

IBM Word Processing Developments

IBM has been the leader in a variety of word processing innovations since the introduction of the Magnetic Tape/SELECTRIC Typewriter in 1964 by the Office Products Division (OPD). Since then the basic approach of combining quality printed output and magnetic storage with new functions has been followed by OPD, while other IBM divisions have concentrated on new applications with data processing systems and shared-logic word processing systems. This article summarizes the major technical contributions by IBM that have supported the growth of an area of business that today is widely recognized as one of great potential for increased productivity in the modern office environment.

Introduction

The history of automatic typing in IBM dates from 1933, when IBM purchased Electromatic Typewriter, Inc. and introduced the "latest additions to IBM's line of business machines" [1]. These products were the Electromatic Typewriter, a Master Perforator (which punched a paper roll) and an Automatic Letter Writer (which printed from the paper roll). For almost the next thirty years, a series of typewriter products evolved with primary emphasis on the advantages of electric typing with typebar technology.

The single-element IBM SELECTRIC® Typewriter, announced in 1961, was the beginning of a long series of developments that have been instrumental in the evolution of word processing products using the single-element technology for low-cost, high-quality printing. The characters on the print element of the SELECTRIC Typewriter could be selected with a seven-bit code, so it was easily adaptable for use as a 15-character-per-second (cps) input/output printer in addition to its basic application as a familiar typing workstation. The Electric Typewriter Division of IBM in Lexington, Kentucky used this new technology in conjunction with magnetic recording devices and electronics to begin the development of a series of product families that have led the way for substantial changes in the efficiency of offices throughout the world.

During that same period, activities were also underway in IBM to use computers to assist in the preparation of publications. These activities were precursors to a num-

ber of program products using computers for text-oriented functions, and later to specific hardware and system configurations.

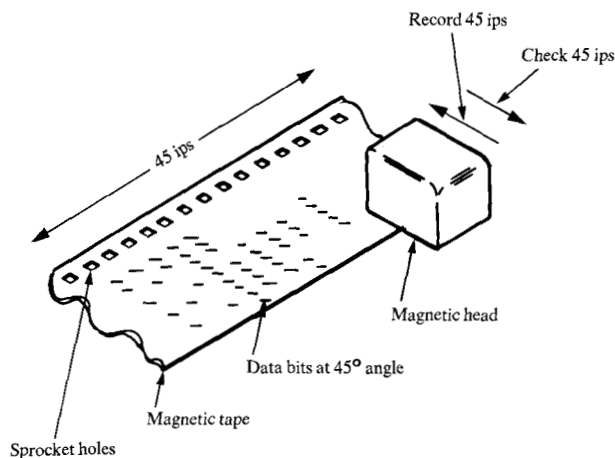
This paper will describe the evolution of word processing product families and systems in IBM, with emphasis on the key technological advances that have made possible the great versatility and high performance available today.

MT/ST family

The Magnetic Tape/SELECTRIC Typewriter (MT/ST) [2, 3] was announced in 1964 by the Electric Typewriter Division, which later that year became the Office Products Division. Four models were introduced, but Models II and IV were most preferred by users because of certain features that are described below.

Development of the MT/ST began in 1955, when IBM was considering the use of magnetic tape with an electronic typing calculator. Such a product did not evolve, but the early work did lead to a limited project, called the "Serial Magnetic Tape" project, to experiment with a magnetic-tape-oriented typewriter. The recognized potential for storage, efficient revision, and multiple replication afforded by the magnetic medium sustained interest in the project and, after the IBM SELECTRIC Typewriter was announced in 1961, the project gained full program status.

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Tape format

- Bits recorded at 45° angle (for transverse and linear use).
- 7 bits per character across the tape plus one bit for odd parity and one bit for linear search.
- 20 characters per linear inch.
- 100-foot tape = 24 000 characters per tape.

Tape transport

Read/record

- The tape was incremented into position; then the magnetic head was driven across the stationary tape by a 360° cam cycle with a 45-inch-per-second velocity over the recorded bits.
- Record in forward motion
- Check in return motion
- 50-millisecond cycle = 20 characters per second.

Search

- The magnetic head was positioned over the search track and the tape was driven at 45 inches per second to look for a series of "search bits" for access to a location on the tape specified by a reference code. This was the reason for recording the bits at a 45° angle.

Figure 1 Magnetic tape and transport.

The tape drive [4] was designed specifically for the recording of information one character at a time within the cycle time of a 15-cps printer. The record-and-check operation was a 50-millisecond cycle yielding a maximum speed of 20 characters per second. The specifications for the recording format were very low density, even by the standards of the 1960s (see Fig. 1). However, the simple low-speed character-by-character recording scheme was sufficiently fast to keep up with a typist and to drive the serial printer. It also relieved the electronics of any requirement to buffer the characters in a text memory, which would have been relatively expensive.

The most important aspect of the MT/ST, however, was not the specific technical design (which obviously

was behind comparable computer technologies when the product was announced). The real significance was the introduction of a product that addressed the productivity of the typist with technologies new to that user. It could be emphasized for the first time that the typist could type at "rough draft" speed, "backspace and strike over" errors, and not worry about the pressure of mistakes made at the end of a page. These concepts, collectively called "power typing," were very attractive, even at a price that was substantially greater than that of an electric typewriter.

The only comparable products available in 1964 were paper tape typewriters, which had a storage medium that could be recorded on only once and was cumbersome to handle. They were not commonly used for general typing applications. The concept of power typing was therefore new with the MT/ST, and the marketing approach focused more and more on the preparation, correction, and production of typed information in an office environment. Increased emphasis was placed on operational procedures to more effectively produce written communications with the MT/ST models.

Since the MT/ST was being used for new applications, it was necessary to make numerous special adaptations of its features and functions. This was accomplished primarily through special engineering requests (SERs) from customers. A long list of such requests was implemented and aided in fitting the product to customer needs. This list of SERs was also very beneficial in defining the specifications for the next family of products from OPD.

Models II and IV were preferred over I and III because they provided the search function, which made it convenient for the operator to store and access multiple segments of text on a tape. They also had an electronic adjust feature for semi-automatic line-ending decisions. The Model II had only one tape cartridge position and was the less expensive option, primarily used for initial typing. Insertion of text onto a previously recorded tape required the transfer and insert feature of the Model IV, which had two tape cartridge positions.

Other models and product offerings were also based on the MT/ST, and these included a number of innovations for word processing products. (A listing of the MT/ST family of products is given in Table 1, with brief comments on their key features.)

A major development in these "spin-offs" from the MT/ST was in the composing area with the Magnetic Tape/SELECTRIC Composer (MT/SC) [5]. This product combined the Magnetic tape transport unit with a modi-

fied SELECTRIC Composer [6] to provide the power typing features of a modified MT/ST Model V keyboard as an input for cold type composition for the printing industry and for in-house composition departments. The main points of technical interest in the MT/SC were composition-quality printing and a programmable control unit. (The latter is based on a small dedicated processor that was developed years before the term microprocessor was coined.) Special features were developed, as required, by storing programs on magnetic tapes. These features were called "precons," since they could be activated by preconditioning the MT/SC with the tapes.

The basic composition precon provided

- Justification
- Flush left/flush right
- Centering
- Dot leader insertion

The input of text from an MT/ST to a computer was also accomplished with both a communicating feature, called "Remote Record," and a direct computer-entry unit, the IBM 2495 Tape Cartridge Reader. The MT/ST Remote Record could only communicate between MT/STs when first announced in September 1967, but later modifications allowed for sending and receiving information with an IBM 2741 and an IBM System/360. The 2495 could read EBCDIC-coded tapes from a modified MT workstation at a rate of 900 characters per second. These tapes could also be transmitted via the remote record feature. These early efforts marked the beginning of combining word processing typing stations with data processing systems.

MC/ST family

In October 1969, OPD announced the addition of the Magnetic Card/SELECTRIC Typewriter (MC/ST) to its magnetic media product line. This product was an extension of the power typing concept established by the MT/ST, and it introduced the magnetic card as a recording medium. Important improvements included low acoustical noise, simple operation, small size, and high reliability. Two other models were subsequently announced (see Table 2).

Exploratory efforts leading to the development of the MC/ST began even before the MT/ST was announced, and increased in 1966 as customer acceptance of power typing began to grow. The functional specifications were influenced by experience on the MT/ST obtained from engineering, sales, and service personnel, and a thorough study was made of the various features and SERs requested and implemented for the MT/ST.

Table 1 MT/ST family of products.

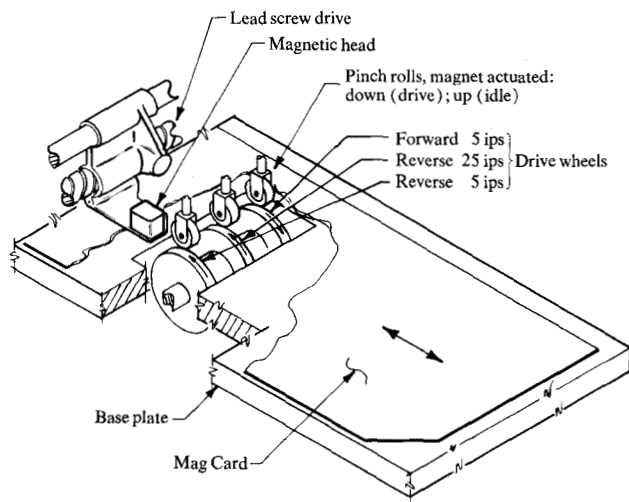
<i>Product</i>	<i>Date announced</i>	<i>Comments</i>
MT/ST	July 1964	Model I—one tape II—one tape, search and adjust III—two tapes IV—two tapes, search and adjust V—one tape, record only
MT/SC	Feb. 1966	SELECTRIC composer printer Dedicated processor for control 2 Kbyte core memory Features by "precon" tapes MT/ST keyboards modified for special graphics characters
MT/ST-RR	Sept. 1967	135-baud asynchronous communications point to point SER for 2741 and System/360 communications
IBM 2495	Sept. 1968	Direct entry of text to a System/360 MT tape cartridge reader at 900 cps 12-cartridge capacity

Table 2 MC/ST family of products.

<i>Product</i>	<i>Date announced</i>	<i>Comments</i>
MC/ST	Oct. 1969	New electronics and package Single-card transport Improved SELECTRIC Typewriter Improved "power typing"
Communicating MC/ST	July 1971	Asynchronous 2741-compatible communications MC/ST functions
Mag Card/Exec	April 1972	Proportional spacing MC/ST functions

A major reason for the choice of a magnetic card for the recording medium was the simple relationship that could be maintained between a typed page and a recorded card. In effect, this relationship made the magnetic card a unit record of storage for a typed page, similar to the familiar punched IBM tab card used for a single record in data processing equipment. The physical dimensions were the same as those of the 80-column paper tab card, but the magnetic card could store up to 5000 characters.

The card transport mechanism was designed to record and check characters as they were typed, thus effectively using the magnetic card as a text buffer in a fashion similar to the MT/ST concept. Sufficient space was allowed for starting and stopping between characters on a card so



Magnetic card	
Dimensions	3.25 × 7.375 inches 0.0075 inch thick
Recording material	0.0004-inch IBM series 500 magnetic oxide
Antistatic material	0.0004-inch conductive material (reverse side)
Recording format	50 tracks at 0.0625-inch spacing 100 characters per track 5000 characters per card 0.064 inch per character Phase-encoded 7-bit characters 562 flux changes per inch
Card transport	
Velocity	5 inches per second (read/write) 25 inches per second (high-speed reverse)
Record/check rate	20 characters per second
Read rate	50 characters per second

Figure 2 Magnetic card and transport.

that the incremental recording could be accomplished. The card itself was directly driven; it was part of the mechanism and its physical characteristics were critical to the design. An illustration of the card transport is shown in Fig. 2.

The read/record operations were accomplished by moving the card relative to a stationary magnetic head. This motion was controlled by actuating one of three idler rollers, which forced the card against one of three constantly rotating rolls with a drive system that had high inertia relative to the inertia of the card. A "bootstrap" recording method was used [7]. It recorded by sensing the first bit of a previously recorded character to initiate the recording of a new character. The spacing between the read and write gaps of the head therefore established the character positioning along a track. A 50-millisecond for-

ward/reverse/forward cycle was used to record and check characters incrementally. The characters were recorded at a density of 562 flux changes per inch, which was quite high for a magnetic medium that would be handled by the user.

The 50 recorded tracks generally correspond to lines on a page, and the magnetic head was positioned over the tracks by a leadscrew drive driven by a unique dual clutch mechanism that allowed rotation in either direction.

The printer was a new version of an I/O SELECTRIC Typewriter, which for the first time used electrical instead of mechanical coupling from the typing keyboard to the print mechanism. This allowed the keyboard to be easily used for input of both printing and non-printing codes. This new design had improved reliability and could fit within the typewriter covers, thus eliminating the need for the special desk which the MT/ST had required.

The electronics packaging in the MC/ST was a major introduction for OPD. Two boards contained all of the logic modules and special circuits. Significant cost and reliability improvements were made by eliminating conventional multi-card packaging for the product. The major components to be packaged were SLD modules. (SLD, or Solid Logic-Dense, is a high-circuit-density version of Solid Logic Technology, SLT.) Design work between OPD and the Components Division resulted in new 9 × 15-inch boards that were mounted together as a "planar package." This allowed for a new service philosophy, which used total replacement to test and repair electronic failures and significantly reduced the diagnostic training and repair time.

A communications feature compatible with the 2741 was announced for the MC/ST in July 1971 [8]. It allowed information exchange between MC/STs or with a computer at 135 baud over a dial telephone network. Information could be transmitted from the magnetic card or directly from the keyboard and could be recorded and/or printed at a receiving MC/ST. Initial models were built in 1967 and 1968 and were tested for correspondence communications and computer interaction in real work environments. New planar boards were released to accommodate the additional electronics. Special attention was given to the testing requirements for the announcements made in the United Kingdom, Germany, Canada, France, and Italy.

This feature resulted in extensive use of the MC/ST in communications network applications, with emphasis on error-free typing, magnetic text storage, and quality printing.

In April 1972, the Mag Card Executive Typewriter was announced and added the quality feature of proportional spacing to the power typing features of the MC/ST. A leadscrew escapement system was used to accurately position the print element in 0.014 (1/72)-inch units for the new type designs developed for this product. The MC/ST magnetic card transport was used, and cards were recorded in a compatible format.

This concluded the evolution of products in the MC/ST family, which extended the concepts of power typing to a wide spectrum of users and office environments.

Early evolution of word processing products

In the 1960s there were no other manufacturers offering magnetic media on a power typing product. It was more than a year after the 1969 announcement of the MC/ST before a competitive product was announced [9]. By mid-1972, however, at least ten manufacturers had introduced magnetic-media-based automatic typewriters. The equipment designs were similar in many respects:

- Most used "first-stage" SELECTRIC I/O printers purchased from IBM.
- The most popular magnetic media were tape cassettes available from a selection of more than thirty suppliers to computer manufacturers.
- Solid state electronics provided the I/O control and machine logic for functions similar to those found in the announced IBM products.

A few of the earliest manufacturers introduced the cathode ray tube (CRT) display workstation. The productivity potential offered by a CRT, however, could not be realized until faster printing and better media were available.

One of the most significant innovations that affected the growth of word processing products was the development of the "daisywheel" printer technology, which became commercially available in 1972 [10]. Acceptable "letter-quality" printing was then available at speeds over 30 cps. Only a few suppliers offered this technology initially, but now many models are available with speeds from 30 cps to more than 55 cps. Also, sheet-feed paper handling devices have been added to further improve the printer throughput. The acceptance of this printer technology for word processing applications was very synergistic for the growth of the printer and the product manufacturers.

Some manufacturers offered magnetic card units similar to the MC/ST, but did not offer compatibility with the IBM format. With few exceptions the magnetic tape cassette was the medium of choice. In 1974 the eight-inch

"floppy" diskette was introduced in word processing products. This technology had been pioneered by IBM in 1970 [11] for computer applications and Original Equipment Manufacturing (OEM) suppliers had just begun manufacturing them for general use. Over time, diskettes have become the most popular removable media for word processing products. A 5.25-inch "minifloppy" was subsequently introduced in 1976 for lower cost and smaller workstations.

By 1974 products were being introduced with the hardware combination that has characterized many subsequent announcements [9], *e.g.*,

- 30- to 55-cps daisywheel printer
- Single and dual floppy diskettes
- 24- to 66-line CRT display
- A growing list of text functions

Also by 1974, word processing was introduced on a product that allowed a number of key-to-display workstations to share functions and storage in a cluster design. Initial acceptance was low, but by the end of the 1970s IBM and many other manufacturers had announced advanced designs. (Some of these will be described later.)

Special applications were also addressed by the attachment of I/O devices such as Optical Character Recognition (OCR) [12] readers and photocomposition printers. Generally such attachment has been by means of communications ports, with manual procedures required for incompatibilities in control codes or functions.

Mag Card II family

The Mag Card II was announced in April 1973, with a number of innovations that clearly distinguished it from the earlier MC/ST. The products in Table 3 are classified as the Mag Card II family because they share major technical and functional capabilities from common development efforts, even though some of them do not use magnetic cards.

The major technical advances in the Mag Card II over the two previous IBM product families included

- Electronic buffering of information using MOSFET devices
- Leadscrew-driven printer for improved positioning control
- Correcting SELECTRIC I/O mechanism
- High-speed pack feed for magnetic cards

When the MT/ST and MC/ST were developed, magnetic cores were the conventional internal storage technology for computing products. Electronic latches were

Table 3 Mag Card II family of products.

<i>Product</i>	<i>Date announced</i>	<i>Comments</i>
Mag Card II	April 1973	8-Kbyte electronic buffer Leadscrew-driven printer Correcting SELECTRIC mechanism High-speed pack feed for magnetic cards MOSFET electronics
Memory Typewriter	March 1974	Desktop unit/no magnetic cards 50-page tape-loop storage under the covers Mag Card II electronics 4-Kbyte electronic buffer
Electronic SELECTRIC Composer (ESC)	Jan. 1975	Desktop unit/no magnetic cards Mag Card II editing 8-Kbyte electronic buffer SELECTRIC printing technology 3 print escapements: 0.014 (1/72)-inch, 0.011 (1/89)-inch, 0.010 (1/96)-inch Composition features Microprocessor design
Mag Card/A	Sept. 1975	Mag Card II electronics 6-Kbyte electronic buffer Single-card transport
Mag Card II Communicating	Jan. 1977	Mag Card II electronics Bisynchronous communications
Memory Typewriter—100	March 1977	Increased storage capacity from 50 to 100 pages Memory Typewriter electronics
6240	June 1977	Mag Card II electronics 55-cps daisywheel printer Bisynchronous communications optional
Mag Card Composer	March 1978	ESC features 8-Kbyte electronic buffer Pack feed for magnetic cards

typically used only for transient-character or condition-code buffering. The high cost per byte of these storage technologies was prohibitive in these products, so the long-term storage media were also used for input buffering, as previously described, in both the magnetic tape and magnetic card recording schemes. In the Mag Card II family, information was input from the keyboard, a magnetic medium, or a communications line to an electronic buffer. The new technology for the buffer was a MOSFET dynamic shift register that operated by continually shifting information in a loop at a rate of 156×10^3 bytes/s

and was accessed by appropriate electronic timing at specified ports. With this buffer the machine organization allowed for extensive revision capabilities without the physical constraints of the magnetic recording media and transports. The size of the buffer varied in the product family from 4 to 8 Kbytes (where $K = 1024$), which provided space for editing and merging a page or more of information at a time.

The Mag Card II was only the second IBM product announced with MOSFET electronics, and product development required continual interaction with IBM components development for this technology and for the design and testing systems. The planar packaging concept was continued with the new, higher-density technology, and the added electronic logic capacity supported many advances in the word processing functions of this new machine.

Earlier in 1973, OPD announced the IBM Correcting SELECTRIC Typewriter, which was an immediate success. The new lift-off ribbon technology was incorporated on the I/O printer for the Mag Card II and added substantially to the appeal and utility of that product. It allowed the operator to get error-free copy from the original typing, and both the paper and the electronic buffer could be corrected by the familiar backspace and error-correct procedure. This saved an entire playback step, thus enhancing operator productivity.

Another significant advance was the high-speed pack-feed card transport. The card speed was increased from 5 to 35 inches per second (ips) and continuous recording of a full line was possible since the output was controlled from the electronic buffer. Also, a stack of fifty cards could be placed in the card hopper for automatic feeding, whereas prior to this only a card at a time could be loaded. The functions allowed by this feature were ease of processing for multi-page (*i.e.*, multi-card) documents and the ability to perform unattended printing and communications. Earlier development activities before the MC/ST announcement had anticipated the need for a pack feed. One side of the magnetic card was coated with a conductive anti-static material so that the cards would not be held together with static charge and would be easier to separate for automated stack feeding.

In March 1974, the IBM Memory Typewriter was announced. It was packaged in one set of covers that fit on a desktop, and could be classified as the first IBM "electronic typewriter." The functions were essentially the same as the Mag Card II, but it had a 4-Kbyte electronic buffer and a tape loop under the covers capable of storing fifty 4-Kbyte "pages" on fifty tracks. The tape was

1.5 inches wide, ran at 12.5 ips, and was recorded at a density of 800 bits per inch (bpi). This product was a very good entry-level product for users with applications that did not require extensive magnetic card storage. The tape loop storage was doubled to 100 pages in 1977.

The new technologies of the Mag Card II were also applied to the design of another desktop product, the IBM Electronic SELECTRIC Composer (ESC), which was announced in January 1975. This product essentially replaced an earlier stand-alone mechanical composer product by automating functions such as justification, multiple columns, centering, and dot leader insertion. An 8-Kbyte electronic buffer was the only storage provided, and most of the Mag Card II revision capabilities were standard. This product also incorporated an IBM-developed MOS-FET microprocessor that was programmed with a read-only memory (ROM). A later model was announced in March 1978, with a high-speed pack feed for magnetic cards.

Other products listed in Table 3 added numerous technical and marketing features to round out the offerings of the Mag Card II family of products.

OS/6 family

In January 1977, three models of the IBM Office System/6 Information Processors were announced. They offered key-to-display input, magnetic card and floppy diskette media, and ink jet printing [13]. The various models had different I/O configurations, with the OS/6-450 being the full-function configuration (refer to Fig. 3 and Table 4). Later models offered a daisywheel printer in lieu of the ink jet, primarily for applications requiring impact printing on multi-part forms.

The most notable technical development was the ink jet printer, which combined quality printing at up to 92-cps burst speed with a very versatile and efficient automatic cut-sheet-paper and envelope-handling mechanism. It also featured automatic selection of 10-pitch, 12-pitch, or proportional spacing with up to five "resident" electronic printing fonts. Another model with 184-cps printing was announced in 1979. The printer had been announced earlier (in 1976) as an output printer for a multi-workstation magnetic card environment.

The key-to-display workstation had an eight-line CRT and an eight-inch diskette storage device as standard, but magnetic card compatibility with other IBM products was optional for the support of the large existing inventory of MC/ST and Mag Card II products. A major new function introduced in these word processing machines was records processing. Information could easily be stored in

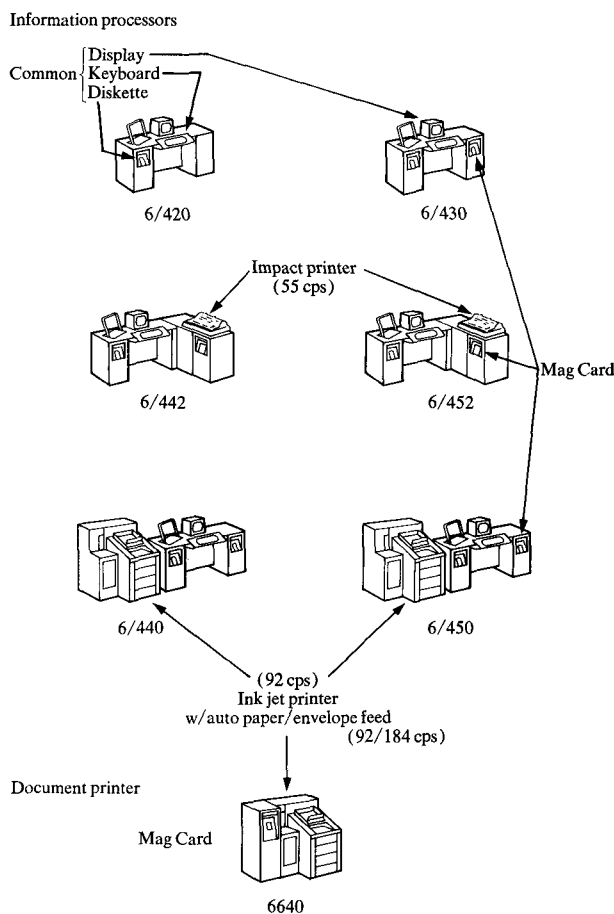


Figure 3 Office System/6 models (Communications Option on all models).

numbered fields of records on diskettes and then accessed, edited, sequenced, qualified, or reformatted to automatically generate listings, reports, and documents in an office environment. Also, information from records could be selected and automatically merged with stored text to create personalized mailings, even including addressed envelopes. Most significantly, no programming was required by the user for records processing. All machine functions could be selected and performed directly by the operator from menus on the CRT display.

Bisynchronous communications up to 2400 baud were optional on all models and also were announced for the Mag Card II. The communications were IBM 2770 compatible, so that information could be exchanged with a computer. In January 1978, models with a 55-cps daisywheel printer were announced and an improved version of automatic document assembly was introduced in March 1978.

Table 4 OS/6 family of products.

<i>Product</i>	<i>Date announced</i>	<i>Comments</i>
6640 Document Printer	June 1976	92-cps ink jet printer Cut-sheet paper Envelope feed Magnetic card reader 184-cps model announced in 1979
Information Processors 6/430 6/440 6/450	Jan. 1977	92-cps ink jet printer Key-to-display 8-inch diskette Magnetic card Text processing Records processing Bisynchronous communications
6/442 6/452	Jan. 1978	Same as above, except 55-cps daisywheel printer in lieu of ink jet printer
6/420	Nov. 1978	Key-to-display and diskette No printer or magnetic card
Information Distributor 6670	Feb. 1979	Copier/laser printer 36 pages per minute Magnetic card reader Internal diskette text buffer Bisync or SDLC communications Document merge Page reduction output Duplex (double-sided) output

Another major technical innovation developed by IBM is the 6670 Information Distributor [14], which was announced by OPD in February 1979. It combined convenience copying with high-speed laser printing. The copy function is essentially a half-speed IBM Copier III with the duplex and reduction functions also available for use in output printing [15]. Attachment to OS/6 Information Processors is via bisynchronous communications. However, the 6670 can also serve data processing needs over "bisync" or SDLC communications lines from main-frame computers, to provide high-function, high-quality printing and to allow for the merging of computer data with standard letters in the 6670 to create finished documents.

Shared-logic word processing systems

The IBM products discussed previously are in the general classification of "stand-alone word processors." These products are workstations that have all I/O components, logic, and memory in a single unit or within close cabling distance. Interaction among machines has been restricted

to compatible magnetic media exchange and telecommunications.

The term "shared-logic word processing systems" [9, 16] is used for multi-station configurations of text entry and editing stations sharing a common control unit that provides access to one or more of the following resources:

- Programming
- Memory
- File storage
- Printers
- Communications
- Other peripheral I/O

• Early IBM innovations

When IBM first announced the System/360 in the mid-60s, phenomenal amounts of support literature were required to accompany the machines. Prior to this time, nearly all of IBM's literature was composed by the "hot type" process by outside suppliers. However, with the masses of publications and a high volume of revisions, IBM began looking for low-cost alternatives to type-setting.

Consequently, in 1964 certain IBM publications departments developed a text system known as ROSS64 [17] to compose technical literature in-house. This system involved the keypunching of text into punched cards, which were subsequently processed via the IBM 1401 computer system. Various format refinements were coded and punched into the cards along with the text. The result was a text composition system that was less expensive and had better revision capabilities than the traditional "hot type" process.

ROSS64 was not without its drawbacks, however; the quality from an esthetic viewpoint was poor because of restrictions in formatting capability as well as the print quality of the IBM 1403 printer. Therefore, in 1965 ROSS64 was enhanced to TEXT90 [18], which was processed on IBM 7090 and 7094 systems and allowed better formatting capabilities. TEXT90 also included an 8000-word spelling dictionary, an automatic table of contents, full-page layout, page numbering, and special format options for insertion of figures within text.

In 1967, TEXT90 evolved into TEXT360 [19] (processed on the System/360), which provided more sophisticated format capabilities and, most importantly, allowed composition to be done on a keyboard (IBM 2741) as opposed to punched cards. The text was stored directly on a computer disk file. This had obvious advantages, since the text editor could now view the page layout as it would

eventually be printed and the integrity of the text information was improved over the punched card method.

Also in 1965, the Administrative Terminal System (ATS) was developed for processing large volumes of text. ATS input was also from terminals directly into storage, and automatic format functions were included.

Output for all of these, however, was still the IBM 1403 printer. Even though, for text purposes, a special 120-character, upper and lower case print chain was used, the quality was inferior to that of typesetting and the typewriter, and only a single font (size and style) could be used at a time.

In order to improve the quality of the composition, TERMTEXT/FORMAT [20] was developed to bridge the gap between text input and photocomposition. This allowed a great improvement in composition quality by allowing extensive formatting possibilities with numerous type styles and sizes. TERMTEXT and another version of this program, known as PRINTEXT, have been marketed since the late 1960s. Because PRINTEXT is mainly for newspaper applications, it has never gained wide acceptance; TERMTEXT was, however, better received as an installed user program. Other formatting programs, such as PAGINATION/360, were offered around 1970 to enhance various text composition systems.

As the power of the computer and the capabilities of text processing increased, a new level of sophistication was achieved. Previously it had been necessary to code the output devices for the format and printing desired. Now, however, a new, high-level macro language made its appearance. Begun as a development effort at the IBM Cambridge Scientific Center, this coding scheme was known as GML (General Markup Language) [21]. In essence GML made it possible to use one data stream to serve multiple output devices by removing all device-dependent coding and substituting a tag which enabled the reader to identify the information structure. Subsequently the computer program could sense the tag and substitute the device-dependent output coding required to format the information and print it as desired.

Advanced Text Management System (ATMS) and SCRIPT, program products processed on System/370 and announced by IBM in the early 1970s, were a result of the prior text composition efforts. Input could be done from an IBM 2741, from 3277 Display Terminals, and from various communicating typewriters. The printed output could be on 1403-like printers or could be processed by various photocomposers. The advantage inherent in ATMS and SCRIPT and its follow-ons [22] is the wide

variety of format capabilities they offer. These allow virtually any capability offered by the "hot type" systems of the past.

In conjunction with these text systems, various retrieval systems, such as the Remote Information Retrieval Management System (RIRMS) and the Storage Access Information Retrieval System (STAIRS) [23], have been developed. These systems augment the text composition systems in that information can be gathered and stored in a computer and retrieved and processed via a retrieval program.

Once the power provided by computers had been added, text systems had the capability to process text in various ways other than simple composition. One such activity includes programs developed to translate stored text to Braille output. There have been several successful efforts in this area since the late 1960s, and IBM has been providing technical material to blind programmers and technicians for the past decade.

- *The growth of shared-logic word processing systems*

The first dedicated shared-logic systems for word processing were announced in the early 1970s. By 1977 this classification represented almost 10% of the value of text processor shipments, according to industry consultants [16]. This value has been projected to exceed 33% by 1983.

The growth of shared-logic word processing systems has been greatly influenced by the integration of new technologies with data processing architectures and components. CRT terminals have been modified to provide improved formatting, display attributes, and character fonts. A selection of printers with speed and quality tradeoffs are offered. Distributed processing design technologies are being used for data exchange and function distribution. Communications facilities are being extended to provide electronic document distribution.

The present distinction between word processing and data processing systems is primarily in the application software and data base structure, now that the hardware is being modified for text. These modifications have required significant emphasis on the workstation interface (which must be acceptable for a wider range of users) as well as on improvements in the quality and versatility of the printers.

The emergence of the microprocessor in small systems design has been a major factor in meeting the demands of designing for word processing. For example, system response to most user actions at a workstation needs to be

The initial system unit to become available featured 29 Mbytes of disk storage with later models offering up to 130 Mbytes. An internal document library, used to retain active on-line documents, is maintained on the disk storage by the system. Documents can be loaded onto diskettes for off-line storage. Either a single-feed or a magazine-feed diskette drive is available. The IBM 5253 and 5254 workstations feature single 24-line and dual 12-line display screens and up to seven can be multi-dropped along a 5000-foot "twin-ax" cable. A one-megabit data rate is shared by the devices attached to the cable. The ink jet and daisywheel printers used on OS/6 are modified for local attachment as the 5258 and 5257 Printers via the SNA communications ports.

The flexibility and extendability of the 5520 accommodates a wide range of office environments. Devices locally attached can be centralized or decentralized within the 5000-foot cabling constraints. Remote attachment allows document exchange with compatible communicating devices at distant locations. Up to 18 display workstations and 12 printers can be locally attached to a Model 50 System Unit. Several system units can be connected to make up a network of office systems in a single location or in multiple locations with remote attachment; see Fig. 5, which also illustrates remote attachment to compatible communicating models of the IBM Mag Card II and Office System/6.

Extensive processing power is distributed throughout the design of the 5520. A main storage processor and a control storage processor are used in the Model 20 System Unit, and the other models add a third processor for extension of the number of workstations that can be attached. IBM-developed microprocessors are used for added groups of communication lines, up to a maximum of 16, in the Model 50 System Unit. The display workstations and printers also use microprocessors for their functions and controls.

In June 1980, enhancements of the 5520 were announced with software for file processing with arithmetic functions and an additional bisynchronous communications capability. Also, support was announced for enhanced document interchange between the 5520 and OPD products as part of the 5520 electronic document distribution network.

Displaywriter system

The latest addition to the OPD Word Processing product families is the IBM Displaywriter System, which was announced in June 1980 [26]. The design is modular and expandable with a hardware and software architecture that makes extensive use of microprocessor and memory

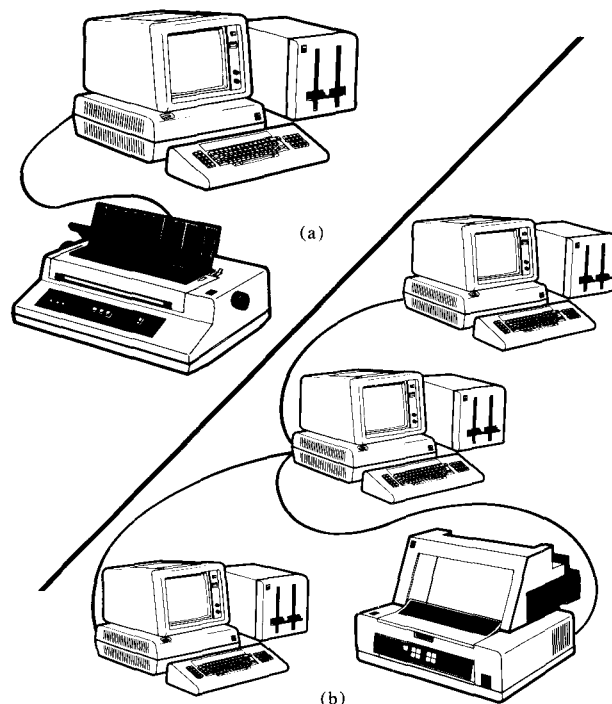


Figure 6 (a) Entry-level and (b) printer-sharing Displaywriter Systems.

technologies. It features a high-resolution 25-line CRT display, single and dual diskette units, a magnetic card unit, communications, and either a SELECTRIC technology or a new IBM daisywheel technology for an attached printer (see Fig. 6).

The basic functions focus on a variety of typing tasks that include text formatting, entry, alignment, assembly, editing, proofing, processing and printing. These tasks include many evolutionary improvements in the functions provided, with extensive use of display menus and prompts to lead and direct the operator in plain language.

One of the most innovative functions is text proofing, which allows the operator to check all words in a document against a "dictionary" of effectively 50 000 words based on an IBM-developed algorithm [27]. The operator can tailor the dictionary by adding up to 500 additional words for specific user-oriented needs. Spelling errors are highlighted for operator review and correction.

The high-performance printer on the Displaywriter System is a serial, bidirectional, 60-cps, high-quality daisywheel technology with good acoustic characteristics. Paper handling includes two-drawer automatic sheet feed or continuous-form tractor feed options. Also, an automatic first-line feature simplifies the insertion and alignment procedure for the operator. It has 10-pitch, 12-pitch,

and proportional-spacing 96-character printwheels that are conveniently packaged in a functional cartridge assembly. Positioning accuracy is 0.004 (1/240) inch horizontal and 0.010 (1/96) inch vertical. Another key feature of the printer is a new ribbon cartridge design, with a capacity of one million characters, that can be easily replaced by the operator. Also, more than one display workstation can share a daisywheel printer on a first-in/first-out queue with simple procedures for printer status, selection, cancellation, or priority change.

Either asynchronous or binary synchronous (BSC) communications are available, with the flexibility and versatility to address a broad operation of applications. The asynchronous communications feature emulates the CMC/2741 and Teletype for connection to a wide variety of mainframe computers and minicomputers as well as certain compatible terminals and communicating word processors. Speeds up to 1200 baud are supported for half and full duplex, dial-up or dedicated facilities. The BSC feature enables the Displaywriter System to send and receive documents at speeds up to 2400 baud with a variety of other machines. Examples are IBM Mag Card IIs, IBM OS/6 Information Processors, IBM 6640 ink jet Document Printers, IBM 6670 copier/laser Information Distributors, IBM 5520 Administrative Systems, compatibly programmed System/370s and other CPUs, or another Displaywriter System.

Predefined configuration setups can be established by the customer for simplicity in day-to-day operations when using these communications features.

Summary

Word processing developments have progressed substantially since IBM announced the MT/ST in 1964. The early products introduced by IBM in the 1960s established the basic text-oriented functions, and applications were expanded with the introduction of new hardware and software designs. By 1974 word processing products were available with CRT displays, daisywheel printers, floppy diskettes, and shared-logic designs. IBM has continued in the 1970s with major products announcements by OPD, GSD, and DPD. Technical innovations have ranged from ink jet and laser/copier printing technologies to records processing, document storage and distribution, and advanced text processing functions. The number of manufacturers has grown to more than fifty, with more than 100 models of stand-alone and shared-logic systems being tracked by industry consultants [9].

The hardware for word processing applications has improved and become available on data processing systems, and stand-alone word processors are now controlled by

microprocessors. Essentially all data processing technologies from electronic logic and memories, system architecture, storage and I/O devices to software design now apply equally to word processing development. These advances are clearly leading toward the "integrated electronic office" [28], which promises large productivity gains for a broad spectrum of executives and office workers and demonstrates the significance of applying technology to meet the needs of business.

(Note: Additional background material on the development and application of both IBM and other word processing systems will be found in Refs. [29-43].)

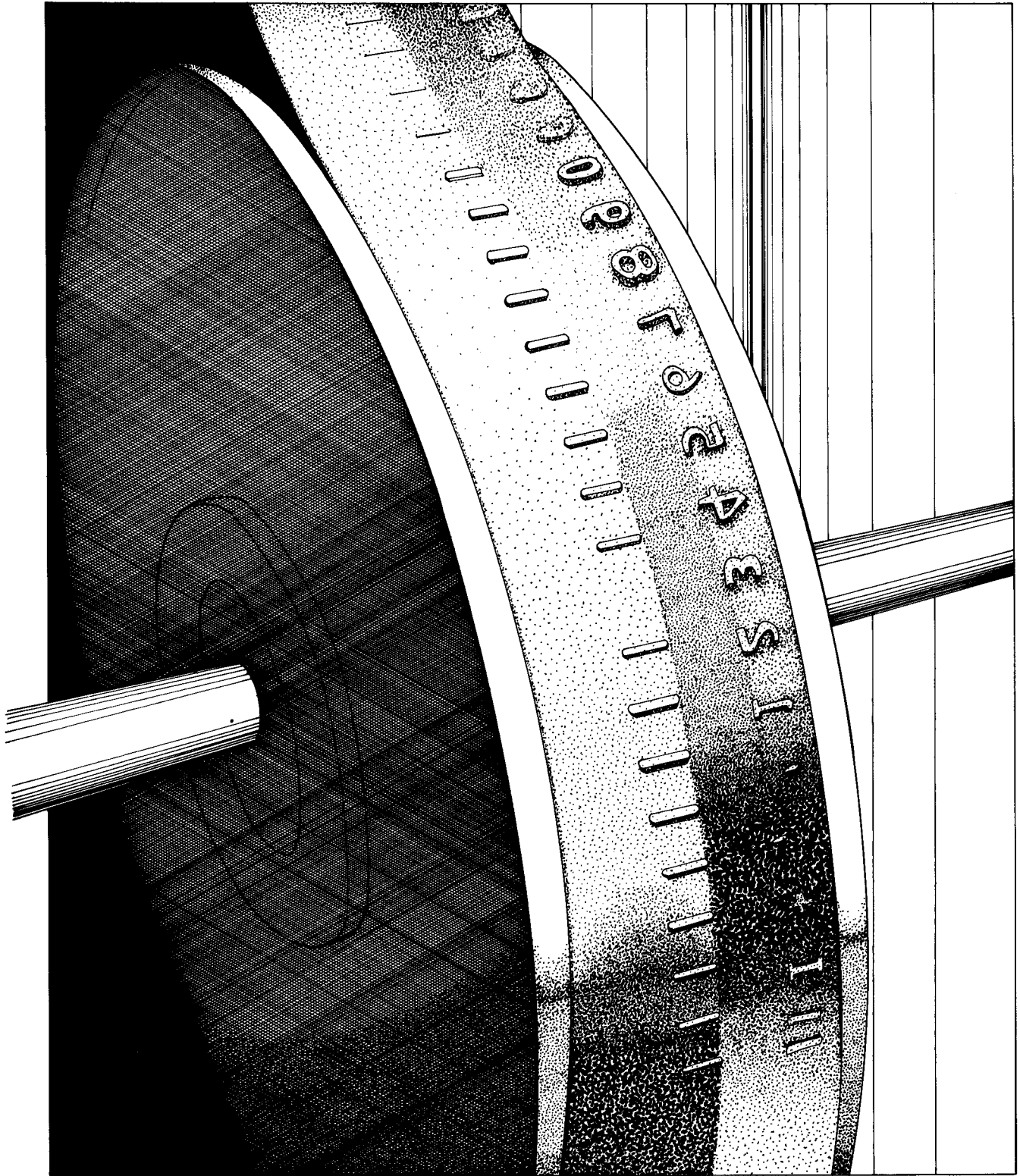
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Printing band of the IBM 3262 printer