From Charles Bazerman ed.
Handbook of Research on Writing:
History Society School, Individual, Text
(Routledge 2007)

CHAPTER 2

History of Writing Technologies

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Despite Socrates' caution that writing gave the "appearance of wisdom instead of wisdom itself" (Plato, 1988, para. 275), humans have always desired means and media to preserve and reproduce expressions of their culture and history (H. Martin, 1988). History shows that different cultures developed technologies to create these means (hardware) and media (software) to accommodate their socioeconomic needs and to extend knowledge (Fang, 1997), or, as David Sholle (2002) puts it about technologies, they "do not simply fulfill a function in meeting natural needs, but rather their development is caught up in the social construction of needs" (p. 7). The history of writing technologies reveals a past, containing stories of competition and secrecy, of stability and portability, of resistance and acceptance, and of refinement and use. Although scientific observation often initiated changes in writing technologies, others appeared, as it so often happens, by sheer luck. Furthermore, some changes evolved slowly whereas others appeared rapidly. The writing stylus, for example, has kept a basic form for centuries, and the printing press changed little in appearance from Guttenberg's original 15th-century design until the early 19th century. As electricity's use and the development of electronics arrived, changes in technologies—in both form and function—accelerated. This chapter briefly explores significant developments in writing technologies that enabled humans to record the important, as well as the mundane, facts about their lives, and it places those developments into three somewhat permeable categories: manual, mechanical, and electrical/electronic technologies.

MANUAL TECHNOLOGIES

Long before Socrates' warning about writing, ancient civilizations were creating permanent records on stone and clay. Likely, the first writing hardware was a human finger dipped in plant juice or animal blood (Lambrou, 1989) and the first writing software a bone, a shell, or tree bark (Coulmas, 1996). Certainly, early hunter societies used animal hides for clothing, shelter, and writing. Still, no one knows with complete certainty who ingeniously realized some 5,000 to 8,000 years ago in Mesopotamia, China, or Egypt (H. Martin, 1988) that permanent records could be etched, stamped, or painted onto available materials. Many of these first transcriptions were likely a simple record-keeping shorthand useful for business transactions (D. Baron, 1999). In ancient Mesopotamia's fertile crescent of the Tigris and Euphrates Rivers, the abundance of clay and the development of a refined stylus with a wedge-shaped tip that made make fairly uniform triangular impressions led to cuneiform's development (Lambrou, 1989; Fang, 1997). These crude technologies were significant advances because they provided the first means and medium of creating and maintaining a standardized communication

system that preserved and spread meaningful examples of Mesopotamian culture (H. Martin, 1988), such as the epic story of the Babylonian King Gilgamesh, a story that ancient scribes preserved on clay about 4,000 years ago (Gilgamesh, 1996/1999).

In ancient Egypt, artisans working along the Nile River serendipitously found a new medium both lighter and certainly more portable than clay. Although lacking clay's durability, papyrus, fashioned from certain river reeds, split, and hammered together, proved relatively easy to manufacture. Its popularity turned Egypt into a papyrus mill for other civilizations, such as the Greeks and the Romans, who could easily scroll and transport important documents (Coulmas, 1996). Unfortunately, papyrus's lack of durability means today that few scrolls survived into the modern era (Fang, 1997). This significant disadvantage, combined with Egypt's production monopoly, likely encouraged the literate cultures of Greece and Rome to make greater use of an already available and lasting medium made from sheepskins. Like papyrus, parchment could be produced relatively cheaply, scrolled easily, and transported from points of origin; but unlike papyrus, parchment did not crumble with age and could be reused. Parchment's obvious technological advantages led to the medium's increased use, which eclipsed that of papyrus, and led to parchment becoming the preferred writing medium of both the ancient and the medieval worlds (Coulmas, 1996). Because both sides of a parchment page could be used, the development of the modern book became possible. For example, the early Christian Gospels were fashioned as a Roman codex, a book prototype that used cut parchment sheets bound between wooden covers (Fang, 1997; Petroski, 1990). By the second century BCE, the Greeks and Romans were using parchment or vellum, a similar material made from calfskin.

Although parchment and papyrus certainly suited the needs of their cultures, their significance as writing media would never surpass that of paper, whose origins began in ancient China. There writers had already experimented with diverse media such as bones and bamboo, silk and ivory, and developed permanent inks made from soot, lamp oil, musk, and the gelatin of donkey skin or from berries or other plants (Bellis, 1997/2006; Carter, 1955/1995). However, in 105 CE, Ts'ai Lun, a high-ranking eunuch in the Han imperial court, wisely recorded for the first time that plant and animal fibers, such as mulberry or bamboo, could be separated to produce the new writing medium—paper (Carter, 1955/1995; "The Amazing History of Paper," 2001). Because paper was thin, portable, and durable, it became popular among Chinese elites who wanted its manufacturing process kept secret (Coulmas, 1996; Fang, 1997; Weaver, 1937). For centuries, then, this new technology remained in China until finally spreading to Korea and Japan by the seventh century and a century later to Arab traders, who introduced the medium to Europeans (Carter, 1955/1995). Evidence in the form of old manuscripts on paperlike, cotton-based material indicates that Europeans were using the medium as early as 1050 (Carter, 1955/1995; Martin, 2003). As for paper's inventor, Ts'ai Lun, he later killed himself after becoming involved with imperial court intrigues.

Paper, papyrus, and parchment were not the only writing media used to keep records. Elsewhere another portable and cheap, but different medium barely survived the European conquest of South America. The Incan civilization developed khipu (or quipu), which used strings tied into sequences of knots to maintain records. For many years, archaeologists have assumed these strings and knots could be a method of business record keeping, and recent scholarship now suggests khipu could be a binary system of communication strings, similar to a computer language, that, if decoded completely, might unlock the secrets of Inca civilization before the Spanish arrived (Urton, 2003; Wilford, 2003). Because no "Rosetta stone" exists to decode the surviving pieces of this complex of knots and strings, they remain mysterious mementos of Spanish conquest of the New World. Elsewhere in the Americas, other pre-Columbian records stored on the inner bark of certain trees did not survive the Spanish conquest. One 16th-century missionary wrote of finding some early "literature" of the Yucatan peoples: "We found a great number of books written with their characters, and because they contained nothing but superstitions and falsehoods about the devil, we burned them all" (Fang, 1997, p. 7).

Just as writing media (software) evolved, so, too, did their hardware. Greek and Roman writers had already modified the stylus from a device used to make triangular cuneiform impressions to one that could hold ink for writing on papyrus or parchment. Initially, reeds made suitable writing implements because they could be trimmed to make broad or fine lines with simple inks from native plants or soot, but reed brushes wore out quickly. Because of this, scribes turned to other materials such as animal horns and bones, and, even among Pompeii's ruins metal pens have been found. At some point, someone discovered that a bird feather held ink, and, this led to the quill's fashionable use around 500 CE and its eventual dominance as the stylus of choice for more than a thousand years. Like reeds, quills have natural limitations and need constant replacement (Fang, 1989; Lambrou, 1997). By the 18th century, artisans, using the quill's design, made metal ink pens available. Although quills, pens, and ink were portable, writers needed to be vigilant to prevent messy ink spills. In 1883, inventor Lewis Edson Waterman solved this problem when, after several tries with various inks, he devised the first practical fountain pen in 1883 (Lambrou, 1997). An American, J. J. Loud, invented a version of a ballpoint pen in 1888, but it could only make marks on rough surfaces (see Albus, Kras, & Woodham, 2000). Fifty-five years later, the Hungarian journalist Laslo Josef Biro, experimenting with heavier printer's ink, small ball bearings, and the fountain pen concept, patented the first ballpoint pen, and Biro's name would become synonymous for the ballpoint pen (Albus et al., 2000). Marcel Bich, a French ink maker, improved on Biro's design and founded the company that bears his name, *sans* h. Bich introduced the Bic pen in 1950 and its ubiquitous see-through, crystal version in 1958 (see http://www.Bicworld.com).

Another stylus innovation appeared about the same time as metal-tipped pens became popular in Europe and America. The modern wooden pencil, as pencil historian Henry Petroski (1990) puts it, is a "dream invention" because it "needed no liquid ink," was "relatively clean and smudge-proof," and was "erasable" (pp. 30–36). The word comes from Latin's *pencillum*, a thin paintbrush the Romans thought early pencils resembled. Early pencils were crude and potentially lethal devices that used lead not encased in wood and exposed writers to lead poisoning or *plumbism*, as it was called. By the 18th century, pencil makers developed a more prudent pencil-making recipe that combined safer graphite with clay, which was cooked and extruded into pieces cut and glued into wooden frames. In the 19th century, the best graphite or *plumbago* originated in Borrowdale, England, and, in America, Henry David Thoreau, a man better known for his stay at Walden Pond, became a master pencil maker himself (Baron, 1999). Like the first, ancient Chinese paper makers and the modern computer software developers, 19th-century pencil manufacturers kept their plumbago recipes secret. Not all pencil advancements, however, won unanimous approval. For example, some early 20th-century schoolteachers warned that erasers attached to pencils would encourage students to forget how to prepare their lessons properly.

Certainly, writing technology's improvements led to greater needs for information storage and distribution. As to distribution, the Chinese created a postal system by the 10th century BCE (Martin, 2003) and sent official news throughout the dynastic empire. The Romans had a postal service by the fourth century CE (Fang, 1997) and posted "news by decree" in official diurnals, which busy slave scribes copied for subscribers (Martin, 1988). These scribes, who produced manuscripts quickly and relatively cheaply, became the essential hardware of a flourishing slave scribe-to-buyer publishing industry that began with the Greeks in the fifth century BCE and ended a thousand years later when Rome fell (Mumby, 1930). During the Middle Ages, religious monks sitting in their scriptoriums produced lasting, beautiful works of calligraphic art and replaced the slave scribe as the major producers of written text (Kubler, 1927). As Europe entered the Renaissance, these scriptoriums became vestiges of the past (Hobson, 1970). As for storage, nearly all ancient civilizations built libraries to house written works (Fang, 1997; Khurshodov, 2001; Jacob, 2002). The Greek Ptolomies built the Great Library at Alexandria in the third century BCE that contained possibly 40,000 volumes (Fang, 1997; Hobson, 1970). Some dispute exists about

who eventually destroyed the library in the fifth century CE, but it may have been the Bishop of Alexandria's order to destroy pagan temples that led to the library's eventual destruction. Centuries later, a forgetful medieval book borrower might face excommunication for failing to return an overdue monastery manuscript (Mumby, 1930).

The Chinese, who had already bested Europeans in the development of ink, paper, and postal systems, also advanced a printing technology called xylography, which eventually made *mass* communication possible. Xylography's importance cannot be understated because it *was* the "invention of printing" (Carter, 1955/1995), but pinpointing an exact date for its origin may be impossible because, as historian Thomas Francis Carter notes, its evolution "was so gradual as to be almost imperceptible" (p. 41). Another historian, Joseph Needham (1965a), asserts xylography or block printing started around 880 CE, adding that China's massive imperial "civil examination system" spurred the technique's use. Officials likely understood that the process, which transferred whole pictures and ideographic text from a carved block onto a permanent surface (Coulmas, 1996), might strengthen the central government's control by easily re-creating government-approved texts for distribution (Needham, 1965b). The oldest surviving printed book, however, is a ninth-century CE religious text called the *The Diamond Sutra* that presents Buddha's discourses on the "subject of non-existence of all things" (Carter, 1955/1995, p. 56; see also Fang, 1997; Kubler, 1927). Eventually spreading to Europe by the 12th century CE, xylography's use is evident on 15th-century Venetian playing cards (Martin, 2003).

MECHANICAL TECHNOLOGIES

Although manual writing technologies, notably the pencil, pen, and paper, remain in common use, they do not mass-produce information efficiently. Mechanical printing technologies made that possible. Of those mechanical technologies, the printing press and a system of moveable type, an idea the Chinese first developed but made little use of (Carter, 1955/1995; Gernet, 1996), transformed the literate world in the West. Johannes Gutenberg's letter press was a simple machine that resembled in form the basic wine-making press. Though history is murky about whether the German goldsmith knew much about China's block printing, Gutenberg deserves credit for revolutionizing printing technology by fashioning individual, reusable letters and setting them into a wooden frame, thus enabling any printer to duplicate a printed page as many times as desired (Fang, 1997). His system of moveable type also made infinitely more sense in Europe, whose printed languages, based on the Roman alphabet, required relatively few characters, versus in China, which, in Gernet's (1996) words, was "a world [in] one whose riches was precisely the wealth and diversity of the signs used for writing" (p. 335). Gutenberg also developed a suitable printer's ink, a combination of linseed oil and soot, which adhered cleanly to a surface and made printing possible on both sides of a page (Kubler, 1927). From about 1450 to 1455, Gutenberg and six workers completed 100 Bibles with 42 lines per page, each requiring an estimated 300 sheepskins to produce (Fang, 1997). Of the first Gutenberg Bibles, 30 were on parchment; the others were printed on paper. Like past innovators, Gutenberg desired secrecy but could not keep the knowledge of his letterpress and moveable-type system from reaching most of Europe by century's end, including England, where the printer William Caxton set up a printing press in 1476 (Mumby, 1930).

Books, especially the Bible and other sacred writings—now mass-produced in the common language or vernacular—prompted great social change in Western Europe and helped break the Roman Catholic Church's monopoly on the interpretation of important Christian texts (Curran, 2002; Eisenstein, 1983). Despite the Roman Catholic Church's reactionary efforts against what it viewed as heresies, such as the execution of printers like William Tyndale, who produced the first English Bible in 1526, the Church could not prevent the Reformation from spreading throughout Europe (Fang, 1997; Mumby, 1930). Letterpress

printing technology created as well two powerful groups, the printers and stationers and greatly expanded the literate class (Curran, 2002; Lebvre & Martin, 1984). The printed book replaced the manuscripts once done by monks and created a need for such innovations as the modern title page and improved book-binding techniques (Mumby, 1930).

However, centuries passed before the first truly significant change in printing technology occurred. *Stereotyping*—a term coined in the late 18th century—eliminated lead type's constant shortage by creating an impression of a type-set page for use and reuse (Fang, 1997). In 1803, the Earl of Stanhope received one of the first patents for this process (Kubler, 1927). Other changes, such as Friedrich Koenig's steam press that printed on both sides of a sheet of paper and Richard Hoe's faster, rotary cylinder press, ushered in a new age of mass-produced, printed text. These and later press technologies, such as lithography and offset lithography, which transferred a picture of the printed page onto a metal plate, gradually replaced the labor-intensive letterpress and relegated it to arcane and artisan endeavors (Fang, 1997).

By a rare coincidence, Gutenberg's printing press appeared almost concurrently with a greater availability of paper, which was a result of a short-lived surplus of cloth rags created by the Black Death that had ravaged Europe's population. Still, printing only increased a demand for paper, and technology needed to keep pace. In the early 18th century, the French naturalist and physicist Rene de Reaumur made an important observation about certain wasps' nests, which he noted were made from a pasty woodlike substance resembling paper. Printing's reliance on expensive, handmade paper from cloth rags or parchment would come to an end when, finally, decades later, a German cleric working with Reaumur's ideas created paper from wood pulp, a cheap and abundant paper source (Hunter, 1930). In late 18th-century France, Nicholas Robert built a machine that mass-produced paper in a continuous sheet cut to appropriate lengths, and across the Channel, England's Fourdrinier brothers financed refinement of Robert's machine that now bears their name and not Robert's.

Although the typewriter ushered in portable mechanical printing technology during the 19th century, the machine's conceptualization originated decades earlier when Henry Mill received a queen's patent for "an artificial machine or method for impressing or transcribing of letters singly or progressively one after another" in 1714 (Adler, 1973, pp. 47–48; Bliven, 1954). In subsequent decades, inventors tinkered with other "proto" type-writing machines variously called the machine *tachygraphique*, *universal compositor*, and *mechanical typographer* (Lundmark, 2002). Some resembled small pianos, and most were considered mechanical ways to help the blind "read" printed pages. Although many of these early typewriters passed into history, the "Sholes and Glidden Type Writer" made history. Christopher Latham Sholes and his partners, working for the Remington gun company, developed an upstrike machine that sold for $125 (Gitelman, 1999; Lundmark, 2002). Sholes gave the machine its name and chose its easily memorized but inefficient QWERTY keyboard layout, which prevented too-quick typists from jamming the keys by forcing typists to press with weaker fingers the most frequently used letters. Because the machine's other design flaw prevented the typist from seeing the page while typing, the Sholes typewriter lost the marketing edge to its major competitor, Underwood's "frontstrike" machine. This machine solved the "typing blind" problem in 1894, and typing "visibility" became a selling point with the public and with business. As the typewriter's commercial use increased, many women found they could find work outside the home. About this Sholes is to have said, "I do feel I have done something for women who have always had to work so hard. This will enable them to more easily earn a living" (Fang, 1997, p. 59; Thurschwell, 2001). The machine also changed composition, as media technology scholar Lisa Gitelman argued, by separating the author from the text during its creation. Pamela Thurschwell similarly observes that intimacy is mediated through "teletechnologies" like the typewriter and the telegraph. Mark Twain, one first notable author-typist, typed a note to his brother on his Remington that said it "piles an awful stack of words on one page" (reprinted in Current, 1954, p. 72). To his publisher, Twain submitted the first typewritten

manuscript, *Life on the Mississippi* (Lundmark, 2002). Although some technologies like the typewriter increased office jobs, others like the mimeograph machine eliminated them. The first mimeograph machine made in 1884 by Chicago inventor Albert B. Dick, quickly duplicated office documents while eliminating the need for office copyists or scriveners who had heretofore replicated them ("Antique Copying Machines," 2006).

In his book *Power of the Written Word,* Alfred Burns (1989) called the years from 1815 to 1914 the "Golden Age" of the printed word. Clearly, new printing and paper-making technologies created a new information age by making the printed word cheaper and more available to a mass 19th-century audience. As a result, the publishing industry's growth exploded along with a demand for popular literature and newspapers, especially the penny press (Fang, 1997). The penny press era, which began with Benjamin Day's New York *Sun* in 1833 and James Gordon Bennett's *New York Herald* in 1835, created a news media for the masses. The rise of the penny newspapers, which stressed scandal and human interest stories over those of commercial or partisan natures (Fang, 1997), led to the creation of the modern newsroom that separated printers from editors. New mass-communication technologies were determining newspaper content as well, leading to what press historian Donald Brazeal (2003) called the *perishability of news.*

American and European postal systems also improved to keep pace with burgeoning amounts of newspapers, business, and personal correspondence for delivery. In America, the Continental Congress created the future U.S. postal system by decreeing "that a line of posts be appointed under the direction of the Postmaster General from Falmouth in New England to Savannah in Georgia, with as many cross posts as he [sic] shall think fit" ("The Postal Service Begins, 1999–2006). In 1860, demand for fast delivery of news and correspondence from east to west led to the creation of the Pony Express (Fang, 1997), which the transcontinental railroad and telegraph abruptly turned into a romantic 19th-century artifact. In England, sending correspondence became simpler and more reliable as the country refined its postal system in the 1800s (N. Baron, 2000). In 1874, an international agreement reached in Berne, Switzerland, created the Universal Postal Union, which settled differences among nations regarding postal rates. Although not a writing technology *per se,* the simple postage stamp would symbolize America's success in quickly distributing communication. As the Industrial Age propelled the world through the 19th century, which historian Henri-Jean Martin (1988) called the "century of the communication revolution" (p.480), it ushered in the electrical and electronic age in mass-communication technology.

ELECTRICAL AND ELECTRONIC TECHNOLOGIES

In some respects, the history of electrical and electronic writing technologies is a story of technology catching up to science. The ancient Greeks and the scientists of the Enlightenment, for example, experimented with and were fascinated by electromagnetism ("A Ridiculously Brief History," 1999). Yet the idea that energy could be harnessed for communication did not happen until 1843 when Charles Wheatstone and William Cooke built the first electrical telegraph line, which paralleled England's Great Western Railroad (Fang, 1997). The telegraph made communication *instant* over long distances and turned electricity into a common carrier of communication (H. Martin, 1988). A method to standardize these electrical impulses into a universally accepted communication system developed in America when Samuel B. Morse perfected his codes of dots and dashes. Morse, after observing printers at work and noting their efficient arrangement of letters, realized that the most commonly used letters should become the most easily memorized codes (Winston, 1998). With U.S. government funding, Morse established the first U.S. telegraph line from Baltimore to Washington, DC, and sent along that wire his famous "What hath God wrought?" message to assistant Alfred Vail on May 24, 1844. Later that year, Morse warned Vail of the telegraph's misuse and cautioned Vail to "be especially careful not to give a partisan character to any information

you may transmit" ("Samuel F. B. Morse Preview," 1997). Morse code eventually pushed all rival systems into the footnotes of communication history. By the 19th century's end, Guglielmo Marconi's successful experiments on England's Salisbury Plains proved that wireless, electrical communication was also possible (Fang, 1997).

Other electrical writing technologies emerged in the 19th and 20th centuries and found their way into the modern business office. One of Morse's chief competitors, Alexander Bain, patented in 1843 the first facsimile machine that re-created images with electric impulses on specially treated paper (Bellis, 2006; Fang, 1997; Meadow, 1998), and the great American inventor Thomas Edison patented the first electric typewriter by the end of the 1800s (Adler, 1973). Later, a combination of photoconductivity and human ingenuity resulted in the first photocopier. In Astoria, New York, Chester Carlson, a shy soft-spoken patent attorney, along with his assistant experimented with India ink, a lightbulb, and wax paper to develop a feasible process that Carlson called *xerography*, which in Greek meant dry writing. Carlson, whose first photocopy read "10-22-38 ASTORIA," signifying the date and place of his success, finally sold the idea to the Haloid Company of Rochester, New York, a company that became better known as the Xerox Corporation. It sold the first office-friendly photocopier, the Xerox 914, in 1959 (Fang, 1997; "Making Copies," 2004; Xerox, 1999–2006). For many office workers, *to Xerox* is an infinitive defined as the act of making a photocopy of a printed page. The same principles underlying Carlson's early photocopier are the same as those applied later to modern facsimile machines and laser printers.

As a piece of writing technology, the computer's use was more evolutionary than revolutionary. During the Renaissance, Leonardo Da Vinci envisioned a computer, and, in the 17th century, the French mathematician Blaise Pascal created an eight-digit mechanical calculator (McCartney, 1999). By the Industrial Age, the first practical computers were mechanical contraptions made for business and government use (Freiberger & Swaine, 2000). In the late 1700s, the Frenchman Joseph-Marie Jacquard designed a machine that used punch cards to repeat intricate woven patterns. Because the machine also eliminated many mill worker jobs, some incensed workers destroyed these Jacquard's looms and, thus, became participants in the anti-industrialization, antitechnology movement known as the Luddites. In 1833, Charles Babbage adapted a similar punch card method for his "Analytical Engine" and, by the century's end, Herman Hollerith built a punch card machine to tabulate the 1890 U.S. census in the remarkable span of 6 weeks (Fang, 1997; "The Jacquard Loom," 2001–2003; McCartney, 1999).

Scientists working at the University of Pennsylvania built the first truly electronic computer, the ENIAC—short for electronic numerical integrator and computer—to compute ballistic firing tables that required relatively simple decimal-based mathematical operations (Meadow, 1998; Winston, 1998). The massive device weighed some 30 tons, took up an entire room with its nearly 19,000 vacuum tubes, and required a cool, constant stream of air to keep from overheating. ENIAC and other early, similar computers were not digital and needed full-time staffs to rewire hardware to enable the machines to handle new functions (McCartney, 1999; Stern, 1981). In 1938, William Hewitt and David Packard built a computer that used binary code in a Palo Alto, California, garage ("The Digital Century," 1999).

Further computer refinements such as random access memory in 1957 (Khurshodov, 2001) and solid-state transistor technology made computers smaller and faster. The integrated circuit and the microchip further increased speed and reduced size. Beginning in the 1940s, improvements in magnetic storage meant computers could maintain larger amounts of data, and, by the 1970s, hard disk drives resembling washing machines became common in data-processing departments managing payroll and other business functions. From the start, the news media recognized the computer's potential, and, for example, CBS News used a UNIVAC computer to predict an Eisenhower presidential victory in 1952 (Fang, 1997). However, the view that computers could also be word processors required a perceptual shift about them and their use (Ernst, Oettinger, Branscomb, Rubin, & Wikler, 1993).

In 1964, International Business Machines (IBM), which defined *word processing* as "electronic ways of handling a standard set of office activities—composing, revising, printing, and filing

written documents," took the lead in word processing's development. In the early 1960s, the company perfected its iconic Selectric typewriter with its unique golf ball-size typing element and stationary carriage. By 1964, IBM introduced a system called Magnetic Tape/Selectric Typewriter (MS/ST) that used reusable magnetic tape (Kunde, 1986–2001). The introductions of the floppy disk in 1972 (Ernst et al., 1993) and IBM's personal computer (PC) for home and office use in 1981 made the marriage of computers to word processing feasible and desirable. (Although Apple Computer had been selling personal computers by the late 1970s, it notably did not have IBM's marketing or financial clout.) In a rare move, IBM also contracted with Intel and Microsoft companies to manufacture PC computer microchips and disk operating software (Freiberger & Swaine, 2000), thus allowing other PC manufacturers to flourish. As a result, IBM and its clones dominated the personal computer market.

The explosion of PC clones in the 1980s created natural demands for word-processing software. One of the first, the "Electric Pencil" (Freiberger & Swaine, 2000), and early versions of Word, WordPerfect, and AppleWriter II were hardly user-friendly. One popular program, WordStar, was described as "difficult to learn" but "easy to use once the commands and the control keys become familiar" (Langman, 1998, appendix). As the word-processing market expanded, programs improved so that updated versions replaced the earlier ones with their strange codes and keystrokes (Baron, 2000). Today, word processors commonly present electronic pages to the typist just as they appear in printed and even published forms. Such innovations turned word processing into a primary computer use, and the advent of easy-to-use desktop-publishing software programs, such as the Adobe Company's PageMaker, enable anyone to produce printing house-quality documents.

True paperless, electronic communication began in the late 1960s with the simultaneous developments of the Internet and the U.S. Department of Defense's Advanced Research Project Agency's system of transferring packets of information (ARPAnet) (Sholle, 2002). By the 1980s, the early Internet was a sophisticated communication medium that used hypertext protocols to transfer whole electronic text pages to computer screens (Swiss, 2004). With electronic communication came electronic-mail delivery. Ray Tomlinson, a computer engineer working on ARPAnet's crude electronic-mail system, chose the "@" symbol to denote a Web address and sent the first e-mail message, that read, "QWERTYUIOP" (Bellis, 2006). Improvements such as the development of Hypertext Markup Language (HTML) enabled computers to share electronic documents regardless of the software application used to create them (Sellen & Harper, 2002). By the 1990s, anyone with Web design software could invite global visitors to an Internet Website, containing vast, perhaps unlimited amounts of electronically created digital material. In McLuhanesque fashion, the Internet has created new digital global villages where, according to Paul Levinson (1999), "centers are everywhere and margins are nowhere" (p. 7). Ironically, increasing electronic and digital communication has not decreased paper's use, as Abigail Sellen and Richard Harper argue in *The Myth of the Paperless Office*. Instead, they propose that the electronic age has simply switched communication's distribution from *printing-then-distribution* to electronic *distribution-then-printing*. Although the "hegemony of paper" may not be at an end, as Sellen and Harper (2002. p 5) note, the "new technologies will *shift* the role of paper rather than *replace* it" (p. 194; italics original).

The Internet as a communication technology could not have developed without previous writing and computer technologies (Sholle, 2002) and has become a hugely responsive and popular "means of communication" in the 21st century (Meadow, 1998). Advances in digital and electronic communication technologies have created a boom in knowledge-based industries, including libraries, news, and publishing, where some publications are now distributed strictly online, providing authors with new venues for their work. In newsrooms throughout the world, journalists and their editors are converging media as they update their online newspaper and broadcast editions. Even more remarkable, Michael A. Keller, the head librarian at Stanford University, has predicted the following: "Within two decades, most of the world's knowledge will be digitized and available, one hopes for free reading on the Internet, just as there is free reading in libraries today" (cited in Markoff &

Wyatt, 2004,p. A1). Powerful Internet search engines like GOOGLE enable anyone to obtain what had once been available in only printed text or to specialists. As for the mails, almost all documents once restricted to the mails (or fax) can be sent instantly in original form via e-mail attachment. Therefore, a combination of increasing computer speed, expanded memory capacity, durable and portable storage media like CD-ROMs, DVDs, the Internet (Khurshodov, 2001; Meadow, 1998) have permanently changed the nature of writing and communication. The inevitable results of such dramatic changes are still unknown.

CONCLUSION

Just as centuries ago when "new" media such as reeds and papyrus communicated human knowledge and culture, so, too, do today's "new" media of electronic bits and bytes. Furthermore, these new media do not necessarily replace old media if a need for that old media remains. It is important to understand, as Sholle (2002) notes, that "there is no clear moment at which a technology is something radically new, nor is there a definite point where a new technology eradicates previous technologies"(p. 9). Although it may happen that printed material will become what Meadow (1998) calls "technological artifacts" (p. 41), it is equally likely that readers will never completely forego printed words for electronic ones (e.g., Sellen & Harper, 2002; Swiss, 2004). Just as some observers have noted the printing press' standardizing effect on language, others have warned that electronic technologies will do the opposite. Truss (2004), the author of a popular English punctuation book, wrote: "Electronic media are intrinsically ephemeral, are open to perpetual revision, and work quite strenuously against any sort of historical perception" (p. 181). Despite her observation, it seems that no writing medium or technology has ever guaranteed permanence. The beginning of this chapter began with Socrates' warning that printing gave the "appearance of wisdom instead of wisdom itself." Although the philosopher's words are preserved on a printed page, another printed page in another book puts Socrates' warning this way: "It is no true wisdom that you offer your disciples, but only its semblance" (Plato, 1952, para. 275). Although an awkward concluding point, the comparison suggests that words merely put onto a printed page (or any other medium) hardly guarantee their immutability. As such, the effects that writing technologies—in fact all technologies—have on humans and human communication will continue as an important debate among scholars and practitioners for the present and the future.

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