print books are far too hardy, reliable, long-lived, and versatile to be rendered obsolete by digital media. Rather, digital media have given us an opportunity we have not had for the last several *hundred years*: the chance to see print with new eyes, and with it, the possibility of understanding how deeply literary theory and criticism have been imbued with assumptions specific to print. As we work toward critical practices and theories appropriate for electronic literature, we may come to renewed appreciation for the specificity of print. In the tangled web of medial ecology, change anywhere in the system stimulates change everywhere in the system. Books are not going the way of the dinosaur but the way of the human, changing as we change, *mutating and evolving* in ways that will continue, as a book lover said long ago, to teach and delight.