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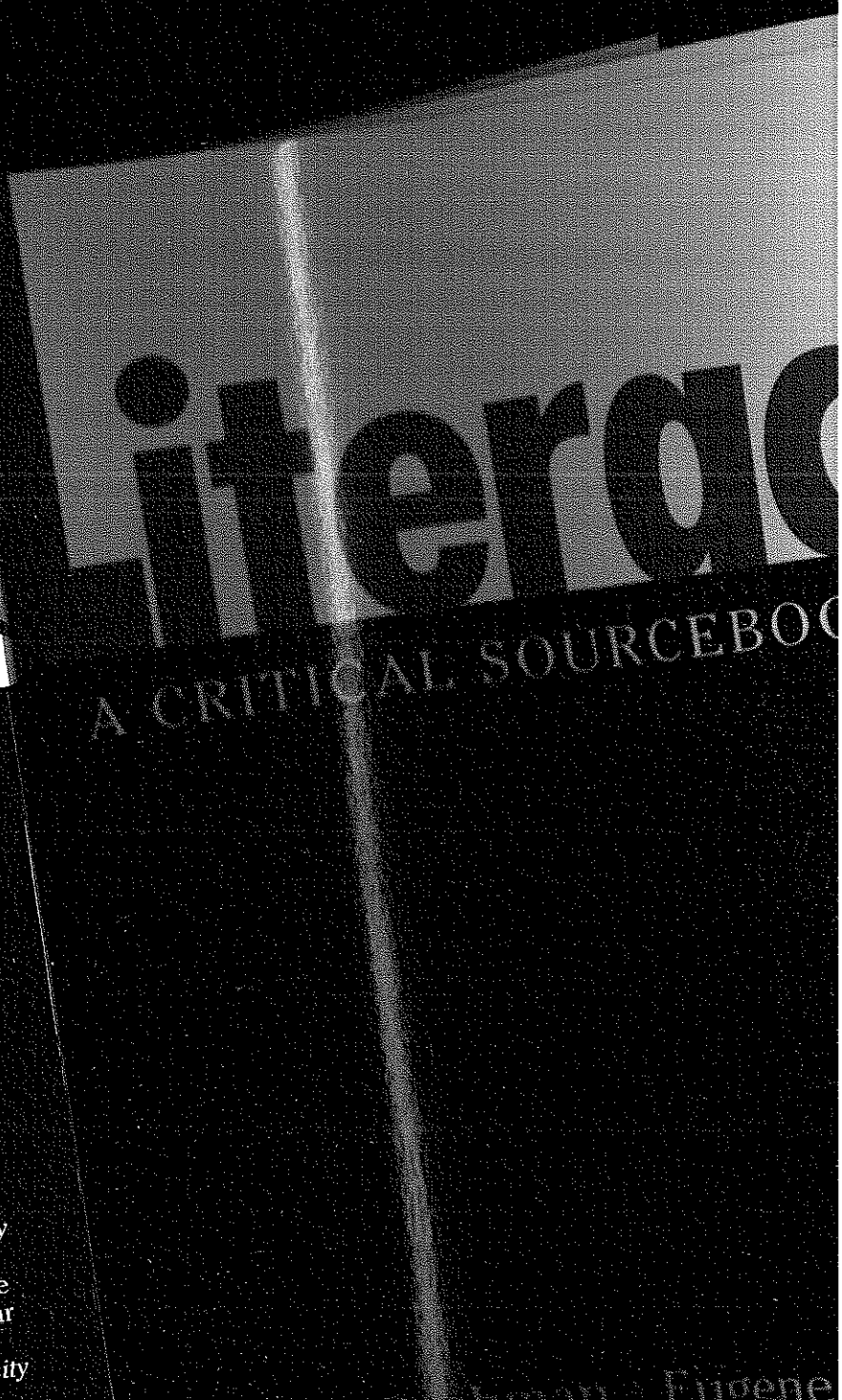


# From Pencils to Pixels: The Stages of Literacy Technologies

DENNIS BARON

The computer, the latest development in writing technology, promises, or threatens, to change literacy practices for better or worse, depending on your point of view. For many of us, the computer revolution came long ago, and it has left its mark on the way we do things with words. We take word processing as a given. We don't have typewriters in our offices anymore, or pencil sharpeners, or even printers with resolutions less than 300 dpi. We scour *MacUser* and *PC World* for the next software upgrade, cheaper RAM, faster chips, and the latest in connectivity. We can't wait for the next paradigm shift. Computerspeak enters ordinary English at a rapid pace. In 1993, "the information superhighway" was voted the word—actually the phrase—of the year. In 1995, the word of the year was "the World Wide Web," with "morph" a close runner-up. The computer is also touted as a gateway to literacy. The Speaker of the House of Representatives suggested that inner-city schoolchildren should try laptops to improve their performance. The Governor of Illinois thinks that hooking up every school classroom to the Web will eliminate illiteracy. In his second-term victory speech, President Clinton promised to have every eight-year-old reading, and to connect every twelve-year-old to the National Information Infrastructure. Futurologists write books predicting that computers will replace books. Newspapers rush to hook online subscribers. The *New York Times* will download the Sunday crossword puzzle, time me as I fill in the answers from my keyboard, even score my results. They'll worry later about how to get me to pay for this service.

I will not join in the hyperbole of predictions about what the computer will or will not do for literacy, though I will be the first to praise computers, to acknowledge the importance of the computer in the last fifteen years of my own career as a writer, and to predict that in the future the computer will be put to communication uses we cannot now even begin to imagine, something quite beyond the word processing I'm now using to produce a fairly conventional text, a book chapter.

From *Passions, Pedagogies, and Twenty-first-Century Technologies.* Ed. Gail E. Hawisher and Cynthia L. Selfe. Logan: Utah State University Press, 1999. 15–33.

I readily admit my dependence on the new technology of writing. Once, called away to a meeting whose substance did not command my unalloyed attention, I began drafting on my conference pad a memo I needed to get out to my staff by lunchtime. I found that I had become so used to composing virtual prose at the keyboard I could no longer draft anything coherent directly onto a piece of paper. It wasn't so much that I couldn't think of the words, but the physical effort of handwriting, crossing out, revising, cutting and pasting (which I couldn't very well do at a meeting without giving away my inattention), in short, the writing practices I had been engaged in regularly since the age of four, now seemed to overwhelm and constrict me, and I longed for the flexibility of digitized text.

When we write with cutting-edge tools, it is easy to forget that whether it consists of energized particles on a screen or ink embedded in paper or lines gouged into clay tablets, writing itself is always first and foremost a technology, a way of engineering materials in order to accomplish an end. Tied up as it is with value-laden notions of literacy, art, and science, of history and psychology, of education, of theory, and of practicality, we often lose sight of writing as technology, until, that is, a new technology like the computer comes along and we are thrown into excitement and confusion as we try it on, try it out, reject it, and then adapt it to our lives—and, of course, adapt our lives to it.

New communications technologies, if they catch on, go through a number of strikingly similar stages. After their invention, their speed depends on accessibility, function, and authentication. Let me first summarize what I mean, and then I'll present some more detailed examples from the history of writing or literacy technologies to illustrate.

## The Stages of Literacy Technologies

Each new literacy technology begins with a restricted communication function and is available only to a small number of initiates. Because of the high cost of the technology and general ignorance about it, practitioners keep it to themselves at first—either on purpose or because nobody else has any use for it—and then, gradually, they begin to mediate the technology for the general public. The technology expands beyond this "priestly" class when it is adapted to familiar functions often associated with an older, accepted form of communication. As costs decrease and the technology becomes better able to mimic more ordinary or familiar communications, a new literacy spreads across a population. Only then does the technology come into its own, no longer imitating the previous forms given us by the earlier communication technology, but creating new forms and new possibilities for communication. Moreover, in a kind of backward wave, the new technology begins to affect older technologies as well.

While brave new literacy technologies offer new opportunities for producing and manipulating text, they also present new opportunities for fraud. And as the technology spreads, so do reactions against it from supporters of what are purported to be older, simpler, better, or more honest ways of writ-

ing. Not only must the new technology be accessible and useful, it must demonstrate its trustworthiness as well. So procedures for authentication and reliability must be developed before the new technology becomes fully accepted. One of the greatest concerns about computer communications today involves their authentication and their potential for fraud.

My contention in this essay is a modest one: the computer is simply the latest step in a long line of writing technologies. In many ways its development parallels that of the pencil—hence my title—though the computer seems more complex and is undoubtedly more expensive. The authenticity of pencil writing is still frequently questioned: we prefer that signatures and other permanent or validating documents be in ink. Although I'm not aware that anyone actually opposed the use of pencils when they began to be used for writing, other literacy technologies, including writing itself, were initially met with suspicion as well as enthusiasm.

## Humanists and Technology

In attacking society's growing dependence on communication technology, the Unabomber (1996) targeted computer scientists for elimination. But to my chagrin he excluded humanists from his list of sinister technocrats because he found them to be harmless. While I was glad not to be a direct target of this mad bomber, I admit that I felt left out. I asked myself, if humanists aren't harmful, then what's the point of being one? But I was afraid to say anything out loud, at least until a plausible suspect was in custody.

Humanists have long been considered out of the technology loop. They use technology, to be sure, but they are not generally seen as pushing the envelope. Most people think of writers as rejecting technological innovations like the computer and the information superhighway, preferring instead to bang away at manual typewriters when they are not busy whittling new points on their no. 2 quill pens.

And it is true that some well-known writers have rejected newfangledness. Writing in the *New York Times*, Bill Henderson (1994) reminds us that in 1849 Henry David Thoreau disparaged the information superhighway of his day, a telegraph connection from Maine to Texas. As Thoreau put it, "Maine and Texas, it may be, have nothing important to communicate." Henderson, who is a director of the Lead Pencil Club, a group opposed to computers and convinced that the old ways are better, further boasts that Thoreau wrote his anti-technology remarks with a pencil that he made himself. Apparently Samuel Morse, the developer of the telegraph, was lucky that the only letter bombs Thoreau made were literary ones.

In any case, Thoreau was not the complete Luddite that Henderson would have us believe. He was, in fact, an engineer, and he didn't make pencils for the same reason he went to live at Walden Pond, to get back to basics. Rather, he designed them for a living. Instead of waxing nostalgic about the good old days of handmade pencils, Thoreau sought to improve the process by developing a cutting-edge manufacturing technology of his own.

The pencil may be old, but like the computer today and the telegraph in 1849, it is an indisputable example of a communication technology. Henderson unwittingly concedes as much when he adds that Thoreau's father founded "the first quality pencil [factory] in America." In Thoreau's day, a good pencil was hard to find, and until Thoreau's father and uncle began making pencils in the New World, the best ones were imported from Europe. The family fortune was built on the earnings of the Thoreau Pencil Company, and Henry Thoreau not only supported his sojourn at Walden Pond and his trip to the Maine woods with pencil profits, he himself perfected some of the techniques of pencil making that made Thoreau pencils so desirable.

The pencil may seem a simple device in contrast to the computer, but although it has fewer parts, it too is an advanced technology. The engineer Henry Petroski (1990) portrays the development of the wood-cased pencil as a paradigm of the engineering process, hinging on the solution of two essential problems: finding the correct blend of graphite and clay so that the "lead" is not too soft or too brittle; and getting the lead into the cedarwood case so that it doesn't break when the point is sharpened or when pressure is applied during use. Pencil technologies involve advanced design techniques, the preparation and purification of graphite, the mixing of graphite with various clays, the baking and curing of the lead mixture, its extrusion into leads, and the preparation and finishing of the wood casings. Petroski observes that pencil making also involves a knowledge of dyes, shellacs, resins, clamps, solvents, paints, woods, rubber, glue, printing ink, waxes, lacquer, cotton, drying equipment, impregnating processes, high-temperature furnaces, abrasives, and mixing (Petroski 12). These are no simple matters. A hobbyist cannot decide to make a wood-cased pencil at home and go out to the craft shop for a set of instructions. Pencil-making processes were from the outset proprietary secrets as closely guarded as any Macintosh code.

The development of the pencil is also a paradigm of the development of literacy. In the two hundred fifty years between its invention, in the 1560s, and its perfection at John Thoreau and Company, as well as in the factories of Conté in France and Staedtler and Faber in Germany, the humble wood pencil underwent several changes in form, greatly expanded its functions, and developed from a curiosity of use to cabinet-makers, artists, and note-takers into a tool so universally employed for writing that we seldom give it any thought.

## The Technology of Writing

Of course the first writing technology was writing itself. Just like the telegraph and the computer, writing itself was once an innovation strongly resisted by traditionalists because it was unnatural and untrustworthy. Plato was one leading thinker who spoke out strongly against writing, fearing that it would weaken our memories. Pessimistic complaints about new literacy technologies, like those made by Plato, by Bill Henderson, and by Henderson's idol, Henry David Thoreau, are balanced by inflated predictions of how

technologies will change our lives for the better. According to one school of anthropology, the invention of writing triggered a cognitive revolution in human development (for a critique of this so-called Great Divide theory of writing, see Street 1984). Historians of print are fond of pointing to the invention of the printing press in Europe as the second great cognitive revolution (Eisenstein 1979). The spread of electric power, the invention of radio, and later television, all promised similar bio-cultural progress. Now, the influence of computers on more and more aspects of our existence has led futurologists to proclaim that another technological threshold is at hand. Computer gurus offer us a brave new world of communications where we will experience cognitive changes of a magnitude never before known. Of course, the Unabomber and the Lead Pencil Club think otherwise.

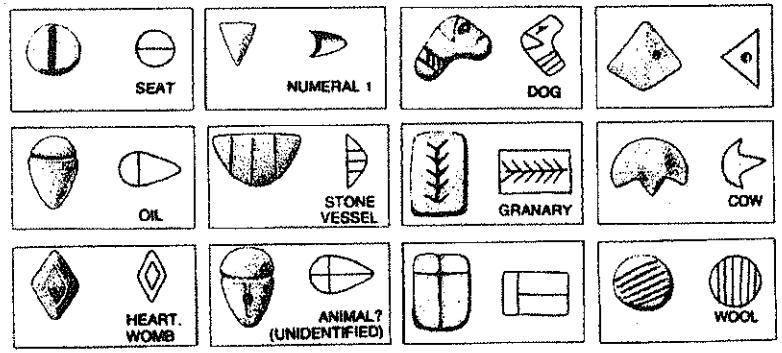
Both the supporters and the critics of new communication technologies like to compare them to the good, or bad, old days. Jay Bolter disparages the typewriter as nothing more than a machine for duplicating texts—and as such, he argues, it has not changed writing at all. In contrast, Bolter characterizes the computer as offering a paradigm shift not seen since the invention of the printing press or, for that matter, since the invention of writing itself. But when the typewriter first began to sweep across America's offices, it too promised to change writing radically, in ways never before imagined. So threatening was the typewriter to the traditional literatus that in 1938 the *New York Times* editorialized against the machine that depersonalized writing, usurping the place of "writing with one's own hand."

The development of writing itself illustrates the stages of technological spread. We normally assume that writing was invented to transcribe speech, but that is not strictly correct. The earliest Sumerian inscriptions, dating from ca. 3500 B.C.E., record not conversations, incantations, or other sorts of oral utterances, but land sales, business transactions, and tax accounts (Crystal 1987). Clay tokens bearing similar marks appear for several thousand years before these first inscriptions. It is often difficult to tell when we are dealing with writing and when with art (the recent discovery of 10,000-year-old stone carvings in Syria has been touted as a possible missing link in the art-to-writing chain), but the tokens seem to have been used as a system of accounting from at least the ninth millennium B.C.E. They are often regarded as the first examples of writing, and it is clear that they are only distantly related to actual speech (see Figure 1).

We cannot be exactly sure why writing was invented, but just as the gurus of today's technology are called computer geeks, it's possible that the first writers also seemed like a bunch of oddballs to the early Sumerians, who might have called them cuneiform geeks. Surely they walked around all day with a bunch of sharp styluses sticking out of their pocket protectors and talked of nothing but new ways of making marks on stones. Anyway, so far as we know, writing itself begins not as speech transcription but as a relatively restricted and obscure record-keeping shorthand.

As innovative uses for the literacy technology are tried out, practitioners may also adapt it to older, more familiar forms in order to gain acceptance

FIGURE 1 Clay Tokens and Sumerian Inscriptions




*Clay tokens. Some of the commonest shapes are here compared with the incised characters in the earliest Sumerian inscriptions (only some of which have been interpreted) (Crystal 1987, 196).*

from a wider group. Although writing began as a tool of the bean counters, it eventually added a second, magical/religious function, also restricted and obscure as a tool of priests. For writing to spread into a more general population in the ancient world, it had first to gain acceptance by approximating spoken language. Once writers—in a more "modern" sense of the world—discovered what writing could do, there was no turning back. But even today, most written text does not transcribe spoken language: the comparison of script and transcript in Figure 2 makes this abundantly clear.

Of course writing never spread very greatly in the ancient world. William Harris (1989) argues convincingly that no more than ten percent of the classical Greek or Roman populations could have been literate. One reason for this must be that writing technology remained both cumbersome and expensive: writing instruments, paints, and inks had to be hand made, and writing surfaces like clay tablets, wax tablets, and papyrus had to be laboriously prepared. Writing therefore remained exclusive, until cheap paper became available and the printing press made mass production of written texts more affordable and less labor-intensive.

## What Writing Does Differently

As a literacy technology like writing begins to become established, it also goes beyond the previous technology in innovative, often compelling ways. For example, while writing cannot replace many speech functions, it allows us to communicate in ways that speech does not. Writing lacks such tonal cues of the human voice as pitch and stress, not to mention the physical cues that accompany face-to-face communication, but it also permits new ways of bridging time and space. Conversations become letters. Sagas become novels. Customs become legal codes. The written language takes on a life of its own,

and it even begins to influence how the spoken language is used. To cite an obvious example, people begin to reject traditional pronunciations in favor of those that reflect a word's spelling: the pronunciation of the "l" in falcon (compare the l-less pronunciation of the cognate name Faulkner) and the "h" in such "th" combinations as *Anthony* and *Elizabeth* (compare the nicknames *Tony* and *Betty*, which reflect the earlier, h-less pronunciation).

In order to gain acceptance, a new literacy technology must also develop a means of authenticating itself. Michael Clanchy (1993) reports that when writing was introduced as a means of recording land transfer in eleventh-century England, it was initially perceived (and often rightly so) as a nasty Norman trick for stealing Saxon land.

As Clanchy notes, spoken language was easily corroborated: human witnesses were interactive. They could be called to attest whether or not a property transfer had taken place. Doubters could question witnesses, watch their eyes, see whether witnesses sank when thrown bound into a lake. Written documents did not respond to questions—they were not interactive. So the writers and users of documents had to develop their own means of authentication. At first, seals, knives, and other symbolic bits of property were attached to documents in an attempt to give them credibility. Medieval English land transfers also adopted the format of texts already established as trustworthy, the Bible or the prayer book, complete with illuminations, in order to convince readers of their validity.

Questions of validity came up because writing was indeed being used to perpetrate fraud. Monks, who controlled writing technology in England at the time, were also responsible for some notorious forgeries used to snatch land from private owners. As writing technology developed over the centuries, additional ways of authenticating text came into use. Individualistic signatures eventually replaced seals to the extent that today, many people's signatures differ significantly from the rest of their handwriting. Watermarks identify the provenance of paper; dates and serial numbers further certify documents; and in the absence of other authenticators, stylistic analysis may allow us to guess at authorship on the basis of comparative and internal textual evidence. In the digital age, we are faced with the interesting task of reinventing appropriate ways to validate cybertext.

## The Pencil as Technology

Just as writing was not designed initially as a way of recording speech, the pencil was not invented to be a writing device. The ancient lead-pointed stylus was used to scribe lines—the lead made a faint pencil-like mark on a surface, suitable for marking off measurements but not for writing. The modern pencil, which holds not lead but a piece of graphite encased in a wooden handle, doesn't come on the scene until the 1560s.

The sixteenth-century pencil consists of a piece of graphite snapped or shaved from a larger block, then fastened to a handle for ease of use. The first pencils were made by joiners, woodworkers specializing in making furniture, to scribe measurements in wood. Unlike the traditional metal-pointed scribing tools, pencils didn't leave a permanent dent in the wood. By the time Gesner observed the pencil, it had been adopted as a tool by note-takers, natural scientists, or others who needed to write, sketch, or take measurements in the field. Carrying pens and ink pots outdoors was cumbersome. Early pencils had knobs at one end so that they could be fastened with string or chain to a notebook, creating the precursor to the laptop computer.

Pencils were also of use to artists. In fact the word *pencil* means "little tail" and refers not only to the modern wood-cased pencil but to the artist's brush. Ink and paint are difficult to erase: they must be scraped off a surface with a knife, or painted over. But graphite pencil marks were more easily erased by using bread crumbs, and of course later by erasers made of rubber—in fact the eraser substance (caoutchouc, the milky juice of tropical plants such as ficus) was called rubber because it was used to rub out pencil marks. . . .

FIGURE 2 Script and Transcript

*Scripted dialogue:*

THERSITES: The common curse of mankind, folly and ignorance, be thine in great revenue! heaven bless thee from a tutor, and discipline come not near thee! Let thy blood be thy direction till thy death! then, if she that lays thee out says thou art a fair corpse, I'll be sworn and sworn upon 't she never shrouded any but lazars. Amen.

Shakespeare, *Troilus and Cressida*, II.iii.30

*Unscripted dialogue (ostensibly):*

LT. COL. NORTH: I do not recall a specific discussion. But, I mean. It was widely known within the CIA. I mean we were tracking that sensitive intelligence. I—I honestly don't recall, Mr. Van Cleve. I mean it—it didn't seem to me, at the time, that it was something that I was trying to hide from anybody. I was not engaged in it. And one of the purposes that I thought we had that finding for was to go back and ratify that earlier action, and to get on with replenishing. I mean, that was one—what I understood one of the purposes of the draft to be.

from *Taking the Stand: The Testimony of Lt. Col. Oliver North*, 15

## The Telephone

The introduction of the telephone shows us once again how the pattern of communications technology takes shape. The telephone was initially received as an interesting but impractical device for communicating across distance. Although as Thoreau feared, the telegraph eventually did permit Maine and Texas and just about everywhere else to say nothing to one an-

other, Samuel F. B. Morse, who patented the telegraph and invented its code, saw no use for Alexander Graham Bell's even newer device, the telephone. Morse refused Bell's offer to sell him the rights to the telephone patent. He was convinced that no one would want the telephone because it was unable to provide any permanent record of a conversation.

Indeed, although we now consider it indispensable, like writing, the uses of the telephone were not immediately apparent to many people. Telephone communication combined aspects of speaking and writing situations in new ways, and it took a while to figure out what the telephone could and couldn't do. Once they became established, telephones were sometimes viewed as replacements for earlier technologies. In some cities, news and sports broadcasts were delivered over the telephone, competing with the radio (Marvin 1988). Futurologists predicted that the telephone would replace the school or library as a transmitter of knowledge and information, that medical therapy (including hypnosis) could be delivered and criminals punished over the phone through the use of electrical impulses. The telephone even competed with the clock and the thermometer: when I was growing up in New York in the 1950s, my family regularly called MEridian 6-1212 to find out the time, and WEather 7-1212 for the temperature and forecast.

Of course the telephone was not only a source of information. It also threatened our privacy. One early fear of putting telephones in people's homes was that strangers could call up uninvited; people could talk to us on the phone whom we would never wish to converse with in person—and no one predicted then that people selling useless products would invariably call at dinner time. Today, as our email addresses circulate through the ether, we find in our electronic mailboxes not just surprise communications from long-lost acquaintances who have tracked us down using Gopher and other Web browsers, but also unwelcome communiqués from intruders offering get-rich-quick schemes, questionable deals, and shoddy merchandise. Even unsolicited religious messages are now circulating freely on net newsgroups.

The introduction of the telephone for social communication also required considerable adaptation of the ways we talk, a fact we tend to forget because we think of the modern telephone as a reliable and flexible instrument. People had to learn how to converse on the telephone: its sound reproduction was poor; callers had to speak loudly and repeat themselves to be understood, a situation hardly conducive to natural conversation. Telephones were located centrally and publicly in houses, which meant that conversations were never private. Telephones emulated face-to-face communication, but they could not transmit the visible cues and physical gestures that allow face-to-face conversation to proceed smoothly, and this deficiency had to be overcome. Many people still accompany phone conversations with hand and facial gestures; very young children often nod into the phone instead of saying "Yes" or "No," as if their interlocutor could see them.

Initially, people were unsure of the appropriate ways to begin or end phone conversations, and lively debates ensued. The terms "hello" and "good-bye" quickly became standard, despite objections from purists who maintained that "hello" was not a greeting but an expression of surprise, and that "good-bye," coming from "God be with you," was too high-toned and serious a phrase to be used for something so trivial as telephone talk. As people discovered that telephones could further romantic liaisons, guardians of the public morality voiced concern or disgust that sweethearts were actually making kissing noises over the phone. Appropriate language during conversation was also an issue, and phone companies would cut off customers for swearing (like today's computer Systems Operators, or Sysops, the telephone operators, or "hello girls" as they were called in the early days, frequently listened in on conversations and had the authority to interrupt or disconnect calls).

While the telephone company routinely monitored the contents of telephone calls, when transcripts of telephone conversations were first introduced as evidence in trials, phone companies argued that these communications were just as private and privileged as doctor-patient exchanges (Marvin 68). Phone companies also tried to limit telephone access solely to the subscriber, threatening hotels and other businesses with loss of phone service if they allowed guests or customers to make calls. Telephone companies backed down from their demand that phones be used only by their registered owners once another technological development, the pay telephone, was introduced, and their continued profits were assured (this situation is analogous to the discussions of copy protection and site licensing for computer software today).

## The Computer and the Pattern of Literacy Technology

Writing was not initially speech transcription, and pencils were first made for woodworkers, not writers. Similarly, the mainframe computer when it was introduced was intended to perform numerical calculations too tedious or complex to do by hand. Personal computers were not initially meant for word processing either, though that has since become one of their primary functions.

Mainframe line editors were so cumbersome that even computer programmers preferred to write their code with pencil and paper. Computer operators actually scorned the thought of using their powerful number-crunchers to process mere words. Those who braved the clumsy technology to type text were condemned to using a system that seemed diabolically designed to slow a writer down well below anything that could be done on an IBM Selectric, or even with a pencil. (Interestingly, when the typewriter was developed, the keyboard was designed to slow down writers, whose typing was faster than the machine could handle; initially computers too were slow to respond to keystrokes, and until type-ahead capability was developed, typists were frustrated by loud beeps indicating they had exceeded the machine's capacity to remember what to do.)

Early word-processing software for personal computers did little to improve the situation. At last, in the early 1980s, programs like Wordstar began

to produce text that looked more like the typing that many writers had become used to. Even so, writers had to put up with screens cluttered with formatting characters. Word wrap was not automatic, so paragraphs had to be reformatted every time they were revised. Furthermore, printed versions of text seldom matched what was on the computer screen, turning page design into a laborious trial-and-error session. Adding to the writer's problems was the fact that the screen itself looked nothing like the piece of paper the text would ultimately be printed on. The first PC screens were grayish-black with green phosphor letters, displaying considerably less than a full page of text. When it came along, the amber screen offered what was seen as a major improvement, reducing eyestrain for many people. Today we expect displays not only with black on white, just like real paper, and high-resolution text characters, but also with color, which takes us a step beyond what we could do with ordinary typing paper.

If the initial technical obstacles to word processing on a PC weren't enough to keep writers away from the new technology, they still had to come up with the requisite $5,000 or more in start-up funds for an entry-level personal computer. Only diehards and visionaries considered computer word processing worth pursuing, and even they held on to their Selectrics and their Bics just in case.

The next generation of word-processing computers gave us WYSIWYG: "what you see is what you get," and that helped less-adventurous writers make the jump to computers. Only when Macintosh and Windows operating systems allowed users to create on-screen documents that looked and felt like the old, familiar documents they were used to creating on electric typewriters did word processing really become popular. At the same time, start-up costs decreased significantly, and with new, affordable hardware, computer writing technology quickly moved from the imitation of typing to the inclusion of graphics.

Of course that, too, was not an innovation in text production. We'd been pasting up text and graphics for ages. The decorated medieval charters of eleventh-century England are a perfect parallel to our computerized graphics a millennium later. But just as writing in the Middle Ages was able to move beyond earlier limitations, computer word processing has now moved beyond the texts made possible by earlier technologies by adding not just graphics, but animation, video, and sound to documents. In addition, Hypertext and HTML allow us to create links between documents or paths within them, both of which offer restructured alternatives to linear reading.

The new technology also raises the specter of digital fraud, and the latest literacy technology is now faced with the task of developing new methods of authentication to ensure confidence and trust in its audience.

Over the years, we have developed a number of safeguards for preventing or detecting fraud in conventionally produced texts. The fact that counterfeit currency still gets passed, and that document forgeries such as the *Hitler Diaries* or hoaxes like the physicist Alan Sokal's spoof of deconstruction, "Transgressing the Boundaries: Toward a Transformational Hermeneutics of Quantum Gravity," come to light from time to time shows that the safeguards, while strong, are not necessarily foolproof. The average reader is not equipped to detect many kinds of document falsification, and a lot of text is still accepted on trust. A writer's reputation, or that of a publisher, predisposes readers to accept certain texts as authoritative and to reject others. Provenance, in the world of conventional documents, is everything. We have learned to trust writing that leaves a paper trail.

Things are not so black and white in the world of digital text. Of course, as more and more people do business on the Internet, the security of transactions, of passwords, credit card numbers, and bank accounts becomes vital. But the security and authenticity of "ordinary" texts is a major concern as well. Anyone with a computer and a modem can put information into cyberspace. . . . Digitized graphics are easy to alter. Someone intent on committing more serious deception can with not too much trouble alter text, sound, graphics, and video files. Recently several former Columbia University students were arrested for passing fake twenty-dollar bills that they had duplicated on one of Columbia's high-end color printers. The Treasury Department reported that while these counterfeits were easy for a non-expert to spot, some $8,000 to $9,000 of the bad money had been spent before the counterfeiters attracted any attention. Security experts, well aware of the problems of digital fraud, are developing scramblers, electronic watermarks, and invisible tagging devices to protect the integrity of digital files, and hackers are probably working just as hard to defeat the new safeguards. Nonetheless, once a file has been converted to hard copy, it is not clear how it could be authenticated.

Digitized text is even easier to corrupt accidentally, or to fiddle with on purpose. Errors can be inadvertently introduced when print documents are scanned. With electronic text, it may be difficult to recover other indicators that we expect easy access to when we deal with print: the date of publication, the edition (sometimes critical when dealing with newspapers or literary texts), editorial changes or formatting introduced during the digitization process, changes in accompanying graphics (for example, online versions of the *Washington Post* and the *New York Times* use color illustrations not found in the paper editions). And of course digital text can be corrupted on purpose in ways that will not be apparent to unsuspecting readers.

Electronic texts also present some challenges to the ways we attribute expertise to authors. When I read newsgroups and electronic discussion lists, I must develop new means for establishing the expertise or authority of a poster. I recently tried following a technical discussion on a bicycle newsgroup about the relative advantages of butyl and latex innertubes. I can accept the advice of a bicycle mechanic I know, because we have a history, but posters to a newsgroup are all strangers to me. They may be experts, novices, cranks, or some combination of the three, and in the case of the two kinds of tire tubes, I had difficulty evaluating the often-conflicting recommendations I received. After reading the newsgroup for a while, becoming familiar with those who post regularly, and getting a sense of the kinds of advice they gave

toward the subject, I began to develop a nose for what was credible. My difficulty was compounded, though, because the most authoritative-sounding poster, in the conventional sense of authoritative—someone who evoked principles of physics and engineering to demonstrate that flats were no more common or disastrous with latex than butyl tubes, and who claimed to have written books on bicycle repair—was clearly outshouted by posters attesting to the frequency and danger of rupturing latex inner tubes. In the end I chose to stay with butyl, since everyone seemed to agree that, though heavier than latex, it was certainly not the worst thing in the world to ride on.

My example may seem trivial, but as more and more people turn to the World Wide Web for information, and as students begin relying on it for their research papers, verifying the reliability and authenticity of that information becomes increasingly important, as does revisiting it later to check quotations or gather more information. As anyone knows who's lost a file or tried to revisit a website, electronic texts have a greater tendency to disappear than conventional print resources.

## Conclusion

As the old technologies become automatic and invisible, we find ourselves more concerned with fighting or embracing what's new. Ten years ago, math teachers worried that if students were allowed to use calculators, they wouldn't learn their arithmetic tables. Regardless of the value parents and teachers still place on knowing math facts, calculators are now indispensable in math class. When we began to use computers in university writing classes, instructors didn't tell students about the spell-check programs on their word processors, fearing the students would forget how to spell. The hackers found the spelling checkers anyway, and now teachers complain if their students don't run the spell check before they turn their papers in.

Even the pencil itself didn't escape the wrath of educators. One of the major technological advances in pencil making occurred in the early twentieth century, when manufacturers learned to attach rubber tips to inexpensive wood pencils by means of a brass clamp. But American schools allowed no crossing out. Teachers preferred pencils without erasers, arguing that students would do better, more premeditated work if they didn't have the option of revising. The students won this one, too: eraserless pencils are now extremely rare. Artists use them, because artists need special erasers in their work; golfers too use pencils without erasers, perhaps to keep themselves honest. As for the no-crossing-out rule, writing teachers now routinely warn students that writers never get it right the first time, and we expect them to revise their work endlessly until it is polished to perfection.

The computer has indeed changed the ways some of us do things with words, and the rapid changes in technological development suggest that it will continue to do so in ways we cannot yet foresee. Whether this will result in a massive change in world literacy rates and practices is a question even more difficult to answer. Although the cost of computers has come down significantly enough for them to have made strong inroads into the American office and education environments, as well as in the American middle-class home, it is still the case that not every office or every school can afford to computerize, let alone connect to the World Wide Web. And it is likely that many newly computerized environments will not have sufficient control over the technology to do more than use it to replicate the old ways.

After more than a decade of study, we still know relatively little about how people are using computers to read and write, and the number of people online, when viewed in the perspective of the total population of the United States, or of the world—the majority of whose residents are still illiterate—is still quite small. Literacy has always functioned to divide haves from have-nots, and the problem of access to computers will not be easy to solve.

In addition, researchers tend to look at the cutting edge when they examine how technology affects literacy. But technology has a trailing edge as well as a down side, and studying how computers are put to use raises serious issues in the politics of work and mechanisms of social control. Andrew Sledd (1988) pessimistically views the computer as actually reducing the amount of literacy needed for the low end of the workplace: "As for ordinary kids, they will get jobs at Jewel, dragging computerized Cheerios boxes across computerized check-out counters."

Despite Sledd's legitimate fear that in the information age computers will increase the gap between active text production and routine, alienating, assembly-line text processing, in the United States we live in an environment that is increasingly surrounded by text. Our cereal boxes and our soft-drink cans are covered with the printed word. Our televisions, films, and computer screens also abound with text. We wear clothing designed to be read. The new computer communications technology does have the ability to increase text exposure even more than it already has in positive, productive ways. The simplest one-word Web search returns pages of documents which themselves link to the expanding universe of text in cyberspace.

Computer communications are not going to go away. How the computer will eventually alter literacy practices remains to be seen. The effects of writing took thousands of years to spread; the printing press took several hundred years to change how we do things with words. Although the rate of change of computer development is significantly faster, it is still too early to do significant speculating.

We have a way of getting so used to writing technologies that we come to think of them as natural rather than technological. We assume that pencils are a natural way to write because they are old—or at least because we have come to think of them as being old. We form Lead Pencil Clubs and romanticize do-it-yourselfers who make their own writing equipment, because homemade has come to mean "superior to store-bought."

But pencil technology has advanced to the point where the ubiquitous no. 2 wood-cased pencil can be manufactured for a unit cost of a few pennies.

One pencil historian has estimated that a pencil made at home in 1950 by a hobbyist or an eccentric would have cost about $50. It would cost significantly more nowadays. There's clearly no percentage in home pencil making. Whether the computer will one day be as taken-for-granted as the pencil is an intriguing question. One thing is clear: were Thoreau alive today, he would not be writing with a pencil of his own manufacture. He had better business sense than that. More likely, he would be keyboarding his complaints about the information superhighway on a personal computer that he assembled from spare parts in his garage.

5

# *The Effect of Hypertext on Processes of Reading and Writing*

DAVIDA CHARNEY

## Texts and Hypertexts

Most people conceive of *text* as a collection of ideas that a writer has carefully selected, framed, and organized into a coherent sequence or pattern in hopes of influencing a reader's knowledge, attitudes, or actions. A key element in this conception of text, from the perspective of both writers and readers, is structure. Linguists and discourse analysts have identified a host of structural patterns that writers work with (and, more frequently, against) at every level of text production, from small units, such as sentences and paragraphs, all the way to grand structures that describe entire texts, such as sonnets, fairy tales, résumés, or policy arguments (Halliday and Hasan; van Dijk; Fahnestock and Secor). Indeed, readers depend on such patterns to identify a text's genre, anticipate its development, and integrate its parts. Studies of reading comprehension confirm that readers understand and learn most easily from texts with well-defined structures that clearly signal shifts between parts (van Dijk and Kintsch; Kieras, "Initial Mention"; Frase). But apart from any natural disposition we may have to expect structure in text, our conception of text as an orderly succession of ideas is strongly reinforced by the constraints of the standard print medium: texts come to us on printed pages that we generally read in order, from the top down and from left to right.

Today, the constraints of the medium are being lifted by developments in computer technology. Visionaries of information technology foresee a time when most forms of written communication (from books and journals to reference manuals and mail) will be composed and disseminated electronically rather than on paper. And instead of taking the traditional form of linear blocks of prose, such online material will be presented in hypertexts that link together individual bits of text and even whole documents.[1] Thus far, the most common application of hypertext has been for computer manuals,

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