Remembering the Office of the Future: The Origins of Word Processing and Office Automation

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Word processing entered the American office in 1970 as an idea about reorganizing typists, but its meaning soon shifted to describe computerized text editing. The designers of word processing systems combined existing technologies to exploit the falling costs of interactive computing, creating a new business quite separate from the emerging world of the personal computer.

Most people first experienced word processing as an application of the personal computer. During the 1980s, word processing rivaled and eventually overtook spreadsheet creation as the most widespread business application for personal computers.[1] By the end of that decade, the typewriter had been banished to the corner of most offices, used only to fill out forms and address envelopes. By the early 1990s, high-quality printers and powerful personal computers were a fixture in middle-class American households. Email, which emerged as another key application for personal computers with the spread of the Internet in the mid-1990s, essentially extended word processing technology to electronic message transmission. To the casual observer, word processing might thus appear to be among the most creative and important applications originated by the personal computer.

But in fact word processing was already the center of a thriving industry well before the personal computer gained general acceptance in business. Historians have not yet explored word processing's development, and so to provide a rounded treatment, I examine the story from multiple perspectives. I review the conceptual development of word processing and office automation; the development of word processing's constituent hardware and software technologies; the relationship of word processing to changes in the organization of office work; and the business history of the word processing industry.

Word processing: Overview

Word processing's origins are complex and various: Consider the genesis of the term *word processing*. Today, when someone talks about using a word processor, we think of a software package, such as Microsoft Word. However, in the early 1970s, when the idea of word processing first gained prominence, it referred to a new way of organizing work: an ideal of centralizing typing and transcription in the hands of specialists equipped with technologies such as automatic typewriters. The word processing concept was promoted by IBM to present its typewriter and dictating machine division as a complement to its "data processing" business. Within the *word processing center,* automatic typewriters and dictating machines were rechristened *word processing machines*, to be operated by word processing operators rather than secretaries or stenographers. Quickly, however, the term acquired a more specialized meaning to refer almost exclusively to computerized text editing systems aimed at office applications.

Computerized word processing does not fit the conventional concept of a distinct invention, attributable to a particular time, place, and brilliant mind. The creation of a distinct market for computerized word processing systems during the early 1970s was more a matter of repackaging, integrating, and marketing technologies already devised for different purposes. Word processing software's core technical capabilities were taken from text editors, used to manipulate program code on time-sharing computer systems since the 1960s. Word processing systems also drew on techniques in a number of broader, longer established fields in which computers were used to store, retrieve, index, and format textual information.

During the 1970s, the falling cost of interactive computer access made it practical to apply the same techniques to ordinary admin-

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istrative work, meaning that word processing's invention as a new computer application was more a matter of marketing than of any software breakthrough. During the 1970s, the first widely used computerized word processing systems were not application programs for general-purpose personal computers but minicomputer-based systems and special-purpose computer packages dedicated to clerical work. By the end of the 1970s, when someone spoke of purchasing a "word processor," he or she would have most likely been referring to a specialized computer system such as Wang Labs' Word Processing System. Only later did people begin to assume that a word processor was a program rather than a machine.

By the late 1970s, the computer industry was promoting a new vision—office automation—of which word processing was just a small part. The most advanced word processing systems of the early 1980s, such as the famous-in-retrospect Xerox Star, were created not as self-contained applications for stand-alone personal computers but as office automation systems for networked workstations. In the paperless office of the future, a multifunction networked workstation with word processing, email, and graphical and voice capabilities would sit on the desks of every manager and every professional.

I argue that office automation represented a decisive break with the earlier concept of word processing, based as it was on the segregation of document preparation in the hands of specialist clerical workers. However, office automation ran into technological, economic, and social problems. Workstations were expensive, while managers and professionals proved a more elusive target than typists for office efficiency experts. These systems were not widely adopted, but the broader vision of the electronic office they represented was eventually realized when personal computer hardware and software matured in the mid-1990s.

Instead of adopting specialist office workstations, most companies gradually shifted from word processing systems to stand-alone personal computers. These spread word processing power more broadly, shifting editing work from word processing centers into the hands of department secretaries and, increasingly, of managerial and professional workers.

Far from breaking new technical ground, the leading personal-computer word processing programs of the late 1970s and 1980s—such as EasyWriter, WordStar, and MultiMate—merely gave an increasingly good imitation of the more expensive and capable special-purpose systems. From this perspective, the proliferation of personal computers in the early 1980s triggered a 10-year detour away from the networked office model being promoted by the leading office automation equipment suppliers of the period. In a pair of articles elsewhere in this issue, Tim Bergin details the history of personal computer word processing packages; consequently, my analysis here is confined to a sketch comparing their abilities with those of earlier specialized systems.

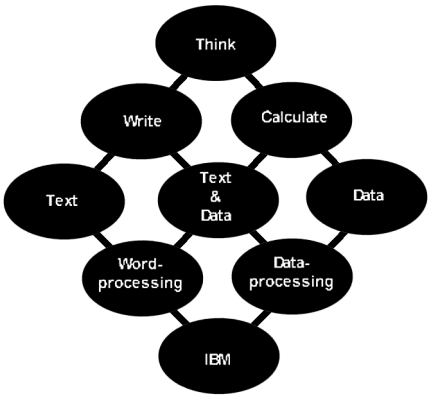

Figure 1. Steinhilper's chart, which he claims to have devised in 1955, reflects his original sense of word processing as a concept that would put IBM's Office Products Division on an equal footing with its Data Processing Division. (Courtesy of Ulrich Steinhilper.)

Invention of word processing

The phrase *word processing* was nowhere to be found in 1960s office management or computing literatures, though many of the ideas, products, and technologies to which it would later be applied were already well known. By 1972, however, discussion of word processing was common in publications devoted to office management and technology, and by the mid-1970s the term would have been familiar to any manager who regularly consulted general-interest business periodicals. *Word processing* paralleled the more general *data processing,* which since the 1950s had been the standard term used to describe the application of computers to business administration.[2]

Coinage of *word processing* is usually attributed to Ulrich Steinhilper, a German IBM typewriter sales executive. In his memoir, Steinhilper wrote that he devised the concept in the mid-1950s and promoted it for many years within IBM's Office Products Division. He submitted the diagram shown in Figure 1 to IBM's internal suggestion program, receiving just 25 Deutsch Marks and a reply that the idea was "too com-

plicated to explain." According to Steinhilper, the term finally caught on after he used it in a 1966 speech to senior Office Products Division managers gathered at the Miami meeting of the Hundred Percent Club of successful IBM salespeople where he lobbied, unsuccessfully, for Word Processing as a new name for the entire Office Products Division. In 1971, once the concept finally gained traction, Steinhilper was awarded an Outstanding Achievement Award and a trip around the world for having authored and promoted it. It had particular appeal to typewriter salespeople within IBM as a linguistic means of putting the Office Products Division (formerly the Electric Typewriter Division) on a more equal basis with the mighty Data Processing Division. The word processing concept cast the two groups as responsible for different, but equally important-sounding, kinds of business processing. Steinhilper recalls that its genesis came when he realized that

> We could confidently state that IBM, with its DP division, assisted in many ways in the processing of pages containing data, but could we say the same for the written word? Shouldn't we now, I asked, not also follow in the same direction with the Electric Typewriter Division?[3]

The first sustained public attempt to promote the idea of word processing to a broad American audience came in the minor office management and office equipment trade publication *Administrative Management*. In June 1970 it published a short article on a new word processing center at Auburn University, which had been "working closely with the local IBM representative" to centralize typing and dictating operations. This may have been the earliest mention of word processing in the American press. In December 1970, it ran a feature article on automatic typing systems that included the following definition:

> "Word processing," a concept that combines the dictating and typing functions into a centralized system, is replacing the one-man, one-secretary, one-typewriter idea in a growing number of firms. By organizing the flow of office correspondence on a more efficient basis, word processing is becoming to typing what Henry Ford's assembly line was to the original methods used for automobile making.[4]

Then in June 1971, *Administrative Management* devoted a special 32-page section to the new concept. *Administrative Management* continued to heavily promote word processing. It published a bimonthly magazine-within-a-magazine devoted to word processing, its publishers launched a separate twice-monthly newsletter—*Word Processing Reports*—to spread news of developments in the field, and its editor, Walter A. Kleinschrod, published a small book on the subject in conjunction with the American Management Association.[5] Other publications rushed to offer their own reports on the new field, and within a few months, a cluster of conferences, organizations, and consulting operations had grown up devoted to word processing.[6] The public's exposure to the concept of word processing took place almost simultaneously with the spread of the then-novel term *food processor*, a term introduced to the US in 1973 by Cuisinart to describe a multifunctional kitchen device able to chop, blend, and mix.[7]

But what was word processing? *Administrative Management* set the pattern for the next few years by defining word processing as a general approach to the reorganization of clerical work around new and emerging technologies. In its earliest days, the concept of word processing did not refer exclusively, or even primarily, to the use of full-screen video text editing. Advocates focused on a human rather than a technological goal. They sought to eliminate the practice of supplying individual managers or small work groups with their own "general-purpose secretaries" responsible for tasks ranging from filing and answering the telephone to making coffee and sorting the mail. In his book, Kleinschrod quoted findings that such women might spend just 2 percent of their time taking dictation and 19 percent of it typing and proofing documents. This meant that "her typing may not necessarily be all that good," that "it's very hard to establish procedures and controls over what she does," and that she would spend much of her time sitting around waiting for something to do.[5]

The traditional secretary was seen as the enemy of efficiency. The solution was to move all typing and dictation work to a centralized word processing center, where it could be handled by highly skilled, specialized typists and stenographers doing nothing but typing and transcription all day, using the most advanced equipment available. Kleinschrod suggested that a word processing center might achieve "a speedup from 500 to 1000 percent" provided that "the place is properly supervised [with] good methods, controls and standards."[8] He recommended

> a formalized work-measurement, work standards program. This involves the familiar techniques

of task analysis, methods-time measurement, standard allowed hours—techniques long used in the factory and in certain clerical areas and now being expanded to encompass WP.[8]

The technologies of early word processing

Although word processing was primarily a managerial rather than a technological concept, its sudden popularity owed much to a growing sense in the early 1970s that technology was about to transform the office. Because the new technology was bound to be complicated and expensive, this appeared to support the idea that clerical work would have to be specialized and centralized to take full advantage of its potential. Early news stories on word processing liked to point out that each factory worker was responsible for an average of $25,000 worth of equipment, whereas the poor clerical worker had only $2,000 worth of capitalization behind her.[9] Thus, the stories claimed, rising office labor costs reflected a failure to invest.

An *Administrative Management* editorial in January 1970 set the tone: "By the end of the 1970s," it suggested, "we should have climbed out of the Gutenberg rut. Paper—memos, letters and other business forms—will have been replaced to a large extent by electronic communications devices." This bold claim was based on the potential of dictating machines, calculators, and microfilm, rather than any clearly articulated expectations for the use of computers in the office. However, the author did anticipate computerized word processing with the rather vague prediction that "[t]ypewriters will continue to become more automated. They will be hooked into a growing number of [electronic data processing] systems." [10]

Two technologies were particularly associated with word processing: dictating machines and automatic typewriters. In its seminal 1971 special issue, *Administrative Management* included feature articles on both. "System Stage 1: Dictating Machines Sound Off Four Ways" reviewed developments in dictating technology. Technological advancements in dictating technology meant that desktop (and even handheld) cassette machines were common by the early 1970s, but word processing advocates were particularly excited by the ability of centralized systems, hooked into telephone switchboards, to provide a "continuous flow" of material from executive desks to busy transcribers. "System Stage II: Automatic Typing and Text Editing Devices" concerned itself with automatic typewriters.

This sense of word processing as a broad approach, including a variety of specific technologies, typified the early 1970s. IBM liked to apply the term to as many of its office products as possible. In the same 1971 *Administrative Management* issue, an advertisement (see Figure 2 next page) from IBM's Office Products Division suggested that its "range of word processing machines" included dictating machines, typewriters, and copiers.[11] According to one IBM document, the next year the Office Products Division "announced that all of its dictating equipment would be known as 'input processing equipment' since the term better describes the equipment's function within the total word processing concept."[12] A 1974 report noted that the division was "calling virtually everything it makes a piece of word processing equipment—from a dictating machine on up to an office copier."[13] Although dictating machines gradually slipped from definitions of word processing, discussion of word processing equipment continued to include electronic typewriters and other devices without large video displays well into the 1980s.[14]

Automatic typewriters were already a familiar office technology by the 1970s. They coupled a typewriter mechanism with an automatic control unit. The technology received its first widespread use in printing telegraphs, where a message entered on a keyboard was printed on a typewriter mechanism hundreds of miles away. One of the first automatic typewriters intended for clerical use, the 1917 Hoven Automatic Typewriter, used a wide tape roll and a mechanism modeled on a player piano to type up to 130 words a minute.[15] These machines were useful when preparing letters that included a mix of standard paragraphs with individualized elements. Other models gradually appeared, including the pneumatic 1935 Robotyper.

The 1950s saw widespread use of a more compact breed of automatic typewriter driven by six-track paper tapes, such as the Friden Flexowriter. Although Flexowriters are best remembered today in their role as I/O devices for many early computers or as terminals for corporate communication networks, they could also be used in a freestanding mode to record and play back text typed on the keyboard.

In 1964, IBM's Electric Typewriter Division introduced the IBM MT/ST or "Magnetic Tape 'Selectric' Typewriter". This machine coupled a Selectric or "golf-ball" typewriter with a bulky cabinet holding an electronic control mechanism that recorded keystrokes onto magnetic tape cassettes. Each tape could store 28,000

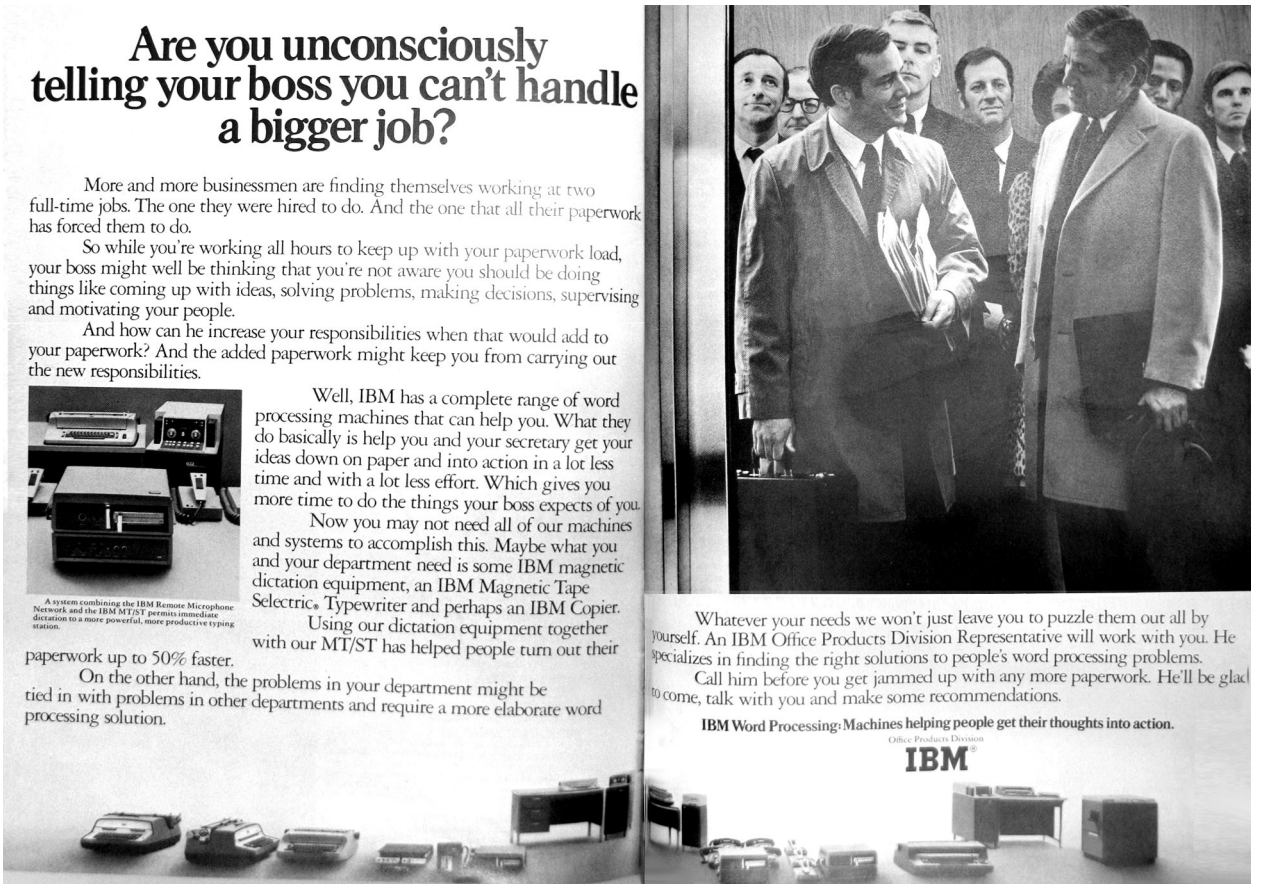

Figure 2. This 1971 IBM advertisement was one of the first to reflect the adoption of the phrase "word processing machines" by its Office Products Division as a new term for its dictation equipment, automatic typewriters, and copiers. (Courtesy of IBM Archives.)

characters. One novel feature was the ability to insert special codes on the tape to mark the start and end points of standard blocks of text. The biggest advance, however, came in its ability to correct simple typing mistakes. When a mistake was made, the operator would simply backspace the typewriter and retype the correct text over the error. This left a mess on the paper, but after finishing the page the operator would insert a blank sheet and wait, as the machine rewound the tape and retyped the corrected version at the rate of about 175 words a minute. The operator needed several months' experience and had to learn many special control sequences to become fully productive. The term *power typing* was often used to describe this new, more flexible kind of automatic typing.[16] The machines were also sometimes called *editing typewriters*.

When the first word processing centers were established in the early 1970s, most relied on IBM MT/ST machines. As a text editor, the MT/ST had some flaws. In particular, it was hard to edit text once it was recorded on tape, although this could be overcome by linking two machines together to copy the document from one tape to another, up to the point where editing was required. Things improved with the MT/ST Mark IV, which merged two tape drives into a single unit to make editing easier and to automate mail-merge operations (one tape would hold the outline of a standard letter and the other a list of names and other data to be inserted into personalized copies of the letter).

Another Selectric, the MC/ST (Magnetic Card/Selectric Typewriter), introduced in 1969, used small magnetic cards with a capacity of 5,000 characters. Neither model was particularly cheap—in 1972, the tape version sold for $7,875 and the card version for $7,150 (though many customers preferred to rent rather than buy). A more expensive machine, the MT/SC or "composer," could take the MT/ST tape and output it using proportionally spaced letters and other then-novel formatting options. Because the Selectric typewriter mechanism was widely available, many IBM competitors

used it as the core of their own competitive automatic typing systems.[17]

Early word processing in practice

Enthusiasts depicted word processing centers as good news for operators, who could now upgrade their typing skills and earn more money, and for the surviving secretaries, or—as some thought they should now be called, once freed from typing and transcription duties—"administrative support" specialists. *Business Automation,* a leading trade magazine for business computer users, claimed in 1972 that

> [t]he personal relationship of bosses and secretaries will be changed through the elimination of dictation and typing as we know it today. Secretarial duties will change greatly as transcription of dictation and the production of letters and documents is shunted more and more into a central word-processing center, freeing the secretary of much present-day typing drudgery.[18]

These ideas were common in early discussions of word processing. The *New York Times* first reported on the idea in October 1971, suggesting that word processing had been the new buzzword at the Business Equipment Manufacturer's Association trade show. Under a picture of IBM's latest automatic typewriter, the *Times* defined word processing as "the use of electronic equipment, such as typewriters; procedures, and trained personnel to maximize office efficiency." The paper also suggested that this could be the "answer to Women's Lib advocates' prayers" because it would eliminate traditional secretaries.[19] The same month, a *Chicago Tribune* report gave a similar definition, opening with the claim that "Women's Liberation has hit the technology field in the guise of a new theory called 'word processing.'" The report, which relied heavily on quotations from IBM managers, suggested that "The basic unit of word processing is the IBM Selectric typewriter, adapted to magnetic tape," that "the other mandatory tool" was a centralized dictating system connected to telephones, and that putting secretaries into a typing pool not only boosted productivity but also meant the women were given higher salaries with "more responsibility, less pressure."[20]

Nothing about the idea of centralizing typing and dictation was novel, except for the name—word processing—itself. Advocates of word processing, such as *Administrative Management* magazine and the American Management Association, were part of a community we can trace back to the scientific office management movement of the 1910s and 1920s.[21] That movement, in turn, was inspired by Frederick W. Taylor's *Principles of Scientific Management*.[22] The basic idea had changed little over 60 years: the office would work most efficiently when it resembled a factory in which workers were paid on a piece work or incentive bonus basis to perform highly specialized and repetitive tasks, slavishly following the optimal work procedures designed by experts. Expensive technology, scientific management adherents believed, could be justified only when combined with a fundamental redesign of work procedures to optimize their effectiveness.

Indeed, the prescriptions made by word processing experts of the early 1970s were identical to those made by office management experts of the 1910s with respect to an early generation of dictating machines. Both insisted true business benefits of the new technology would come primarily from work centralization and specialization that the new machines would demand. Back in the 1920s, William Henry Leffingwell (often called the "father of scientific office management") had hailed the dictating machine as an invention with the power to revolutionize the office. He seized on it to justify the elimination of shorthand stenography and in-person dictation, and its replacement with a centralized pool of typists who would handle a constant stream of wax recording cylinders delivered by messenger boys.[23] This would centralize work in the hands of specialists, who could be monitored and paid on a production bonus system—exactly the objectives espoused 50 years later by word processing experts.

In reality, the word processing center suffered from many of the same disadvantages as the centralized dictating pool of a half-century before. In response to its first coverage of the topic, *Business Automation* published a letter written by a word processor operator from Evanston, Illinois, identified only as "D.W." She complained about her physical conditions: MC/ST machines were noisy and the word-processor staff spent their entire working day in cramped conditions looking directly at a wall. But her bigger complaints were cultural. She was paid the lowest salary in the office and cut off from its social life, writing that "the people in the office regard those of us who run the machines as part of the machines rather than as human beings like themselves!" Early reports claimed that the shift to word processing reduced employee turnover, but D.W. disagreed. The work required people who were good typists, could spell, and would not become bored—a combination she found rare. "Word processing

What we would now think of as word processing technology has a separate history from the concept of word processing.

removes nearly all of the remaining rewards of secretarial work. ... In the last year two-thirds of the word processing personnel in my office have left." She was particularly prescient in her suggestion that the new technology would trigger endless rewrites, dashing hopes for paper savings.[24] IBM's early attempts to present centralized word processing centers as a breakthrough for feminism do not appear to have resonated with the women involved, however successful they initially were in grabbing newspaper headlines.[25]

Computerized word processing: Technical roots

The original sense of word processing to mean a centralized pool of typewriter and dictating machine operators to boost clerical productivity is now long forgotten. But, as we have seen, when word processing first gained popularity in 1971, no companies were promoting computers as general-purpose text editing systems suitable for routine office work. The development of what we would now think of as word processing technology, the use of computers to manipulate text, has a separate history from the concept of word processing. Only in the mid-1970s did people start to associate computers with word processing, and by late 1970s this was perhaps the fastest growing and most fiercely contested segment of the entire computer industry. This was not the result of any single conceptual breakthrough or technical innovation. Rather, computerized word processing was the recombination of existing technological capabilities, prompted by long-term declines in the cost of computer memory, disk storage, and processor power and a general shift toward distributed and interactive systems based on minicomputer and microprocessor technologies. Unlike some other breakthroughs in computer applications, such as the spreadsheet or relational database, the word processor was the historically inevitable result of dozens of minor and largely anonymous advances in the packaging and application of existing technologies.

To understand how this occurred, and where the technologies of computerized word processing came from, we must step back in time to explore a parallel history dating to the computer industry's early days in the 1950s. The sudden emergence of computerized word processing in the office was made possible by a far more gradual evolution in computerized text manipulation. From a business viewpoint, computerized word processing was invented in the 1970s. From a technology viewpoint, however, word processing's various capabilities had all been demonstrated by the end of the 1950s (though not all in the same system): displaying text on a video screen, storing text for easy retrieval on a tape or disk, printing formatted text on a printer within established margins, numbering pages, editing text by inserting or deleting characters, and applying operations such as search and replace.

Even in the 1950s, processing letters as well as numbers was not in the least novel. Admittedly, the first programmable computers, such as the Harvard Mark I and the ENIAC, were designed with numbers rather than letters in mind. But the nature of the stored-program digital computer as a general-purpose processor of encoded symbols meant that storing and manipulating a string of letters was scarcely different from manipulating and storing a string of numbers. Getting letters in and out of a computer was not a problem: punched card machines had added letters to their repertoire in the 1930s, and teletype machines could also handle textual input and store messages on paper tape.

Early systems followed the lead of teletype machines in using just 6 bits of memory to store each character, restricting systems to uppercase letters and a handful of punctuation characters.[26] By the 1960s, however, the EBCDIC coding scheme created by IBM for its System 360 machines and the ASCII standard favored by much of the rest of the industry gave computer equipment an easy way to handle the full range of English characters in both upper- and lowercase and a full range of punctuation marks.[27]

Computers thus had no absolute technical barriers preventing them from reading, analyzing, and printing text. However, this capability was never applied to general-purpose office work. It then seemed no more sensible to use a computer to edit than to travel to the shopping mall in a supersonic fighter jet. Only the plummeting cost of interactive computing could

turn an absurd luxury into an expensive tool with economic justifications in specialized fields, and eventually into an inexpensive office commonplace. The business data-processing applications of the 1950s and 1960s squeezed textual information into rigidly defined and rather short fields such as "title" or "last name," each corresponding to particular groups of columns on the punched input card. These would show up in the appropriate places on paychecks, invoices, and printed reports. This parsimony in text handling and storage is hardly surprising. Computer time was expensive, and space on disk drives and magnetic drums was limited.

Early text processing

Some specialized text processing applications did develop during the 1950s and 1960s, generally where one or both of the following conditions were met. First, the application involved much analysis and manipulation of the encoded text, rather than simply storing or editing it. Second, those involved had access either to a vast amount of money or to computer facilities they were not required to pay for.

A key feature of word processing systems, the automatic manipulation of text (literally, the processing of words), was pioneered in other systems early in the history of digital computing. During the early 1950s, the machine translation of natural languages was viewed as a promising area of research. This, of course, involved storing, processing, and printing documents, although as a necessary preliminary step rather than an end in itself. In 1954, IBM demonstrated a working, if highly limited, system able to translate a small number of technical phrases.[28] Although further progress was disappointing, this was the first widely publicized application of the computer to natural-language text processing. Also during the 1950s, the widespread adoption of assemblers and, from 1957, of high-level languages such as Fortran made the automatic parsing of computer languages a more successful kind of text processing.[29]

One of the best-known early applications of text processing was the analysis of literary texts. From the 1950s on, computers were used to cross-reference the occurrences of phrases within texts and to develop numerical descriptions of the prose styles associated with particular authors, shedding new light on long-running disputes over biblical and Shakespearean texts. Specialized "string processing" programming languages, most notably Snobol variants, emerged to aid textual applications.[30] Word processing capabilities such as search and replace, and even indexing, were just specialized applications of these techniques.

Computerized word processing systems made it possible to store entire documents on disk and retrieve them as needed. Again, this capability was not novel, but had previously been too expensive to apply to office correspondence. *Information retrieval* grew as a research area alongside the computer's spread during the 1950s and 1960s. While the term was also applied to systems based on punched cards, microfilm, and other technologies, by the late 1960s a number of online computer systems were being created to manage large volumes of text for corporations or government agencies with significant money to spend. These systems, used interactively through teletype terminals, were usually restricted to the retrieval of abstracts or citations based on user-provided keywords. Among the best known were the Dialog system (created for NASA by Lockheed) and the Orbit system produced by the System Development Corporation (SDC).

Time-sharing services made it possible to sell remote access to text retrieval systems. The Lexis database, launched commercially in 1973, offered full-text retrieval from a collection of more than two billion characters of legal and tax rulings. This service targeted two of the few groups able to support the huge costs involved: lawyers and tax professionals. A minimum subscription of $2,500 a month in 1974 helped make Lexis the first major commercial success in online text storage and retrieval.[31]

Enter the text editor

The direct technological ancestor of the word processing program was the text editor. In contrast to high-margin applications like Lexis, simply storing and editing ordinary documents such as letters and manuals showed little commercial value as an application for expensive computer time. Nevertheless, text editing applications seemed to surface with some rapidity whenever creative programmers were given unrestricted interactive access to a computer. The reason for this is straightforward: programmers write programs, program source files are text, and—given the chance—most programmers would rather use a terminal to enter the code directly into the system rather than wait for it to be punched onto a paper card for batch input. Eventually, interactive-computing costs dropped sufficiently to make interactive editing of the kind pioneered by programmers feasible for office work.

The core functions of a text editor are identical to those of a word processor: text must be entered, manipulated, saved, and processed. Text editors are not simply precursors to word processors but an earlier and continuing application of the same technologies for a different purpose. By the early 1970s, the most advanced text editors offered interactive full-screen video editing of text, search and replace, edit files too large to fit in the computer's available core memory, and most of the other key features of later word processing software.

The main difference between the two in terms of core functionality is that word processors usually add greater control over the formatting of printed output because their output is intended for humans rather than computers. But the key distinction is more cultural than technical: text editors are used by programmers to write programs and edit system files; word processors are used by everyone else to do everything else.

Among the first programmers free to experiment with online text editing were the young computer enthusiasts of Massachusetts Institute of Technology, memorably chronicled by Steven Levy in *Hackers*.[32] In the early 1960s, they found themselves in the almost unique position of having direct use of a reasonably powerful computer, the first production model of the DEC (Digital Equipment Corporation) PDP-1, without having to worry about paying for or justifying their time on it. Among the many novel or quirky programs they created was Expensive Typewriter, written by Steve Piner. It made seemingly profligate use of the computer to achieve basic text-editing capabilities and ease preparation of programs stored on paper tape.[33] MIT computer scientist John McCarthy wrote another editor, Colossal Typewriter, for the same machine. Another program, TJ-2, could format a text file to fit a page with margins and justification, sending output either to a tape or directly to a teletype. Although it did not allow onscreen text editing, it did use the PDP-1's vector screen to display candidate words for automatic hyphenation, which the user could manipulate with a light pen.[34]

Few computer users of the 1960s could hope to tie up a whole computer while they edited a program. However, time-sharing operating systems lowered the cost of interactive computing and thus spread online text editing somewhat more widely. These allowed several users to simultaneously access a single computer, each using a teletype unit to control the computer and run programs. Time-sharing systems became increasingly popular in computing research centers during the mid-1960s. Most systems let programmers enter and edit source code using a teletype unit. This code was saved, at least temporarily, on a disk or drum for input directly into a compiler or assembler. This meant that any useful time-sharing system required a text editor, and each major time-sharing research group appears to have produced more than one.

A memo MIT's John McCarthy had written in 1959, proposing the construction of the first time-sharing system, identified compelling advantages of the new approach: interactive debugging and the abilities to "write the program in source language directly into the computer" and to "check out a program directly after writing it."[35] In 1962, the first published paper to describe a working time-sharing system included discussion of its text editing abilities.[36] The finished version of this system, the Compatible Timesharing System for the IBM 7094, included both Typset, an editor, and Runoff, a program to output and justify text files. At SDC in Santa Monica, California, another center of time-sharing innovation during the early 1960s, programmers created an editor called Edtext.

Online text editing spread beyond the laboratory, along with time-sharing. QED, among the most influential of the early text editors, was developed during the mid-1960s by Butler Lampson and Peter Deutsch for the SDS 940 computer at the University of California, Berkeley.[37] Like other editors of the period, it was designed for use with teletype systems rather than video displays, meaning that each line in the document was numbered, and users typed commands to print, delete, move, or edit parts of the document. To edit a file, the user would select a particular line and then specify the required changes. QED boasted some impressive features including search and replace, multiple buffers between which text could be copied (giving capabilities similar to those we think of today as cut and paste), and the ability to label blocks of text for easy reference. QED spread widely, in part because Berkeley's system provided the fundamental technology for two of the earliest commercial timesharing services, Comshare and Tymshare. Tymshare, for example, used an improved version of QED called Editor.

When we think of a word processor now, we tend to assume that it includes a video screen showing many lines of text, around which the user can move a cursor to insert or edit material. Like interactive text editing in general, interactive text editing on video screens was applied to the editing of computer source code some years before it was widely used for office work.

With the spread of more powerful video screen terminals during the 1970s, editors acquired *full screen* or *screen oriented* capabilities. This meant that users could move the cursor to any line on the screen and edit, insert, or replace the text already there.

The editors discussed earlier were all *line editors*, designed to work with teletype systems. These could be used with any kind of terminal, and so remained a standard part of every operating system.[38]

The most celebrated video screen text editor of all, Emacs, originated at MIT as an extension of the institute's earlier TECO (*T*ape *E*ditor and *CO*rrector) editor, first developed circa 1963 for the PDP-1 by Daniel L. Murphy as a replacement for Piner's Expensive Typewriter. Using TECO to edit involved writing short programs in an exceptionally terse programming language to perform operations such as search and replace. This appealed to programmers, the primary users of text editors. Many versions were produced, and TECO evolved more as a programming platform and language for the creation of editors rather than as an editor.

Emacs, which stood for *e*diting *mac*ros, began as a standardized collection of TECO macros for full-screen editing created in the mid-1970s by Richard Stallman of MIT's artificial intelligence lab.[39] Though Emacs evolved into a freestanding editor, this heritage meant that it included its own programming language (a version of Lisp) and users could extend or customize it. Over time, Emacs acquired a wide range of extensions to do, for example, syntax checking and automatic code indenting, and more unusual things such as playing games and browsing Internet newsgroups.

Text formatting system

Meanwhile, computer systems were also making strides in the output of formatted text. Around 1967, Ken Thompson and Dennis Ritchie at Bell Labs produced new implementations of QED, including the specification of elaborate rules for search-and-replace operations.[40] A few years later, the same team created the Unix operating system on a small, almost obsolete PDP-7 system. Unix developed a system tool philosophy in which powerful but specialized software tools could be interconnected by linking their input and output text streams together via an innovation known as a pipe. The operating system kernel did little, but it was accompanied by powerful and portable tools. Unix tools, most notably roff and its successors nroff and troff, took textual input and formatted it for printed output. In fact, the first useful application of Unix was the formatting of patent documents. Unix tools were used in Bell Labs to produce large technical manuals directly on phototypesetting hardware, and soon found a broader audience. A 1981 survey called the troff/nroff combination "probably the most widely used text formatters in the world."[41]

Text formatting systems based on embedded control codes were widely used in the publishing industry, continuing practices established with earlier typesetting hardware. Tools like this provided similar output to later word processing software, but followed the earlier pattern in which separate application programs handled the text editing and the formatted document output. The ultimate expression of this stream of development is Donald Knuth's TeX document description language, created during the 1970s and 1980s.[42] TeX proliferated among computer scientists and mathematicians, who continue to love its programmability, its elegant and precise control over the formatting of output, and its masterful handling of equations. Most administrative users, however, showed little interest in a system that essentially required them to write their document as a kind of computer program and then compile it to view the output.

The users and creators of systems such as Unix, Emacs, and TeX systems differed notably from those of word processing systems, and viewed their tasks differently. Their creators often viewed textual manipulation (including editing and formatting) as a problem to be solved through the creation of flexible and programmable system building tools. Some aspects of their work, particularly advanced search-and-replace capabilities, eventually made their way into word processing, but despite technical similarities to word processing systems, these text editing tools were never designed for the general-office population.

Computerized word processing

Having surveyed the origins of computerized word processing technologies, let's return to the office of the 1970s to see how and why they were first applied to office work to create what we would now think of as the word processor. Text editing software reached the office through several distinct waves of computer technology: commercial time-sharing systems from the late 1960s onward, minicomputers from the early 1970s onward, and specialized word processing computer systems from the mid-1970s onward. Of these, the specialized computer systems were by far the most important in establishing a market for com-

puterized text editing. Over the 1970s, word processing centers increasingly adopted computerized word processing systems produced by firms such as IBM, Wang Laboratories, and Vydec to replace automatic typewriters like IBM's MT/ST. In this way, the original concept of word processing as the centralization of typing and dictation work around new technologies gradually merged with what we now consider word processing technologies.

At end of the 1960s, commercial time-sharing services gave businesspeople outside corporate data processing departments their first real chance to work interactively with computers. In principle, this opened up online text editing tools to a broad audience, though the combination of the high hourly rates charged by time-sharing services and the slow teletype machines used by most people to access them meant that this was not a particularly compelling application. This did not stop *Administrative Management* from promoting the idea in a 1970 article (shortly before it discovered the concept of word processing), when it suggested that

> automated text processing [was] a recently developed office application for time sharing. … Revisions and editing are quickly and easily accomplished without having to retype the entire document.[43]

At least some people in the business technology community believed that document editing was likely to become an important application of computer systems once inexpensive and convenient computer access was commonplace. One firm, Browne Time Sharing Inc., specialized in online text editing and processing services.[44] Browne launched its service in 1969, using an IBM 370 mainframe connected to dial-in telephone lines, and marketed to users needing to make frequent revisions to long documents. Its main business was as a financial printer, and it provided its clients with high-quality printed copies of their remotely edited documents by overnight delivery.[45]

The spread of affordable and increasingly powerful minicomputer systems during the late 1960s and early 1970s broadened access to interactive systems. Beyond disseminating interactive text editing for programming purposes, this situation also made it practical to consider minicomputers' application to document preparation, and appears to have happened first in technologically oriented firms and among those using computers to drive high-quality output systems.

Typesetting machines had been using paper tapes as input for decades. Some major publishers and newspapers had been using computers to prepare tapes for typesetting systems since the 1960s, and interest was growing in phototypesetting systems in which lines of text were generated optically under computer control.[46] Advances in printing technology, combined with the relative affordability of minicomputers, made text editing and computer-controlled phototypesetting viable for a much broader range of publications.[47]

But with different programming, a minicomputer could work much like an automatic typewriter, such as IBM's popular MT/ST. This opened a potentially huge market since, unlike larger computers, minicomputers could be sold directly to small companies or to small departments within larger companies. *Business Automation* profiled a Boston law firm that replaced its three MT/ST-typewriter-based systems with a DEC PDP 8/E minicomputer in 1970. Although Selectric typewriters were used for editing and input, output of large documents was much faster thanks to a high-speed printer. The new system had several advantages. Because it was interactive, it could warn when errors were made and prompt the user for input, making it much easier to learn than the MT/ST. And because it used disk rather than tape cartridges to store documents and standard paragraphs, a much larger library of standard paragraphs could be maintained and accessed with greater ease. The firm later added a second disk drive and a video terminal, allowing onscreen editing of documents. Of course, the minicomputer had the additional advantage that it could run software to perform other tasks such as accounting.[48]

Law firms were the most enthusiastic adopters of such systems. Their work centered on the regular production of long, intricate technical documents incorporating standard elements. This had to be done quickly and accurately. The expensive and novel technology of word processing could pay its way more easily here than in almost any other environment. Lawyers charged high hourly rates, and legal secretaries and paralegals were much better paid than typical office staff. For such firms, word processing was what would later be called a *killer application*—a piece of software so compelling that it justified the purchase of a complete minicomputer system merely to run it. By 1982, more than two-thirds of law firms had installed word processing systems.[49]

Special-purpose word processing systems

Minicomputer-based systems soon faced stiff competition from the new market for

video-based specialized word processing hardware.[50] Lexitron, a start-up firm, offered the first stand-alone word processor with a video screen in 1972. The document being edited was held in memory and displayed on the screen, then saved to magnetic tape or printed at the end of the session.[51] Linolex, a creator of video terminals and keyboards, added word processing capabilities to its terminal technology to create specialized systems. However, it was Vydec, a small start-up firm founded by a former Hewlett-Packard engineering team, that created the template for stand-alone, video-screen-based word processors. Its product, launched in 1973, was the first to display a full page (up to 66 lines) of text on the screen and included floppy disk drives and a daisywheel printer. Though expensive, at $18,000, the machines established the existence of a niche market in which Vydec initially faced little competition.[52] All of these machines sold slowly at first, as the start-ups focused their limited resources on organizations with heavy editing needs, such as federal government agencies. According to a March 1975 report, Vydec had installed almost 300 video word processing systems, Lexitron 1,000, and Linolex almost 700.[53]

While the original Vydec system was something of an engineering feat, the technologies needed to duplicate its capabilities became widely available over the next few years. By the mid-1970s, many firms had the expertise to design a word processor system by assembling a number of off-the-shelf components. Word processors were sold by many companies, including Redactron, Dictaphone, Lanier, CPT, NBI (Nothing But Initials), and Addressograph-Multigraph. The hardware, essentially the same used to produce a personal computer, was similar to that needed to create a video terminal, but it was bundled into a different product. The most obvious of the new components, the microprocessor, shrank the central processor unit of a simple computer to fit on a single chip.

The original Vydec model did not use a microprocessor, but in 1975 another start-up, NBI, produced a microprocessor-based word processor and other manufacturers were quick to follow. Expensive hand-woven magnetic core memory, the standard memory technology of the 1950s and 1960s, was quickly replaced in smaller computers with DRAM (dynamic RAM) chips, first sold commercially by Intel in 1970. This dramatically lowered the cost of a memory unit able to store a few pages of text for editing.

Another key technology was the floppy disk. Floppy disk drives were first sold in 1971 to store microcode for IBM mainframes. Within a few years, eight-inch floppy drives and disks were readily available from several manufacturers. Their main application was as a versatile, inexpensive replacement for punched cards and paper tape, becoming the standard medium for information storage and exchange on less-powerful computer systems. The floppies had significant advantages for word processing over the IBM MT/ST and MT/SC magnetic tapes and cards. Likewise, the falling costs and rising capabilities of video displays meant that a screen able to display a full page of text was no longer prohibitively expensive. The word processing software was stored on disks, and would run automatically when the machine was turned on.

By the mid-1970s, many firms had the expertise to design a word processor system.

Just as important, though less celebrated, was the daisywheel printer. Previously, computers had been coupled with adapted typewriter mechanisms such as the Flexowriter or IBM Selectric for slow, high-quality output and with large, expensive "line printers" to produce high-speed output on continuous paper. Daisywheel printers gave typewriter-quality output at several times the speed of a Selectric and with greater reliability under heavy loads. In 1972, Diablo (later acquired by Xerox) launched the first daisywheel printer. It faced stiff competition from Qume, a rival firm begun by the technology's original inventor.[54] Word processing systems usually incorporated a printing mechanism built by one of those two firms.

Word processing market matures

The small, specialized firms that pioneered the market faced growing competition over the next few years, most notably from Wang Laboratories. Wang had been selling specialized electronic devices, such as desk calculators and control equipment, since the 1950s. Its 1971 model 1200, like IBM's MC/ST, was a typewriter controlled by magnetic tape. Although not particularly ambitious technically—its control unit is said to have been adapted from that of a desk calculator—this earned Wang a foothold in the market.[55] Wang had been selling computers

since the 1960s, and in the late 1970s its computer and word processing product lines began to converge. In 1975, Wang launched the Wang Computer System (WCS) range, consisting of three models: the 10, 20, and 30.[55,56] The systems were integrated into custom-built desks, and were aimed at technical applications and small business administration.

Wang took a similar approach to selling its Word Processor System, launched in 1976. The Wang Word Processor range likewise included three models coded 10, 20, and 30. The screens and cases of the workstations used on this range closely resembled those of the WCS machines, though internally they used Intel 8080 microprocessors rather than the custom logic of Wang's earlier computers.[57] The model 10 was a stand-alone model with a daisywheel printer and single floppy disk drive, used to load the bundled word processing software and to hold documents. The model 20 supported up to three workstations and their three printers, networked via a proprietary coaxial system to a single "storage station" with twin floppy drives. Editing of one document could continue while another printed in the background. The model 30 built a hard disk drive into a customized desk and supported up to 14 workstations and printers.[58]

Although Wang's stand-alone model 10 was competitive with existing products such as the Vydec systems, it was models 20 and 30 that made Wang synonymous with high-end word processing systems. These machines created a new class of "clustered" word processing systems. It was many years before standard personal computers could share files with comparable ease and effectiveness. From the user's viewpoint, these systems provided capabilities similar to those based on multiple terminals connected to a minicomputer, referred to, in that era, as *shared logic* systems.

Wang was renowned for the quality of its support and documentation, and like its earlier calculator systems, its word processing systems were designed to be used by small-business people rather than technical specialists. They were easy to set up, and relied on menus rather than the command languages common among other text editing and formatting systems of the era. Harold Koplow, leader of the design team, began by writing the user manual for the system with his colleague Dave Moros, refining it until it described a system he believed a secretary could use with minimal training.[59] Only then did programming and design begin—although Koplow later claimed this strategy was not so much the result of a user-centered design philosophy as the unavoidable result of his having been deprived of resources after falling from favor with the firm's autocratic founder.[60] The Wang system of menus and prompts was indeed easy to learn, though some complained that expert users remained hobbled by the designers' assumption that secretaries required a highly structured interface.

Lanier Business Systems, which overtook IBM and Dictaphone in the market for dictating systems during the mid-1970s, also established itself as the leading supplier of stand-alone video-based word processing systems. Its "No Problem" word processor, introduced in 1977, was promoted as easy to use and, as the name suggests, with a certain folksiness.[61] This must have worked, because by 1978 it was outselling all its competitors with about one-fifth share of this fragmented market segment.[62] (Lanier later stumbled when it applied a similar approach to the computer market with its Computereze product line and by 1982 had lost its lead in stand-alone word processors).[63]

In contrast, IBM was slow to compete effectively in the market for video-screen-based word processors, something contemporary observers tended to attribute to internal politics, and in particular to a reluctance to undermine its lucrative MT/ST automatic typewriter business. In 1976, IBM held an estimated 80 percent of the word processing market, based almost entirely on the monthly leased payments it received for around 150,000 magnetic-card- and –tape-based Selectric systems.[64] IBM gradually enhanced these machines, offering several new models based on magnetic cards and revamping its product line to add small electronic memories able to store 8,000 characters for instant retrieval.[65] IBM also added communications functions to its machines, allowing them to transmit text to its computers. Its MT/ST machines were repositioned as companions for newer models such as ill-fated System 6, launched in 1976, which offered an expensive high-speed inkjet printer, floppy disk storage, and communication capabilities, but only an inadequate six-line video display.[64]

IBM's dominance eroded fast over the next few years, though by the end of 1979 it was still estimated to hold around 60 percent of the overall word processing market.[66] Only in 1980 did it finally offer a credible modern word processor with the Displaywriter word processing system, which used floppy disks to store documents and load programs and, as its name suggested, included a video screen for editing.[67] In response, Wang launched the relatively

affordable stand-alone Wangwriter, which sold to corporate customers for around $7,000.[68]

Computerized word processing in practice

Although the cost of word processing systems fell somewhat by the end of the 1970s, the systems remained too expensive for most companies to use as general replacements for typewriters. Instead, they remained fixtures of centralized word processing centers. This push to centralize typing and dictation work did not work well for all companies, even when mandated by senior managers. One consultant reported on an organization where "all of the typewriters were removed from the floors between a Friday and a Monday to make sure that everyone would have to use the new processing center."[69] The results were disappointing for many companies, especially where the work involved was complex and nonroutine.

By 1975, this insistence on the rigid centralization of clerical work had already inspired something of a backlash. IBM's competitors publicized its difficulties, and *Business Week* quoted a vice president of IBM's office products group as admitting that the company had pushed the idea onto firms for which it might not be appropriate. IBM, he explained, now recognized the need to let some secretaries keep their typewriters and to allow specialist groups to establish their own word processing operations.[70] However, the high cost of dedicated word processing systems made it hard for organizations to justify the costs involved in equipping personal secretaries with them. Centralized word processing operations continued to be the norm.

As a result, typewriters proved quite resilient. By 1980, traditional automatic typewriters such as the MT/ST were no longer attractive alternatives to computer-based word processing systems for customers able to spend $10,000 or more for each workstation. But the overall market for automatic typewriters continued to grow well into the 1980s. New firms such as Qyx and established typewriter companies like Olivetti and Smith-Corona competed in this market. The plummeting cost of microprocessors and memory chips made it easy for designers to include features such as a built-in memory able to store the last few pages typed. Editing capabilities were shrunk into a chip inside the typewriter itself, rather than a bulky external controller. At the time, the market for these machines, often called *electronic typewriters*, was perceived as the fastest growing and (in terms of unit sales) potentially the largest segment of the overall word processing market.[71] By the mid-1980s, many typewriters included single-line displays for easy correction and features such as spell-checking and tape or disk storage. Despite the increasing affordability of personal computers, electronic typewriter sales continued to grow until at least 1988.[72]

From word processing to office automation

By the end of the 1970s, word processing was increasingly seen as merely part of a broader goal: office automation. The office automation concept had gained currency in 1975, when *Infosystems* published an article titled "Here Comes the Automated Office" and *Business Week* ran a feature on "The Office of the Future," which proclaimed that "in almost a matter of months, office automation has emerged as a full-blown systems approach that will revolutionize how offices work," at least according to "office equipment makers and the research community."[73] Using slogans such as "the office of the future" and "the paperless office," a host of computer companies from industry stalwart IBM to upstarts like DEC and specialists like Wang served up virtually identical visions of a future in which clerical workers, professionals, and managers performed their daily work on networks of interconnected terminals. For computing suppliers, technology analysts, and data processing managers, office automation seemed a way to finally realize a goal that had been a cliché among computer enthusiasts for decades: a computer terminal on every executive's desk.

Indeed, office automation, rather than the personal computer, was the highest profile and most hyped development innovation of corporate computing during the second half of the 1970s and the first few years of the 1980s. Like the late 1950s and late 1990s, this was a period in which enormous publicity was given to the idea that computers were about to revolutionize business operations. Newspapers and business magazines were awash with discussion of new, or newly popular, buzzwords such as the microelectronic revolution, the information society, the chief information officer, information technology, the postindustrial society, and knowledge workers. The wave of enthusiasm for office automation reflected this broader faith in the transformative power of the computer and its application to ever broader areas of society.

Decades earlier, the office automation concept had enjoyed a brief vogue in business computing's early days. From 1954 onward, computers were successfully applied to clerical tasks in thousands of companies, though not always as economically or straightfor-

The shift in the business computing literature from word processing to office automation represented a change on several levels.

wardly as expected. During this period, the term *office automation* enjoyed brief use, only to vanish again until the 1970s.[74] This disappearance may have been triggered by the realization that computerization served not so much to automate the office as to physically and culturally remove various tasks from the office altogether.[75] Data to be processed by the computer was written onto special forms, to be punched onto cards in a remote and inaccessible data processing center. Voluminous piles of printout eventually made their way back to the office.

Inside the typical office of 1970, little would have shocked a time traveler from a half-century earlier. Documents were still typed, carbon copies still made for reference, messages still transmitted on paper through internal or external mail systems, telephones still used for instant communication, and documents still filed in hanging folders placed in vertical filing cabinets. Changes had occurred, but these were not overly disruptive: mimeograph machines and photographic copying techniques were supplemented by Xerox copiers, electric typewriters became common, calculating machines were now electronic (if still bulky and expensive), and correction fluid made it somewhat easier to remedy typing mistakes.

As originally conceived in the early 1970s, word processing was to continue this trend of work physically removed from the office, to be carried out in a remote center by specialists using expensive equipment. Just as data processing had removed activities such as customer billing, payroll calculation, and stock control from the office and transferred them to specialized equipment in a remote center, so word processing would remove typing and dictation from the office and handle them remotely with specialized equipment.

The return of the phrase *office automation* coincided with the realization that new technologies made it possible to automate ever more work but retain control over its execution in the office rather than shipping it out to a data processing center. This was not a result of the personal computer. The business computing experts of the early 1970s were certainly aware of the power of the microprocessor, and its ability to make inexpensive interactive video terminals a reality. But throughout the 1970s, corporate computing staff paid much more attention to the potential of microelectronics in specialized office automation technology than to early personal computers, which seemed ludicrously clunky and underpowered for business use. In the corporate context, office automation was largely a return to an older dream of a computerized, "totally integrated management information system" in which new and more efficient administrative procedures were designed by experts as part of an integrated and optimized system covering the whole business.[76] One expert made this explicit, suggesting that "word processing has the potential of leading us to the management information system that EDP [the Electronic Data Processing industry] has talked about for 10 years or more and never delivered on."[77]

This shift in the business computing literature from word processing to office automation represented a change on several levels. On the technical level, it was a shift from independent word processing machines or small clustered systems toward networked systems offering shared file storage, electronic mail, and access to larger computer systems. In terms of organizational politics, it was a shift of authority away from the office manager (responsible for clerical workers) and toward the data processing manager (responsible for computers). On the conceptual level, it represented a shift away from the idea that investments in technology should be justified by lowering clerical labor costs to an assumption that computers should be used directly by professionals and managers to make them more productive.

Early research in office automation

Academic and corporate researchers had been exploring the application of computers to managerial and professional work for some time. Doug Engelbart was perhaps the first person to publicly demonstrate the application of text editing technology to everyday managerial tasks. He sought a method of "augmenting human intelligence" through a partnership of human and machine, with the idea that the computer should be one's constant partner through the workday. Engelbart, an idiosyn-

cratic researcher at the Stanford Research Institute, is well known as the leader of the team that produced NLS (O*nl*ine *S*ystem), the first operating system to use windows or mice.[78] In 1968, he famously used a Joint Computer Conference to demonstrate the virtuosity of NLS to a shocked community of computer science researchers. The demonstration included several minutes' presentation of the system's ability to deal with a request from his wife to "do a little shopping on the way home" by creating and organizing a lengthy shopping list.[79]

NLS included many text editing capabilities of later word processors, including word wrap, search and replace, and scrolling, and the use of a mouse to select text to be cut and pasted between documents. Indeed, Engelbart's system was much more complex than most subsequent word processing systems, and was concerned with a document's underlying structure and with processes of group collaboration. NLS treated documents as a hierarchy of elements, enabling the user to expand or hide parts of a document outline, automatically number items, send electronic messages to other users, create hypertext links between documents, work collaboratively on document editing, and include graphics in documents. However, its user interface was complex and cryptic, and the system was never commercialized. NLS offered enormous power to those willing to commit themselves to its mastery but could never be grasped by the more casual user, despite Engelbart's conviction that it should become a universal companion to the human mind.

It took the office products company Xerox to reinterpret Engelbart's ideas in a fashion accessible to ordinary people. During the early and mid-1970s, Xerox researchers created the personal workstation concept, along with the graphical user interface (windows, icons, and pull-down menus), Ethernet, and laser printer. Many of its staff members were veterans of Engelbart's research group, and the researchers followed a similar practice of creating fully developed systems for their own daily use. The story of how Xerox's PARC pioneered many of the key hardware and software technologies of today's computers is perhaps the most celebrated tale in the history of the personal computer. Yet the connection between PARC's accomplishments and the mid-1970s enthusiasm for office automation is often overlooked. It's true that PARC's key researchers were computer scientists, rather than experts on office work. But Xerox's interest in funding the lab stemmed from the general sense that computerization was about to reinvent the office, rather than a philanthropic desire to advance knowledge.

The firm's leaders saw the lab as an insurance policy to make sure that Xerox retained its position in the office of the future, even as printing technologies changed. In mid-1971, PARC's staff created a detailed description of their ideas for the office technology of the 1980s, which served both to win internal support for their work and to guide their subsequent efforts.[80] By 1975, PARC's achievements were already being reported at length in *Business Week* in a feature titled "The Paths to the Paperless Office," further reinforcing the general faith in office automation as an inevitable trend.[77]

The Bravo text editor was one of PARC's most influential creations.[81] Because the Alto computers designed at PARC had high-resolution bitmapped displays and were networked to laser printers, users could create pages mixing graphics with proportionally spaced text in multiple fonts and sizes, display these pages onscreen for direct editing, and print them with unprecedented clarity. Previous text editors had been oriented toward the creation of computer text files. The formatting of printed output was accomplished by entering special codes and interpreted by a separate program. Bravo and its successors merged the functions of these programs to create what was soon dubbed the WYSIWYG (What You See Is What You Get) approach to text editing. Its authors included Butler Lampson, one of the creators of the QED editor, and Charles Simonyi, who went on to lead the development of Microsoft Word. Simonyi himself has suggested that Microsoft Word was based in large part on Bravo and borrowed several of its novel features, including the use of style sheets to simplify the application and modification of formatting standards to different parts of a document.

Other PARC technologies let Alto users share files on network servers and transmit electronic mail messages using the Laurel email program. By 1977, when the first mass-produced personal computers such as the Apple II appeared, these technologies were largely mature and in daily use within Xerox PARC.

Office automation industry

Xerox had unveiled a plausible prototype for the automated office in its lab, but turning this into a successful product family was another story. By the early 1980s, the producers of minicomputers, word processing systems, and even microcomputers were targeting the same strategic goal: integrating word processing sys-

tems with networks and other kinds of data to knit them into more broadly based office automation systems. By the early 1980s, this idea was so widely accepted that one study evaluated whether word processing technology had reached its "system potential" by determining whether it had "brought about any change in management jobs." Unsurprisingly, only 3 out of 21 firms surveyed had "evolved along this critical dimension."[82]

Given the increasing competition and lower margins developing in the market for standalone word processing systems, this push for managerial use made some sense, though it was not in the end a particularly successful strategy. The shift from clerical workers to managers and professionals presumably reflected an assumption that businesses might be more willing to spend $15,000 or more per desk on a system to help a manager manage or a lawyer litigate than to spend the same amount on a system to make a typist more productive. The more expensive the employee, the more valuable a productivity boost would be and so the easier to rationalize the investment. But the strategy faced insurmountable technical and economic issues, most famously seen in Xerox's efforts to sell products derived from its pioneering Alto. The Star workstation, introduced in 1981 for $16,595 per workstation (plus the cost of printers and servers) has gone down in computer lore as a remarkable piece of engineering, whose commercial prospects were crippled by its high price tag and by a notable sluggishness. The software designers' ambition outstripped the hardware's power to support it.[83]

Xerox was by no means the only company committing huge resources to the putatively emerging market for integrated office automation systems. IBM, Wang, DEC, and Xerox were all competing to set standards for the field. DEC was selling its All-In-1 integrated office system, including email and filing capabilities as well as word processing. IBM had announced a grand initiative called SNA to network together all its varieties of computer for the smooth exchange of documents and data between office computers and large mainframes. All the major players were exploring new technologies such as video scanners and hybrid documents containing text, charts, and graphics.[84]

Wang's successor to its bestselling Word Processing System, the Wang Office Information System (OIS), launched in 1979 and first shipped in 1980. The OIS was intended to broaden Wang's success with word processing into other areas of business computing. Like its earlier "clustered" word processing systems, the OIS joined individual workstations, each with its own microprocessor and memory, to file servers holding hard disk drives.[85]

Leadership in this field was seen by many as Wang's to lose. By 1982, Wang Labs had captured just over half the market for "clustered" word processing systems and faced little competition there. A new version of its Office Information System called Alliance claimed to offer "data processing, word processing, audio processing, image processing and networking," though in practice it worked slowly and not all these features materialized.[86] Meanwhile, its VS line of powerful 32-bit minicomputers was making a strong showing in the market for mid-size computer systems.[87]

In 1984 it announced its Office integrated software suite to integrate word processing, telephony, and email. That year, as Wang's stock reached its all-time high, a leading computer industry analyst praised the firm as the "Orient Express of Office Automation," remarked on its high R&D spending and its technological creativity, and suggested that, "Wang has both management and marketing to go the distance." He forecast that by 1990 Wang would be the third largest firm in the computer industry.[88] By that year it was, in fact, the tenth biggest, but poised for bankruptcy rather than growth. Its founder, An Wang, had insisted on keeping family control of the business and failed to set up a suitable succession process. Wang Labs struggled, announcing ambitious projects that appeared years late or not at all, while its high-priced integrated systems came under increasing pressure from competitors.

Office automation in use

Users, as well as producers, were struggling to turn the promise of office automation into a productive reality. During the early 1970s, corporate computing managers (heads of data processing and management information systems departments) had viewed word processing as part of office work and therefore of little more concern to them than typewriters or dictating machines. But the idea that the future of business computing lay with elaborate, networked systems able to file, process, and transmit documents of all kinds prompted corporate computing managers to assert control over word processing technology. According to one contemporary, this issue was often "discussed in the abstract, or in the context of relatively empty arguments about whether WP [word processing] or DP managers would become the 'information managers' of the future."[84] The prospect of office automation raised some fun-

damental questions about the role of a centralized computer department in an era of distributed computer systems, topics which became still more important during the late 1980s as companies began to realize the same basic vision through client-server systems based on personal computer technology.

One example of the changing relationship between office work and computing comes from Exxon, which by 1980 was making a major effort to establish itself as a supplier of electronic office equipment, with products marketed or under development in a dozen business units including Qyx for automatic typewriters and Vydec for high-end word processors.[89] Perhaps inspired by the desire to provide a showplace for these technologies, Exxon had in 1976 formed a joint team between its computers and systems group and its administrative services group as the convergence of computer technology and office work became apparent, thus avoiding the turf disputes between the two that plagued many companies. By 1980, a permanent Office Systems Technology Division employed 23 people and had the construction of a single integrated system as its explicit goal. The leader of Exxon's effort wrote of an automated system "having work stations in every manager's, professional's, and secretary's office, tied together into a network via appropriate communications."[90]

But as a central, functional group, the Exxon team's practical authority over the firm's many offices was limited. This problem must have been compounded by its conviction that "the real target for office automation was the managerial and professional worker."[90,91] This justified a focus on things like shared calendar systems and project control tools. Managers, however, were much better placed than typists to resist the efforts of office experts to reorganize their work habits. In practice, firms were more likely to force secretaries into word processing centers than impose collaboration systems onto their senior managers. Professionals and managers exercised more autonomy, carried out less routine work, and were culturally and organizationally better equipped to resist encroachment on their preferred ways of doing things.

The "office of the future," with its beige cubicles, bland furniture, and computer monitors and keyboards on every desk became a familiar setting in popular culture, appearing in 1980s films such as *After Hours* and *Working Girl*. It sometimes served as an emblem of the emptiness and impersonality of corporate capitalism, most consistently on the pages of *Processed World,* a radical magazine published by politically minded and underemployed office workers of the San Francisco area. "Are you doing the processing? … or are you being processed?" asked the cover of the first issue, under a picture of someone whose head was replaced by a computer (see Figure 3 next page). The magazine was sometimes sold with the chant, "If you hate your job then you'll love this magazine."[92] Academics and critics produced a wealth of books on the consequences of white-collar automation, including Barbara Garson's snappily titled *The Electronic Sweatshop: How Computers are Transforming the Office of the Future into the Factory of the Past* and Shoshana Zuboff's weighty *In the Age of the Smart Machine: The Future of Work and Power*.[93]

Rise of the personal computer

The modern-day ubiquity of word processing and email is, of course, a consequence of personal computer technology's proliferation. But thus far the story of the conceptual, technical, commercial, and practical development of word processing has been told almost without reference to the personal computer. This is because, at least until the mid-1980s, the personal computer industry made no real contribution to the development of word processing technology. Whereas new applications such as video games and spreadsheets maximized the strengths of personal computers while minimizing their weaknesses, the reverse was true of word processing. Until the mid-1980s, word processing was better tackled using other kinds of computers.

In 1976, most people who were getting their hands on early personal computers such as the Apple I or an MITS Altair had to be prepared to solder their own circuit boards, build their own cases, or create their own interface boards. The same year saw the launch of the Wang Word Processor line with its polished documentation, easy-to-use menu systems, and file sharing capabilities. Early personal computer users also faced a dearth of high-quality applications software. The situation was slow to improve, even after new machines such as the Apple II and TRS-80 were mass-produced from 1977 on. The first word processing programs for the Apple II, such as Electric Pencil and Apple Writer, were crude copies of those produced for minicomputers and dedicated word processing systems.[94] The programs were often outpaced by touch typists, had badly designed user interfaces, and lacked even the most basic features. The user manual for Electric Pencil, for example, warned users that "Words or phrases may be underlined ONLY in lines shorter than 62 characters and

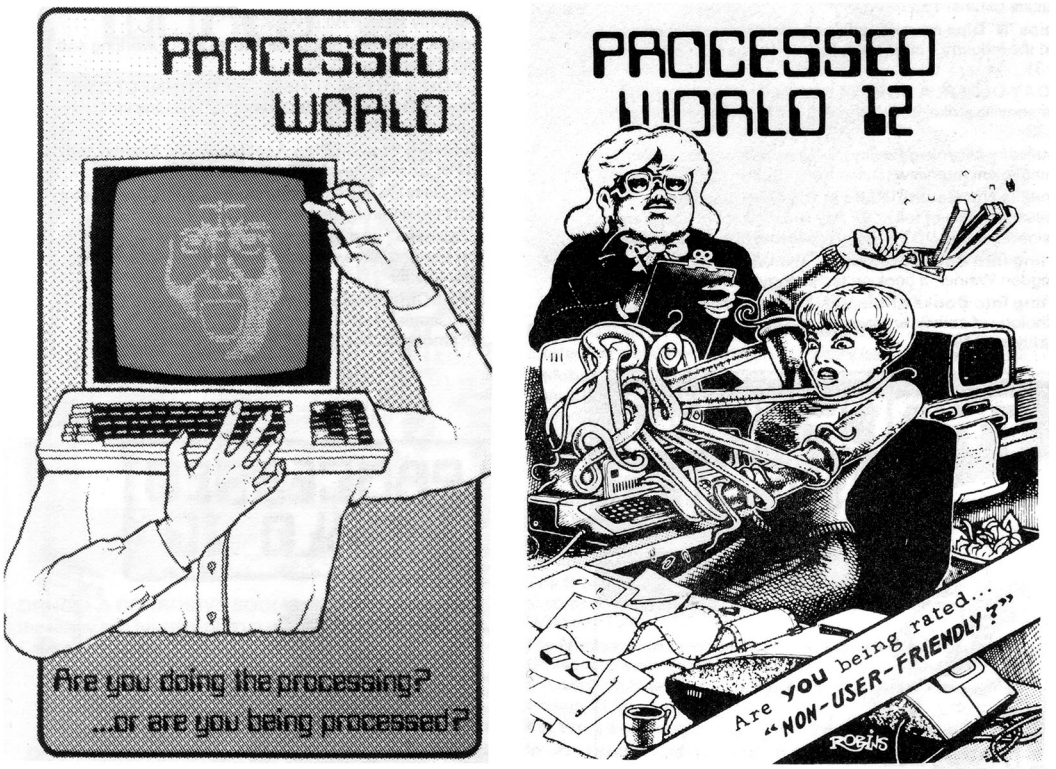

Figure 3. The radical San Francisco magazine *Processed World* illustrates the resentments felt by some office workers during the 1980s toward the use of office automation technology. (Reproduced with permission of Chris Carlsson; http://www.processedworld.com.) The issue 1 cover (April 1981, on the left) is "Are you doing the processing?" by Linda Wiens. The issue 12 cover (November 1984, on the right) is "Non-User-Friendly" by Hal Robins.

terminated by a LINE FEED. Underlining is not permissible within justified text."[95]

The only real virtue of personal computers for word processing was their low cost: a minimal Apple II system plus software was much cheaper than, for example, a Wang. However, the minimal Apple II system was so badly suited to word processing that only a dedicated hobbyist would be likely to bother. As one unusually frank enthusiast admitted, "An Apple II can be tortured into a decent word processor—at great expense."[96] Standard Apple II machines, even when equipped with an optional but common floppy disk drive, had only a 40-column display and lacked lowercase letters altogether. This made it necessary to scroll the screen to read an entire line of text, and forced programs to use colored or inverted text to represent lowercase letters.

Further hardware expansions could remedy these problems but the new capabilities remained clumsy. For example, the only way to type a capital letter at the start of a sentence was to push the shift button twice, type the letter, then push the shift button twice more to reset to lowercase. Hobbyists on a budget would connect personal computers to televisions rather than dedicated monitors, but text was hard to read—a conspicuous problem for word processing. The other problem was the cost of a high-quality daisywheel printer suitable for business correspondence, and the installation of a serial card to drive it. In the late 1970s, such printers cost $3,000 to $5,000, closing much of the cost gap between an Apple and a dedicated word processing unit.[97]

Matters were better with early business-oriented personal computers based on the CP/M operating system, such as those produced by IMSAI and Cromemco. These machines connected to separate terminals and so could be plugged into just the same expensive high-quality text displays and keyboards as minicomputers. Cromemco had a reputation for producing some of the most solid and businesslike CP/M hardware. But its software lagged far behind. One reviewer noted that users were liable to lose a lot of text when using its Writemaster program, because the command to delete everything from cursor to the start of the

file was only one key away from that used to remove underlining and operated without any further confirmation from the user.[98]

MicroPro's WordStar, launched in 1978, established itself as the leading word processor software for CP/M machines. Although it was considerably better than Electric Pencil, it suffered from a badly designed user interface, and the nonstandard nature of CP/M systems required users to spend considerable effort configuring it to work with their own computer, terminal, and printer. This also limited its capabilities to those supported on lowest-common-denominator systems—for example, WordStar used the combination of the control key and S,E,D and X to move the cursor around the screen because many systems lacked dedicated cursor keys.

Well into the 1980s, corporate users continued to prefer dedicated word processing systems to personal computers. WordStar picked up features over the years, but these only added to its awkwardness. One 1983 review of WordStar 3.0 described it as "thousands of Rube Goldberg straps and ropes holding things together without any overall unifying concept (or even a dozen)."[99] The situation was still worse with software written for cheaper home computers such as the Commodore 64. As late as 1984, an introductory guide could report that "most word processing programs for home computers are written by high-tech freaks who've never learned to type properly."[100]

An exhaustive comparison between the features and documentation of 14 microcomputer programs and dedicated systems as of late 1981 found that "dedicated word processors and microcomputer word-processing programs are comparable in their abilities."[101] Three of the top four systems reviewed were dedicated systems, and the author noted that these were much better documented and supported than the software packages. However, the cost of the dedicated full-screen units ranged from $16,000 to $6,000, making them more expensive than comparable microcomputer systems.

The IBM personal computer, launched in 1981, quickly displaced CP/M machines as the standard for business use. Its capabilities were only modestly greater than those of its CP/M-based competitors, but because IBM standardized screen, keyboard, and disk options, software writers could exploit its features without making users go through complex configuration procedures. For the next few years, the IBM PC version of WordStar, a faithful duplication of the CP/M original, remained the leading word processor.

By the mid-1980s, the combination of more flexibility and lower costs made many companies favor a switch toward personal computer word processing systems over dedicated machines. Word processor software for personal computers gradually got better, though this was largely a matter of more effectively duplicating the user interfaces and capabilities already available on dedicated word processing machines and minicomputer systems. IBM offered DisplayWrite, which mimicked the interface of its Displaywriter system. MultiMate, which enjoyed considerable success in the corporate market, was popular largely because its user interface closely resembled that of the Wang machines. Meanwhile WordPerfect, which in the late 1980s overtook WordStar as the leading personal computer word processing software, was originally created for Data General minicomputers in 1980.[102]

Although personal computers were by this point doing a creditable job of duplicating dedicated systems, they remained isolated machines. Personal computer networking was primitive, and the adoption of email, file sharing, and printer sharing lagged behind predictions. During the early 1980s, the shift to personal computers—rather than to the kinds of integrated office automation networks being promoted by firms like Wang, Xerox, and DEC—essentially froze the dominant paradigm for automatic office technology in the mold of the stand-alone video screen models first introduced in 1973: a self-contained machine with a keyboard, screen, disk drive, and printer.

The idea of networked machines, graphically sophisticated machines hooked into databases and sharing electronic mail, only became commonplace during the 1990s. Falling costs, technological improvements, and new software such as Lotus Notes made it possible to add these capabilities piecemeal to ordinary personal computers without raising their costs to an unacceptable level. As everyone with an interest in the history of personal computing is surely aware, the work of Xerox PARC significantly influenced the eventual development of hardware and software, with personal computers slowly evolving into something much like the office automation workstations envisioned at PARC.

Conclusions

The story of word processing and the origins of office automation demonstrates the complexity of the history of computer applications. The fundamental hardware and software technologies needed for word processing were cre-

Word processing has indeed changed the world, although not quite as expected.

ated for other purposes and in other social contexts, before being assembled during the early 1970s as the falling costs of interactive computing opened new potential applications. Even computerized text editing and formatting was well established years before the first computerized word processor was marketed. The concept of word processing, however, was originally tied to automatic typewriters and centralized dictating machines and was entwined with a vision of routine, factory-like typing pools. By the mid-1970s, the technologies of computerized text processing and formatting had come together with the word processing concept to provide the basis for a new breed of word processing workstations. Yet a decade later these dedicated machines were already being replaced by general-purpose computers, as people came to think of a word processor as a piece of software for a personal computer rather than a specialized office appliance.

Like other visions of starkly modern technological futures, the "office of the future" promoted during the late 1970s has been realized in a slower, messier, and less complete manner than once expected. Rather than a sudden shift to the paperless automated office of the future, the result was a hybrid of old and new technologies in which documents were prepared using personal computers but usually disseminated on paper. Electronic document transmission was particularly slow to take hold. During the 1990s, it was common for documents to be prepared on a computer, then printed for fax transmittal to a recipient (a process of redigitization and reprinting) and optically scanned at the far end into another computer. As the new ease of printing sent office paper use to record levels, a joke arose that the paperless office would arrive at around the same time as the paperless toilet.

The consequences of word processing and office automation for the organization of office labor have been the opposite of those originally predicted. In the early 1970s, word processing was a new approach to the division of labor in which typing and stenography tasks were to be removed from secretaries and carried out on an efficient, industrial basis in a word processing center. This approach was justified by the high cost of specialist machinery as well as the efficiency inherent through work specialization and standardization.

Computers and networks have altered the organization of white-collar work in many ways over the past three decades. Much work really has been centralized in factory-like settings: for example, with the creation of centralized and regimented call centers to deal with customer support, the international outsourcing of clerical tasks, and the automation of decision making for things like loan approval. Yet this has not happened with typing and editing work, the original task of word processing centers and the core activity of the automated office.

As inexpensive word processing systems and programs spread through offices during the 1980s, a different dynamic took hold. Typing and editing work returned to the office, carried out by word processors on the desks of secretaries and, increasingly, of professional and managerial staff. Today, general typing and editing work is more distributed than ever, as the number of personal secretaries has plummeted, and more executives and professionals type their own correspondence and reports. The shift to email, instant messaging, and other forms of electronic communication has reinforced this trend, dispelling the formerly widespread assumption that typing is low-status work suitable only for women.

Specialized data entry and typing jobs are actually dwindling, with the US Department of Labor's Bureau of Labor Statistics projecting a continued decline in the number of specialized data entry and word processing jobs as data is increasingly transmitted electronically, entered by customers, or captured automatically.[103] Word processing has indeed changed the world, although not quite as expected.

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References and notes

1. According to material gathered by historian Martin Campbell-Kelly, by fall 1983, WordStar had sold 650,000 copies with a retail value of $325,000,000 while VisiCalc and Lotus 1-2-3, the two leading spreadsheets of this era, had 800,000 copies with a

retail value of $225,000,000. M. Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog: A History of the Software Industry*, MIT Press, 2003, p. 215. By 1996, word processors were outselling spreadsheets measured by volume as well as by value. M. Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog*, p. 270.

2. The parallel with data processing is explicitly made in W.A. Kleinschrod, "The 'Gal Friday' is a Typing Specialist Now," *Administrative Management*, vol. 32, no. 6, 1971, pp. 20-27. The origins, usage, and spread of data processing are discussed in T. Haigh, "The Chromium-Plated Tabulator: Institutionalizing an Electronic Revolution, 1954–1958," *IEEE Annals of the History of Computing,* vol. 23, no. 4, 2001, pp. 75-104.
3. U. Steinhilper, *Don't Talk—Do It: From Flying to Word Processing*, Independent Books, 2006. The quotation is from page 91. He wanted the diagram (p. 166) to be included on all the IBM folders used to hold sales proposals. Steinhilper wrote that he pushed the idea in various ways within IBM Germany and during a spell at IBM World Trade's European headquarters. He promoted it at a 1959 meeting of the IBM Hundred Percent club in Madrid (pp. 102-109). Exactly what word processing meant at that time is not clear—Steinhilper has written that the arrival of dictating equipment in the IBM product line in 1962 led him to redefine it as the process of "making a thought audible, visible and distributable." By the time the MT/ST arrived in 1964, he was Country Manager for Electric Typewriters, and promoted the Word Processing concept along with the machines (pp. 134-146). He began to promote the idea that customer firms should create a"Manager of Business Operations (Text)" of equal status to their existing data processing manager (p. 124). Secondary sources have often claimed that the English "word processing" originated as a translation of the well-established German *textverabeitung*. In fact, the English version was the first to be coined, though the German version was the first to achieve any currency. I have yet to find evidence that IBM used the term in the US prior to 1971 in advertising its office products. Neither does the term appear to have been used much outside the firm prior to 1970. From his book it is clear that Steinhilper feels disappointed in IBM's failure to fully embrace the idea of word processing, and that it "never dared" (p. 142) to rename its Office Products Division.
4. The first mention of word processing in *Administrative Management* appears to have been in "Auburn U Learns about Word Processing," *Administrative Management*, vol. 31, no. 6, 1970, p. 81. The longer feature on new developments in automatic typing—which included the quotation given, a two-page report on a meeting of the Word Processing Association of Arkansas, and an advertisement for a new automatic typewriter called the ITEL Word Processor—was J.G. Zalkind, "Automatic Typing Keys in New Advances," *Administrative Management*, vol. 31, no. 11, 1970, pp. 36-44. The prevalance of early adopters of the term in the southern US may imply that the regional IBM Office Products team led the way in promoting it.
5. W.A. Kleinshrod, *Word Processing: An AMA Management Briefing*, AMACOM, 1974.
6. *Modern Office Procedures,* a rival publication to *Administrative Management,* offered its first discussion of word processing a few months later in "A New Age of Automated Writing," *Modern Office Procedures,* vol. 16, no. 8, 1971, pp. 14-15.
7. *Inventor of the Week Archive: Carl G. Sontheimer—The Cuisinart Food Processor,* Massachusetts Institute of Technology, 1998; http://web.mit.edu/invent/iow/sontheimer.html.
8. W.A. Kleinshrod, *Word Processing,* p. 3.
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10. "Management and the Information Revolution," *Administrative Management,* vol. 31, no. 1, 1970, p. 28.
11. International Business Machines, Office Products Division, "Are You Unconsciously Telling Your Boss You Can't Handle a Bigger Job?" *Administrative Management*, vol. 32, no. 6, 1971, pp. 30-31. Braverman discussed early word processing and its relationship to scientific management on pp. 344-348.
12. International Business Machines, *IBM Office Products Division Highlights,* 1976; http://www-03.ibm.com/ibm/history/exhibits/modelb/modelb_office.html.
13. W.H. Liebman, "Super-Typewriters: The Word-Processing Industry Has Arrived," *Barron's National Business and Financial Weekly,* 31 March 1975.
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and "A New Age of Automated Writing," *Modern Office Procedures,* vol. 16, no. 8, 1971, pp. 14-15.

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67. "When IBM is a Low-Priced Entry," *Business Week,* 7 July 1980, p. 82B. A more powerful IBM product, the 5520 Information System, was a competitor for Wang's Office Information System. It networked up to 18 terminals to share files on a hard disk drive and a higher speed printer.
68. "Wang's Game Plan for the Office," *Business Week,* 15 Dec. 1980, p. 84.
69. T.M. Lodahl, "Designing the Automated Office: Organizational Functions of Data and Text," *Emerging Office Systems*, R.M. Landau, ed., Ablex, 1982, pp. 59-72.
70. "Putting the Office in Place," *Business Week*, 30 June 1975, p. 56**.** The problems involved in centralized word processing pools were subsequently discussed widely: for example, in B. Garson, *The Electronic Sweatshop: How Computers are Transforming the Office of the Future into the Factory of the Past*, Simon and Schuster, 1988.
71. K.F. Curley, *Word Processing: First Step to the Office of the Future*, pp. 47-48.
72. J. Harnett, "Demand for More Advanced Facilities—Word Processing and the New Generation of Secretarial Workstations" *Financial Times,* 1989, Survey p. IV.
73. "Here Comes the Automated Office!" *Infosystems,* vol. 22, no. 9, 1975, pp. 13-15, 24, and "The Paths to the Paperless Office," *Business Week,* 30 June 1975, p. 80.
74. In the 1950s, the phrase "office automation" featured prominently in discussions of administrative computing such as *Automation in the Office*, Nat'l Office Management Assoc., 1957, and A.N. Seares, "Advancements in Office Automation," *The Hopper,* vol. 4, no. 2, 1953, pp. 6-9.
75. There may be another, more pragmatic reason for the vanishing of the term *office automation*: the phrase was trademarked by Automation Associates, a small firm founded by R. Hunt Brown that issued a series of glossy "Office Automation Reports" on administrative computing technologies from 1955 onward. R.H. Brown, "Office Automation: A Handbook on Automatic Data Processing," 1959, Market and Product Reports Collection (CBI 55), Charles Babbage Inst., Univ. of Minnesota, Minneapolis.
76. The history of the management information system concept is explored in T. Haigh, "Inventing Information Systems: The Systems Men and the Computer, 1950–1968," *Business History Rev.,* vol. 75, no. 1, 2001, pp. 15-61.
77. "The Paths to the Paperless Office," *Business Week,* 30 June 1975, p. 80.
78. Engelbart's story has been recounted in many places, but the only full-length study of his group is T. Bardini, *Bootstrapping: Douglas Engelbart, Coevolution, and the Origins of Personal Computing,* Stanford Univ. Press, 2000.
79. No transcript of the demonstration has been published. The quotation is based on the video recording hosted by Stanford University's "Mouse Site" (http://sloan.stanford.edu/MouseSite/MouseSitePg1.html). Rather inconveniently, this is broken into 35 tiny pieces of streaming video—at the time of writing the appropriate one may be found at http://vodreal.stanford.edu/engel/05enge1200.ram.
80. M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, HarperBusiness, 1999, pp. 121-124.
81. B. Lampson, "Personal Distributed Computing: the Alto and Ethernet Software," *Proc. ACM Conference on the History of Personal Workstations*, ACM Press, 1986, pp. 101-131. Another PARC editor, Gypsy, developed by Larry Tesler, simplified the user interface through the elimination of different command modes and the use of the mouse to cut and paste text. This improved interface style was subsequently used in an improved version of Bravo, named BravoX. Like NLS, the original Bravo responded quite differently to a given user action depending on which of many command modes had been selected. With BravoX, an action like typing a word or selecting text with the mouse would have a consistent outcome whatever commands had been used previously. This made it much easier for nonspecialist users to work with the program.
82. K.F. Curley, *Word Processing: First Step to the Office of the Future*, p. 109. Curley's book appears to be a lightly edited version of her 1981 Harvard Business School thesis, and although the book does not specify when the survey was conducted, internal evidence suggests a date around 1979. For another study with similar findings and a comparable definition of the "highest level" of word processor use as being for "systemwide reinvention," see B.M. Johnson and R.E. Rice, "Reinvention in the Innovation Process: The Case of Word Processing," *The New Media: Communication, Research and Technology*, R.E. Rice, ed., Sage Publications, 1984, pp. 157-183.
83. The efforts of Xerox to commercialize Alto technology receive their most thorough discussion in M. Hiltzik, *Dealers of Lightning: Xerox PARC and the Dawn of the Computer Age*, HarperBusiness, 1999, pp. 259-288 and 361-370.
84. International Data Corporation (IDC), "Major Vendor Strategies in the Electronic Office—Part I," Market and Product Reports Collection (CBI 55), Charles Babbage Inst., Univ. of Minnesota, Nov. 1983.

85. Technical data on the specifications of various OIS models is given at J. Donoghu, *Wang OIS Information Center*; http://www.cass.net/~jdonoghu/. The first OIS file server unit was apparently a rebadged Word Processor 30 model.
86. V. Flanders, "Wang's Integrated Products: Past, Present and Future," *Access 86: The Magazine for Wang System Users*, Dec. 1986, p. 33.
87. "Wang Labs Challenges the Goliaths," *Business Week,* 4 June 1979, p. 100.
88. S.T. McClellan, *The Coming Computer Industry Shakeout: Winners, Losers, and Survivors*, John Wiley & Sons, 1984, pp. 299-303.
89. S. Lohr, "Exxon Said to Lag in Office Machines: But Company Calls Problems Growing," *New York Times,* 12 Aug. 1980, p. D1. Exxon's office automation foray lost hundreds of millions of dollars, and never succeeded in integrating its product lines before being wound down from 1983 onward. "Exxon Wants Out of the Automated Office," *Business Week,* 17 Dec. 1984, p. 39.
90. R.M. Dickinson, "Can Centralized Planning for Office Automation Ever Work in a Large Corporation?" *Emerging Office Systems*, R. Landau, J. Bair, and J. Siegman, eds., Ablex, 1982, pp. 21-38.
91. The idea that "the cost figures for secretarial services compared with management and professional services suggest, however, that it is in these areas the real benefits lie," was also expressed in Xephon Technology Transfer, "Office Automation: An IBM User Perspective," Gartner Group, Market and Product Reports Collection (CBI 55), Charles Babbage Inst., Univ. of Minnesota, Feb. 1982.
92. *Processed World* Web site, 15 June 2006; http://www.processedworld.com.
93. B. Garson, *The Electronic Sweatshop: How Computers are Transforming the Office of the Future into the Factory of the Past*, Simon and Schuster, 1988; and S. Zuboff, *In The Age of the Smart Machine: The Future of Work and Power*, Basic Books, 1988. A voluminous academic literature appeared on the impact of the new technology on the organization of office work, a good review of which is presented in M.C. Murphree, "New Technology and Office Tradition: The Not-So-Changing World of the Secretary," *Computer Chips and Paper Clips: Technology and Women's Employment, Volume II: Case Studies and Policy Perspectives*, Commission on Behavioral and Social Sciences and Education, ed., 1987, pp. 98-135.
94. A brief discussion of the early market for word processing software is given in M. Campbell-Kelly, *From Airline Reservations to Sonic the Hedgehog,* pp. 217-219.
95. M. Shrayer, *The Electric Pencil Word Processor Operator's Manual*, TheBattles.net, 1977; http://www.thebattles.net/sol20/manuals/pencil.pdf. The history of Electric Pencil is discussed in P. Freiberger and M. Swaine, *Fire in the Valley: The Making of the Personal Computer*, 2nd ed., McGraw-Hill, 2000, pp. 186-188.
96. P.A. McWilliams, *The Word Processing Book: A Short Course in Computer Literacy*, 5th ed., Prelude Press, 1983, p. 211.
97. Even in 1983, turning an Apple II into a machine capable of running WordStar well remained a tortuous process, costing several thousand dollars in addition to the price of a printer. See J. Mar, "Word Processing on the Apple with WordStar and Diablo," *Creative Computing*, vol. 9, no. 3, 1983, p. 81.
98. A. Naiman, *Word Processing Buyer's Guide*, BYTE/McGraw-Hill, 1983, p. 177.
99. Ibid., p. 81.
100. C. Platt and D. Langford, *Micromania: The Whole Truth about Personal Computers*, Sphere, 1984, p. 120.
102. A. Naiman, *Word Processing Buyer's Guide*, p. 91.
102. The first version of WordPerfect was called SSI*WP, but was otherwise similar to the version launched for the IBM/PC in 1982. Its origins are explained in W.E. Peterson, *Almost Perfect,* Prima, 1994. For an early review of the product, see L.L. Beavers, "WordPerfect: Not Quite Perfect, But Certainly Superb," *Creative Computing,* vol. 9, no. 11, 1983, p. 74. WordPerfect eventually supported a broad range of platforms, including DEC minicomputers and even IBM mainframes.
103. US Bureau of Labor Statistics, *Occupational Outlook Handbook, 2006-07 Edition: Data Entry and Information Processing Workers*, US Dept. Labor, 4 Aug. 2006; http://www.bls.gov/oco/ocos155.htm.

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