The Commercial Press Model, the only Chinese typewriter actually produced for commercial use.

quick brown fox jumped over the lazy dog

CHINESE TYPEWRITERS:

A case of stimulus diffusion

now is the time for all good men to come to the aid of the

By Kenneth Starr,
Curator, Asiatic Archaeology and Ethnology

ANTHROPOLOGISTS make common use of two terms in referring to the process whereby cultural elements, either material or non-material, diffuse or spread from one culture to another. These terms are *diffusion* and *stimulus diffusion*, which A. L. Kroeber, pioneer American anthropologist, differentiated as follows:

> In ordinary diffusion . . . both the principle and its mechanism are taken over by a receiving culture from the inventing one. Occasionally, however, there are difficulties about acceptance of the mechanism. . . . The idea or principle may then also fail to be accepted. But again, the idea may exercise an appeal that causes it to penetrate. An effort may then be made in the receiving culture to devise another mechanism that will produce the desired result. Thus an invention, or reinvention, is stimulated by contact transmission or [stimulus] diffusion.[1]

The process of stimulus diffusion is quite strikingly illustrated by the manner in which the basic idea of the Western typewriter spread to China and Japan, whose systems of visual linguistic symbolism, distinguished by the use of "characters" (as 藍, for *blue*), instead of an alphabet (a symbol for each sound) or syllabary (a symbol for each syllable), necessitated an almost complete reinvention.

Three variant forms of the Chinese typewriter have been produced: the several models produced in the late 1920's and the 30's by the Chinese publishing company, the Commercial Press, Ltd.; the experimental model introduced in 1946 by the International Business Machines Corporation; and the experimental model invented in 1947 by Lin Yutang.

THE COMMERCIAL PRESS MODEL
舒式華文打字機

Based on a Japanese prototype, the earliest Commercial Press model was produced commercially in Shanghai in the mid-20's. During the next decade the company produced several other models, all based on the same mechanical principle, but differing slightly in operational details as the invention was refined. The model described here was marketed in the mid-30's and seems to have been the last the company produced.[2]

STRUCTURAL FEATURES

The Commercial Press typewriter consists of four main parts: the base, the frame, the grid and finder-chart, and the superstructure.

Base. The heavy base is formed of two sturdy planks, spaced slightly apart and set horizontally between two cast-iron side pieces. This base is 17¼ inches wide, 16¼ inches deep and 2¼ inches high.

Frame. The base carries a cast-iron frame that supports a mobile grid containing several thousand pieces of type, the superstructure, and a typing lever and associated ejector-pin.

Grid and finder-chart. The grid that holds the type fits into a tracked carriage that rides on the cast-iron frame. This grid of type moves from side to side on one pair of tracks, then, together with this first pair of tracks, backward and forward on a second pair of tracks and, by a combination of these two separate movements, diagonally and circularly.

This grid contains spaces for 2,546 separate pieces of type (67 across, 38 from front to back). The spaces are open at the top and partly so at the bottom, with just a slight lip to keep the type from falling through. The pieces of type rest loosely, face up in their spaces, with the type faces, as seen by the operator, backward (mirror image), oriented to the right, and in reverse order, relative to each other. Thus, with Arabic numbers as examples, two vertical rows of type would appear as follows:

Extending from the front of the grid is a short flat metal arm. This arm carries a wooden knob, by means of which the grid is moved, and at its free end, a finder-needle. It is with this needle, used in conjunction with the finder-chart, that one locates a specific piece of type in the grid, for grid, finder-needle and finder-chart are interrelated.

The finder-chart, which in a wild sort of way corresponds to the keyboard of a Western typewriter, is vital to the operation of the machine, and carries the properly printed form of each of the 2,546 pieces of type in the grid, with the location of the character on the chart keyed to that of the corresponding piece of type in the grid.[3]

The characters on the chart and the corresponding pieces of type in the grid are organized by two principles, frequency of usage and the traditional "radical" system of classifying Chinese characters. The primary organization is based upon estimated frequency of usage. Thus, to reduce lateral movement of the cumbersome grid, the most frequently used forms are located in the center of the chart and grid, while the less frequently used forms, divided into two groups, are relegated to the sides. There is also a small additional section containing special forms, including Chinese and Arabic numerals, the English alphabet, forms of address used in correspondence and forms of punctuation.

Secondary organization is according to the traditional classificatory system. Briefly, this system is based upon the fact that the great majority of Chinese characters are composed of two elements, a phonetic element and a meaningful element, the latter commonly called a "radical." Each of the several tens of thousands of characters in the language is subsumed under one or another of these radicals, which are set in number (214), fixed in their sequence and standardized in form and broad meaning. Thus, radical 9 人 is *human*, radical 75 木 is *tree* or *wood*, and radical 140 艸,

grass. The characters in both the central and peripheral groups are organized by this system of radicals, with the only difference being that the peripheral group of characters is divided into two parts, in much the same manner as a two-volume Chinese dictionary, with characters subsumed under radicals 1–96 at the right of the central group and, along with the special forms, those subsumed under radicals 97–214 continued at the left.

The characters on the chart are keyed to the corresponding pieces of type in the grid. The positions and orientations of the two relative to each other, however, are directly opposite. Thus, the characters on the finder-chart are in proper classificatory sequence and are properly printed, while the pieces of type in the grid are in reverse classificatory sequence, backward and oriented to the right. With Arabic numerals once again as examples, this relationship is illustrated here. The usefulness of the chart is apparent.

In construction and function, the carriage is crudely similar to that of a Western typewriter. Thus, it moves from left to right and is equipped with a carriage release. The paper is inserted in similar fashion and can be released by means of a key. Two other keys below and forward from the carriage allow for spacing and backspacing. There is also a ribbon and a single margin bell.

Along with the grid of type, the selector arm and the typing-lever and ejector-pin, are distinctive features of this typewriter, for together they form the basic mechanical modification that allows the typing of a character-language. The Commercial Press typewriter operates on the basis of a selection of some 2,500 separate pieces of type set in a mobile grid. The mechanics of printing one of these characters is based on the joint action of the selector arm, the typing-lever and the ejector-pin. The selector arm is metal, pivoted at its inner end to the front center of the machine, immediately above the mobile grid. The free end of the arm extends out over the grid and is designed to move vertically in an arc upward and back toward the platen. Seen from three-quarter view the head of this arm is similar to a socket wrench, with the square hole of a size to accommodate a piece of type. This selector arm is operated by the typing-lever.

Parallel to the selector arm, and on its left, is a second and more slender arm that supports a roller which as unit also moves in a small vertical arc. When the selector arm is at rest, this roller sits upon the wrench-like head of the arm, but when the selector arm travels upward, the roller is pushed forward and upward in a small arc, out of the path of the selector arm.

OPERATIONAL FEATURES

To type, for instance, the character for *pear* 梨, a kind of tree and its fruit, the typist must first locate the piece of type whose face bears the character for *pear*. Referring to

the finder-chart that he has pulled out of its slot, the typist searches out the printed character for *pear*. An experienced operator will know the precise location of the *pear*-character on the chart. A less knowledgeable typist will look, first, in the central section and then, failing to find the character there, in one of the two peripheral sections. In either case, the operator will focus on those portions of the central or peripheral sections of the chart wherein are located all characters having the radical for *tree* 木 (radical 75) as their meaningful element. (Within the group having the same *tree*-radical, subclassification is based on the number of additional writing-strokes. Thus, the character for *pear* 梨, with seven additional strokes, would precede the character for *kind*, *style* or *form* 樣 with eleven extra strokes.) The operator then grasps the knob on the metal arm and moves the entire unit in such way that the finder-needle at the end of the arm points to the character for *pear* printed on the finder-chart. By synchronization, the selector arm then lies immediately above, and the ejector-pin, immediately below, the corresponding piece of type for *pear*.

By partially depressing the typing lever, the typist raises the ejector-pin and pushes the piece of type for *pear* upward into the waiting wrench-like head of the selector arm.

This action locks the piece of type in the head of the selector arm and, at the same time, turns it a quarter-turn in counter-clockwise direction, so that the character will be printed in proper orientation, that is, standing on its feet. (The procedure outline here produces horizontal lines of characters, reading from left to right, in Western fashion, as 1–2–3. Setting a thumbscrew in the head of the selector arm prevents the piece of type from rotating and so produces lines of characters that still read from left to right, but that lie on their sides as ㅡ-ㄴ-ㅁ. By turning the finished page of typing a quarter-turn in clockwise direction, the result is a page of characters printed vertically in columns and reading in traditional Chinese manner, from the top right corner of the page to the lower left corner.)

At the same time the piece of type is turning, the hard-rubber wheel lying atop the head of the selector arm rises, releasing the selector arm. Final downward pressure on the typing-lever lifts the selector arm sharply upward, causing the piece of type, locked in the head of the arm, to strike against the ribbon and so print the character on the paper behind. As pressure on the typing lever is relaxed, the process is reversed and the piece of type is returned to its space in the grid. The cycle now is complete, and the operator is ready to repeat the whole incredible procedure for the next character.

The Commercial Press typewriter, which is capable of thirty to thirty-five symbols a minute, may be likened to a miniature printing press. The two other character typewriters described more briefly below differ appreciably in both structural and operational principles, especially the method of character selection[4].

The IBM Model
電動華文打字機

First exhibited in New York in 1946, at which time I
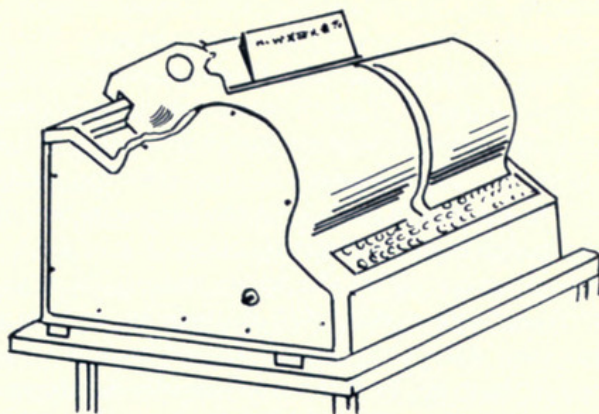
observed it in operation, the Electro-Automatic Chinese Typewriter was built by IBM with the assistance of Mr. Kao Chung-chin, a Chinese engineer and communications expert. The machine was never produced commercially.

STRUCTURAL FEATURES

Although not so clumsy in appearance as the Commercial Press model, the IBM machine still is quite bulky, measuring 24¾ inches wide, 17 inches deep and 13 inches high.

Externally, an aluminum housing leaves open to view only the carriage and keyboard. The carriage, similar to that of a Western typewriter, consists of a platen to carry the paper and the several keys and levers for its operation. The keyboard, the salient external feature of the Electro-Automatic, consists of forty-three keys ranged in two parallel rows and divided into four groups. Thirty-six of the keys are numeral keys that serve directly in the typing, while the remaining seven keys operate allied mechanisms, as follows:

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– – – – 5 4 3 2 1 0        0 1 2 3 4 5 6 7 8 9 –
9 8 7 6 5 4 3 2 1 0        0 1 2 3 4 5 6 7 8 9 –
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Internally, the Electro-Automatic is distinctive and is based on a mechanical principle differing entirely from that characterizing the Commercial Press model, with its font of 2,546 separate pieces of type. The IBM model uses as its "font" a drum, revolving continuously and capable of lateral motion as well, whose outer surface carries 5,400 type figures, arranged in vertical (running around the drum) and horizontal rows. These type figures, which include English letters and business symbols as well as Chinese characters, are grouped according to frequency of use. The first group of 1,000 characters is centrally located and includes 90% of the characters used in ordinary correspondence and 95% of those used in telecommunication. The second group is comprised of some 3,000 characters normally used less than 10% of the time. The third group consists of characters used less than 1% of the time. This grouping serves to decrease the lateral movement of the drum, thereby increasing typing speed.

OPERATIONAL FEATURES

The operation of the IBM model is quite simple, but for the average Westerner, astonishingly clumsy, for requisite to the operation of the Electro-Automatic is the cold-blooded memorization of 5,400 four-digit numbers. Although gen-

erally alien to Europeans, such massive memorization is intimate part of the Chinese and Japanese tradition. For 2,000 years Chinese scholars committed Confucion classics to memory, and even today Chinese telegraphers transmit memorized numbers assigned to characters rather than the charters themselves. The Chinese engineer, Mr. Kao, planned on a four- to six-month period for the memorization of the 5,400 characters and the numbers assigned to them.

Grouped according to the three usage categories described above, each of the 5,400 symbols has a designated four-digit code number. From here on the actual typing procedure is very simple, for it involves only the depression of four keys, one in each of the four groups. The six keys in the upper left group determine the thousands digit, the ten keys in the lower left group determine the hundreds digit, the ten keys in the upper right group, the tens digit, and the ten keys in the lower right group isolate the unit digit and, in addition, operate the typing mechanism. The first two of these number-keys define the lateral location of the character on the drum, and the second two, the vertical location within one line running around the circumference of the drum.

Once the desired symbol has been mechanically located the typing mechanism prints it by the action of a hammer that slaps the paper against the type face. As the drum is in almost continuous motion, however, synchronization is not always perfect, and as a result, the printing sometimes is uneven, with either top or bottom of the symbol improperly printed.

The Electro-Automatic prints in either horizontal lines (Western style) or vertical columns (traditional Chinese style), and in the hands of an expert operator the machine theoretically is capable of typing 50 symbols a minute.

THE MINGKWAI TYPEWRITER
明快打字機
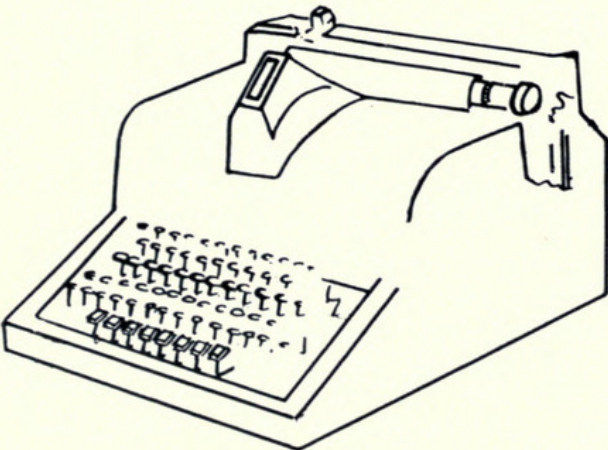
The Mingkwai Typewriter was demonstrated early in 1947 by its inventor, Lin Yutang, the well-known Chinese author and educator. As with the IBM machine the Mingkwai differs from the Commercial Press model in both structure and operation. It is in respect particularly to method of character selection that the Mingkwai has a major advantage over the other two typewriters.

In outward appearance the Mingkwai is more nearly comparable in shape and size to a Western typewriter. Thus, a hood covers the mechanical heart, and keyboard and carriage are patterned after the Western original. The machine measures 14 inches wide, 18 inches deep and 9 inches high.

Diagram of the "Magic Eye" viewer on the Mingkwai typewriter

Despite their similarity in placement and arrangement to those on a Western typewriter the keys of the Mingkwai are labeled in quite different manner. Thus, there are sixty-four round keys, eight square keys and several levers. By use of shift levers each of the round keys represents several alternative symbols. Most prominent on the machine, however, is a viewing device that protrudes from the hood just above the keyboard. As we shall see, this device, the "magic eye," performs a vital function.

As devised by Lin the interior of the machine has some 8,000 type figures mounted on octagonal bars rotating around the axes of six cylinders. The Mingkwai is said to be capable of typing 7,000 whole characters and, by combination of component elements, a theoretical total of 90,000 "manufactured" symbols.

OPERATIONAL FEATURES

As will be recalled, the Commercial Press typewriter utilized two principles in selecting one of the 2,546 available pieces of type, one, frequency of use and, two, the traditional radical system of organization. The IBM model also utilized frequency of use, but dispensed with the radical system and, instead, relied upon memorization of four-digit numbers assigned to each of the 5,400 symbols on the surface of the revolving drum. The Mingkwai machine operates on an entirely different scheme, that of breaking up the characters into component parts. The principle thus is similar to that which underlies the traditional method of dividing characters into phonetic and radical or meaningful elements. Instead of classifying the characters by their 214 radicals, however, the inventor groups them by their top and bottom parts. According to Lin, who refined his system of classification over a 30-year period, 36 tops and 28 bottoms exhaust the possibilities of top and bottom components to be found in the corpus of Mingkwai characters. To operate the machine one therefore only has to be able to recognize in any character the presence of one of the tops and one of the bottoms, an easy matter even for those only slightly versed in Chinese. Once these 64 components are part of one's experience, the actual typing procedure is admirably simple, for it consists only of depressing three keys for each character typed.

First, from among the 36 keys composing the top three rows of the keyboard, the operator selects and depresses the key that represents the top (or top left) component of the character to be typed. Thus, for the character 侶 (mate, *companion*) the typist depresses the 亻 key, and for the character 藍 (*blue*), the 艹 key. This step isolates out all of those characters having those particular tops.

Second, from among the 28 keys composing the bottom two rows of the keyboard, the operator depresses the key that represents the bottom (or bottom right) component of the character. Thus, for the character 侶, the typist would select the 口 key, and for the character 藍, the 一 key. This step acts further to isolate out from those characters having the same top element all those characters having the bottom element represented by this second key that was depressed.

With the depression of two keys, one from the upper rows and one from the lower, a group of characters has been isolated, all of which have similar tops and bottoms. Lin Yutang has calculated that out of his selection of 7,000 characters, there will never be more than eight with common tops and bottoms. After this electronic process of elimination has taken place, this group of not more than eight characters with common tops and bottoms appear on the "magic eye" viewer located on the front of the hood.

By a process of visual selection, then, the typist has only to pick out of the group of characters, numbered from one up to eight, the specific character that he wishes to type. The most frequently used 900 characters are in position one, making for greater typing efficiency. The operator then merely depresses the corresponding square numeral key on the keyboard, in this instance key number four, and automatically the character 侶 is printed. Lin's novel system of character division allows for greater typing efficiency, for only three keys are needed to type a character, and the period required for training is much shorter and simpler.

The Mingkwai, as with the Electro-Automatic, is said to be capable of producing 50 symbols per minute when operated by a skilled typist. That number, though low by Western typing standards, is superior to that generally obtainable with a writing-brush, and there are the further advantages of greater legibility and the availability of carbons. This last, it may be noted in passing, also is a factor in the great popularity of the ballpoint pen in Eastern Asia.

Summary

The three Chinese typewriters described above constitute excellent examples of reinvention as a result of stimulus diffusion. These character typewriters represent a situation in which a basic invention, the Western typewriter, was modified in both principle and structure to meet the demands of a radically different system of writing.

Because of historical and cultural factors these reinventions have been but partially accepted into Chinese culture, for the Chinese still depend almost totally on copyist and the traditional writing-brush. There are several reasons for this lack of general acceptance. One, China still predominantly is an agricultural country and not yet sufficiently needful of the typewriter as an element of common usage. Two, the large population insures an abundant supply of scribes, as all who have frequented government and business offices in China will attest. Three, the narrow selection of characters is a drawback, particularly in the case of the Commercial Press model. Four, in the case of automated models, maintenance and operation are factors, as well as cost, for such models would require a corps of trained maintenance people and an even supply of electricity, still an exception rather than a rule in many parts of China. Finally, there still is some conservatism as regards the mechanical reproduction of characters. Just as the English courts for many years refused to allow their records to be typed, so also there has been some reluctance among the Chinese to discard the brush and inkstone.

Given the present state of China's culture and economy, one can say with fair certainty that in the foreseeable future the Commercial Press style of typewriter, in the form of one of the new Japanese models, will satisfy such need as exists. Should Chinese economic progress allow for some other form of automated typewriter, such use would be very limited. Either way, the situation would be an example of stimulus diffusion, through modification of the Western typewriter to meet the demands of a character language.

One other possibility should be considered. The comments made here concerning the acceptance of the typewriter have been predicated on the assumption that the Chinese would continue in their traditional system of writing. It is within the realm of possibility that in response to pressure from the non-character world, the Chinese ultimately might adopt a system of phonetic or syllabic writing, although such change does not seem likely, given the remarkable tenacity of Chinese cultural tradition. Such a shift thus would obviate the need for a character typewriter, and the Western-style machine, already refined to a high degree, then could fill the cultural need. In such a case the result then would be a rejection of the reinvention in favor of the original invention, the Western typewriter. Should this alternative occur, the situation then in part would be a case of the Chinese modifying their traditional native system of writing to conform with one or another of those used in the non-character world and to fit within the limitations of the original foreign invention. Such a situation indeed would constitute an interesting turn in the endless flow of cultural change.

[1] Kroeber, A. L. *Anthropology* (New York, 1948: pp. 368–69).

[2] The Japanese, with whom the idea of the character-typewriter seems to have originated, still actively produce and market such typewriters which, although highly refined and, in some cases, automated, are based on the same structural and operational principles as the Commercial Press model here described. The Japanese also manufacture a syllabary-typewriter, similar to a Western typewriter, but with the keyboard modified to accommodate their more numerous syllabary of *kana* symbols.

[3] The 2,546 symbols include but a small portion of the total corpus of Chinese characters. The selection is based on common business usage, but even so is not always adequate.

[4] "Two new Chinese typewriters," *The China Magazine*, vol. 17, no. 8 (August, 1947), pp. 48–55.