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Preface: Calligraphy and Books —Their Evolving Relationship Through Chinese History

FREDERICK W. MOTE

Chinese civilization presents innumerable problems of understanding, some of which have intrigued Westerners, who often think that by reason of their sympathetic inclination toward things Chinese they consequently have penetrated the culture, or have gained a measure of Chinese understanding. On analyzing such matters closely, however, we may discover that although we have made satisfying associations, we have not really understood. In fact, many Chinese themselves may fail to go beyond familiar intuitions, seeing little reason to be analytical about their own civilization. Comprehending calligraphy as high art is one of those difficult problems.

This essay will not attempt to probe deeply into the aesthetic content of that art form, but it will attempt to show that a genuine problem of understanding exists, and to clarify its boundaries. Doing so will at least help us in looking at and thinking about the items selected for an exhibition called "Calligraphy and the East Asian Book." In fact, two problems, not one, confront us: first we must understand what made calligraphy so important in East Asia; second, we must see what part it played in the long history of the Chinese and East Asian book. Of course, it is also perfectly valid simply to enjoy the items displayed for their direct appeal to the senses without going further. Neither course is intrinsically more appropriate than the other. Yet the latter course may generate the most common and the most

crippling of errors we can make when observing a civilization from the outside: assuming analogies that do not exist. Let us at least go as far as to show that Chinese calligraphy is quite unlike calligraphy in our Western traditions.

We can get to the crux of the matter by posing a comparison. The facts are well known. China's long tradition in the graphic arts has produced its succession of creative geniuses — its Botticellis, Michelangelos, Rembrandts, and Picassos. As analogues, we might name such Chinese masters as Li Kung-lin, who died in the twelfth century, Ni Tsan of the fourteenth, Wen Cheng-ming of the sixteenth, and Chang Ta-ch'ien of the twentieth. All of these great painters, like their European counterparts, devoted the principal energies of their lives to their painting brushes. Yet not one of the European artists mentioned, or any others whose names come to mind, was a calligrapher, nor did they consider calligraphers to be artists like themselves. We might leap to the conclusion that the reason lay with their painting brushes. The Western painters' brush was not a writing instrument. The Chinese painters' brush was the same as that used by all literate persons for writing; in addition, the Chinese painter painted primarily on the same paper, with the same ink, used for calligraphy. Thus in the European case the material factors of painting were not shared with calligraphy, while in the Chinese case they were. But if we are looking for what caused calligraphy in China to become a high art, this will not do. Brush, ink, paper, and the shared skills of their use provide nothing more than material and efficient causes; they have nothing to do with the final cause, the ultimate reason for calligraphy to be regarded as the supreme expressive art. All the Chinese masters named above and fundamentally all other Chinese painters shared the view that their calligraphy, or other artists' calligraphy, was so important that painting was at best its handmaiden. It is unthinkable that calligraphy as known in the West could have assumed such importance in the minds of Western painters. Although they could greatly admire the beauty of medieval manuscripts or of Roman epigraphy, they did not acknowledge any calligrapher as a great creative figure in the traditions of their own art. Why? The answer does not lie with the materials or the skills of the practitioners of calligraphy, or of typeface design when that became the related minor art in the fifteenth century. The answer lies in the nature of the Chinese script itself.

Our intuitions as admirers of East Asian art can carry us this far. Can we go beyond that and press for a more analytical understanding of the ways in which the script itself could serve as the subject matter of art, to provide the "intrinsic meaning," the content of an art "expressive of human feelings?"[1] Calligraphers in China gave form to the intrinsic meaning conveyed by the script, as they also did (and as Western painters exclusively did) with rocks and trees and human figures, all the elements of nature that form the subject matter of painting. If we do not know Chinese, the script can be seen as abstract forms, but it is not abstract. To a Chinese calligrapher, no matter how radically he may reduce and simplify, or (less typically) ornament and complicate, calligraphy must be legible at some level of perception; it must convey words. The same may be said of Western calligraphy. The difference lies in the nature of the Chinese script itself: its forms are capable of a vast range of extension and variation, subject to the discipline of traditions and the inventiveness of personal styles, for which alphabetic scripts in the Western tradition offer no counterpart. (Islamic calligraphy is excluded here because it is inadequately understood by this writer.)[2]

That is not to denegrate Western calligraphy. Artistic elements of rhythm, balance, and design often were superbly used by the great writing masters to create pages of striking beauty. Their skill in using stylus or pen is often astounding, the elaborate flourishes they loved to add at beginnings and endings can be marvels of perfectly executed, intricately contrived design. A lifetime of practice, a steady hand, and an acute eye for relationships can be discerned in the work of the best calligraphers of their tradition, extending from late Roman times to the present. Their art stressed above all the skill to duplicate strokes with almost machine-like precision, yet precision lightened by the subtle variations that the human hand could impart. It serves no purpose here to evaluate their achievement as greater or lesser than that of East Asian calligraphers. It does, however, serve to describe Western calligraphy more precisely, to note that its place in the self-conscious tradition of Western art was quite different from the subjectively perceived place of calligraphy in East Asia. The calligraphers thought of themselves as doing different things, and were granted different places in their artistic traditions because of that.

One can go a step further in analyzing the character of calligraphy and point out why the artistic act of writing was different, East and West. Again

the difference must be traced to the different natures of the scripts themselves. The most obvious difference is that the graphic symbols, the individual letters of Western scripts number only from twenty to thirty; with capitals, plus lower case letters and nine numerals, they comprise a set of about sixty units. They must be repeated many times on a page, and thus both ideally and practically, must become highly standardized in the process of constant repetition. A good Western calligrapher is one who can repeat the model endlessly with uniformity. Graceful variation comes from subtle elements, such as the positioning of letters in word-units, from mere nuances of individuality in essentially repetitive strokes, from the format of the page, and the like. The range of variation is controlled by the small number of distinctive units — the letters comprising the script. Those letters must be repeated with fluent evenness, letters all of similar height (even though a few extend above the line and a few below, those extensions are similar), the same stroke always thicker or thinner in the same way, all letters either precisely vertical or all inclined in the same way, creating a forward-moving rhythm of repetition. Initial capitals and flourishes of penmanship of a stylized kind allow bits of flamboyance in defiance of that repetition, thereby serving to call attention to it more strongly. Within those conditions six or eight standard styles have prevailed, all derived either from classical inscriptions or from medieval manuscripts, none from the impulses and creative vision of great artists active in the fields of painting or graphic arts. The great artists of Western tradition were doing other things. They were creating forms based on the forms of nature, the subject matter of their paintings and sculptures and drawings. The calligrapher, in contrast, was confined to the simple set of letter shapes that in turn formed word units matching the sounds of speech, as transcribed in twenty or thirty phonetic symbols. The calligrapher-artist had but the most limited degree of control over the forms that he used. They were not reflections of nature. Neither were they ideal creations of his mind. They were symbolic representations of phonemes, the constituent elements of speech. Morphemes or words, with their attendant ideas and their greater stimulus to thought, were a quite secondary preoccupation of the calligrapher.

Chinese script in contrast is one of multiplicity of forms. Instead of the fifty or sixty repeated symbols of the alphabetic scripts, Chinese script makes regular use of literally thousands of characters. To be sure, some one or two hundred of those are of high frequency, yet repetition is not the

dominant feature of the script. It does not demand the constant repetition of a few basic elements that we take for granted in alphabetic scripts. Moreover its units are linear symbols of complete syllables that can be read as words, as semantic units; they are not semantically empty letters. The meaning of the word is in the mind of the calligrapher as he writes it, not secondarily but immediately. He assembles its parts and designs its structure as he writes it so that it will be distinct from the 50,000 other characters that it would be possible to write. The words are not pictures, though in many cases are remotely derived from pictures. Thus it is difficult to say that they are "reflections of nature" to a significantly greater degree than are letters of an alphabet. To a significant degree, however, they could be ideal creations of the artist's mind. That is to say, his freedom to adjust the relationships of the parts, the balance of the elements, the angles and thicknesses of the lines, the links from one character to another, is so vastly greater than that involving elements of alphabetic scripts that, while bearing in mind to whatever degree he might wish the semantic content of the character, he could create an ideal expression from the linear elements composing the symbol. Thus, both from the fact that its units are morphemes and from the fact that the lines composing each character unit are many and varied and that the writer can make innumerable expressive choices in the way he shapes and assembles those lines, the Chinese script is fundamentally dissimilar to Western scripts.

The total outsider to the Chinese language and script, unless he is an experienced viewer of Chinese art, may think he sees explanations for the high place of calligraphy in the arts on analogy to beautiful writing in Western scripts. He will almost certainly be wrong. Almost nothing we can accurately say about Western calligraphy conveys significance for the understanding of Chinese calligraphy as high art. On the other hand, any serious student of Chinese or East Asian civilizations who knows the language and has learned to write the script may be so totally fascinated by the curious appeal of the Chinese characters that he will think he knows why. He may or may not be able to put his reasons into words.

How did the linear symbols standing for the more or less fifty thousand morphemes of the Chinese language acquire their overriding importance as art? It was the result of a process of artistic development that probably began during the Han dynasty, two thousand years ago. It coincided with the widespread use of paper for writing, and the adaptation to paper of the

much older Chinese ink and writing brush. This material factor is not unimportant, but it is but one element in the history of that development. Theoretical considerations of aesthetics also date from about that time. Literature of imagination also flourished. And new facile script styles were replacing older, clumsier ones — clumsier in the sense of being less readily written, no matter how beautiful they were. All of these developments occurred together. The importance attached to literacy and to literary learning involved the entire upper stratum of Chinese society in the daily use of writing. At that time, something most unusual in the history of civilizations occurred in China. The literary and graphic arts acquired maturity under conditions that made the entire literate elite both performer and audience, both producer and consumer of all their arts, that is, the higher arts of that cultural milieu. Primarily those were arts performed with brush, ink, and paper — poetry, calligraphy, and other literary and artistic forms. Music was their only artistic activity of high importance to them that lay beyond brush and ink. Chinese elite society did not hire its artists from other sectors or cultivate its poets among eccentric specialists, as almost all other societies have done. All cultivated men took part both in creating and in appreciating. That meant that the artists' inner secrets of creation were in some measure accessible to all. Because calligraphy assumed such significance and benefited from such widely shared participation, it developed very rapidly. It was a central fixation of the civilization because everyone, as performer himself, could grasp the import of the great masters' achievements, even when he could not equal those. Between the end of the Han dynasty in the third century and the beginning of the T'ang in the seventh, a succession of great calligraphers defined the norms of calligraphy for all later ages. They gave calligraphy its creative scope and made it the premier art throughout East Asia.

From that time to the present, scholars have studied the art historical problems of Chinese calligraphy. They tend to write for each other, as specialists who know what calligraphy is. When they discuss what has been referred to above as the "aesthetic content" of calligraphy, they invariably invoke artful metaphors intended to reveal the special qualities of the great masters. They often speak of "visual energy and excitement," or the "impulse, momentum, poise, and interplay of forces as in dance," in describing a masterwork. Metaphors of movement best convey the qualities that the connoisseur values in this art. Yet it is also common to say that calligra-

phy's inspiration lies in nature, which may be true, but which becomes misleading when developed to the point of declaring that each stroke, each dot, is alive like a living twig or other living thing. A useful metaphor, unless it implies actual imitation of nature in calligraphy. The brushwork of some painters is called "calligraphic," but that implies the opposite, not that brush strokes imitate twigs but that twigs are drawn as if they were brush strokes. In that, twigs are reduced to symbols, symbols are not elaborated to become twigs.

The aesthetic content of calligraphy lies beyond the present concern and, in any case, would be a problem for experts in East Asian art to pursue. The purpose of this essay up to this point has been to show how the particular nature of the Chinese script made it possible for it to become something more than "beautiful writing" (the literal meaning of calligraphy), to serve as the vehicle for the most highly honored of the Chinese arts. While the art historical problems have scarcely been touched upon here, we may at least have gained a sense that the calligraphy utilizing the Chinese script is not just a separate species within the genus "calligraphia" to which Western calligraphy belongs, but should be classified under a different genus, or even under another order, in the taxonomy we might devise for written symbol systems. Despite analogy of function, they spring from different origins.

When we go on to discuss the utilization of scripts in making books, first manuscript and later printed books, that analogy of function becomes a focus of our attention. Both scripts, the alphabetic and the morphemic character script, served in their different ways to record speech in standardized systems. Eventually scripts were used to preserve great quantities of words, that is, the texts produced by the writers and the recorders of their civilizations. Thus books came into being. Before printing was devised for quickly multiplying identical copies of books, both in the East and in the West handwritten books had long existed and had achieved artistic as well as practical characteristics; they were beautiful as well as usable objects. Printing came into being as an alternate way of doing the same thing. The early makers of printed books felt themselves under great pressure to imitate existing manuscript books, adapting their standards as convincingly as possible to the requirements of printing technology. That was true both East and West. But the historical experience surrounding the development

of books was quite different, East from West. Thus, much of what we see exhibited here is a record of the historical experience in East Asia.

We have already established that the scripts, or the calligraphy, which had to be adapted to the technology of printing in both cases worked in quite different ways. Equally important, the new technology of printing that arose in T'ang dynasty China also was quite different from techniques developed (whether independently invented or borrowed) when Europeans began printing seven or eight centuries later. These general explanations — the nature of the scripts and the technology of printing — help explain how the evolving relationship between calligraphy and the printed book went by different routes in China and in Europe.

Only a few salient points need be raised about the early history of European printing to show the contrasts. Paper making and ink manufacture traveled from China to Western Asia, thence into the Mediterranean world, by the eleventh century. Printing pictures and textiles from wooden blocks was known in Europe for centuries before Gutenberg's time and probably was independently invented there. But block printing in Europe had not led to making block-printed books. The technological breakthrough that produced the beginning of printing in Europe, that is to say, the manufacture of books by printing, was that of typography. Typography means printing from movable, in this case cast metal, type. The Chinese had made movable type from ceramic materials and from wood by the eleventh century. The Koreans appear to have greatly developed the techniques for casting type in bronze, iron, and various alloys and may well have invented those techniques. In short, a technology long present in East Asia began to be used in Europe in the mid-fifteenth century; whether it was independently invented there or diffused from East Asia is of secondary importance.

The explosive rapidity of printing's adoption in Europe and consequent social impact allows historians to label it "revolutionary." It made books vastly cheaper and more common than they had been, and that came at a time when the Renaissance was in the bud. The contribution of books to that rebirth of classical learning and the broadening of intellectual horizons was of the greatest importance. Some European historians therefore feel compelled to regard printing as necessarily a European innovation in all of human history, for they know of no parallel stimulus to change elsewhere. One such scholar once said to the present writer: "Well, perhaps it is true in some sense that the Chinese invented printing centuries before Guten-

berg, but it really did not matter until it happened in Europe." That is both amusingly and all too familiarly parochial-minded, and at the same time genuinely revealing of a difference in the patterns of cultural history East and West. In China the availability of books had long been at a higher level. An ordinary scholar's library was relatively much larger and its cost lower, and the application of printing techniques to making books was but another incremental step in gradually increasing the circulation of books in society, not an explosively intrusive new force in history.[3]

Typography perfectly suited the demands of Western alphabetic scripts, and its appearance in the fifteenth century came at a time when European society possessed the capacity for rapid mechanization of the process. The scripts in use there needed only a small number of different type to encompass the alphabet and other needed signs; a font could be cast from a mere sixty bronze matrices, which in turn could be manufactured from a set of the same number of steel punches, designed by an artist and engraved by a master craftsman. The "invention of printing" to which Gutenberg appears to have made crucial contributions consisted of assembling a number of known techniques and adding important refinements, for example in devising alloys for casting, in the design of molds for holding matrices when casting, in the press, and the oil-fast ink. At first the effort to imitate the calligraphy of fine manuscript books went so far that insignificant variations in the forms of letters and their connections in words were cast in type, but in the interests of economy those features were quickly abandoned. Those who made the first fonts of type in the fifteenth century have been called the world's first industrial designers. From the first, European printing was an industry more than a craft; its processes demanded simplification, uniformity, standardization. Within those limits the new typefaces could be very beautiful, but they could not wholly transcend the mechanical dullness resulting from endless repetition of identical forms. Printing induces an expectation of legibility and simplicity. Most readers probably are not highly aware of the differences in the typefaces they encounter in their reading. They feel no loss in the virtual exclusion of aesthetic considerations or, in the best of cases, in the dulling of the aesthetic impact, that typography inevitably induces. The point to be drawn from this is that standardization, routinization, the tendencies toward dull uniformity, were already present in the nature of alphabetic scripts, so there was no great wrench when handwritten pages were superseded by typography. In the

West, despite a brief initial phase of continuing influence, the links between calligraphy and the book were rather quickly and easily broken when printing intervened.

When we look at the parallel experience starting in the seventh century in China, we can discern a long-range trend toward a similar standardization, culminating in the widespread use of typography only within the last century. The relationship of calligraphy to the book was deeper and far more enduring. The nature of the Chinese script succeeded in imposing its demands on the forms of printing technology in East Asia. At the same time, the artistic considerations kept alive by the society's broad involvement with calligraphy as high art found expression in the design of books. This aspect of printing in East Asia gives it an important place in the history of art.

The Chinese, unlike their later European counterparts, adapted woodblock printing technology to the manufacture of books and produced books in that way for several centuries before they began to experiment with typography. Even after discovering that alternate technique in the eleventh century, they found that the expense of manufacturing fonts requiring a minimum of several thousand characters (not to mention arranging and storing, cleaning, and re-sorting after use) made typography a less desirable option. It remained an interesting, though peripheral, alternate technology until recent times. Carving wooden blocks, from each side of which one double page could be printed, was cheaper and more practical. The blocks could be stored, repaired if necessary, even edited for errors, and reused over hundreds of years. That being so, the art of block-printing reigned. The complexity of the script dictated its being the practical method; the artistic component of calligraphy took advantage of the flexibility it offered.

The preparation of blocks for printing has been succinctly described by Tsien Tsuen-hsuin:

> In the preparation for engraving and printing, the manuscript is transcribed on thin sheets of paper by a professional calligrapher. To do this a blank sheet is ruled into columns and spaces with a center line in head column known as a variegated space (*hua ko*); this is used as a guide for writing the characters within each space in a balanced arrangement. The paper is waxed lightly and

> smoothed with a stone burnisher to make the surface easier to write on with a brush. The transcript is placed, written side down, on a block over which a thin layer of rice paste has been evenly spread. . . . The back of the paper is then rubbed with a flat palm-fiber brush . . . so that a clear impression of the inked area is transferred to the block. When the paper has dried, its upper layer is rubbed away with finger tips and brush to expose a fine mirror image of the characters or designs which have been applied to the block, looking as if they had been inscribed directly on it. The block is then ready for carving.[4]

Quite simply, anything that the calligrapher writes can be transferred precisely to the block and, depending on the skill of the carvers, can then be printed as written. All the idiosyncratic and stylistic variations of the calligrapher's hand—his high art—could be duplicated in woodblock printing. Yet that is not what usually happened.

A fine calligrapher, or an ordinary one, when writing a letter to a friend or transcribing a poem or essay, normally did not write on paper ruled into vertical columns or allot the same space to each character. He had wide latitude to vary shapes, sizes, and placements. On the other hand, when writing the text of a proclamation or an inscription, or preparing the text of a book he had authored or submitting a memorial or report as an official act, he would restrict himself to a more formal style neatly formatted on the page. That formality probably derived from chancery practice; government documents from early imperial times demanded it. From the fourth century onward, surviving Buddhist sutras copied by professional scribes also exhibit meticulous formatting requirements: heads of columns precisely aligned and the same number of characters (usually seventeen or nineteen) to each column. That facilitated counting the number of characters in each text to assure that nothing had been omitted; the total number often was written at the end of the text. Scroll books in use before T'ang times exhibit those elements of uniformity and standardization.

Printing began in one of the great ages of calligraphy. The T'ang masters, such as Ou-yang Hsün and Yen Chen-ch'ing (discussed below), impressed their distinctive styles on the calligraphy of their times. While they did not themselves (insofar as we know) write out texts for carving on printing blocks, calligraphers writing in their styles did so. Such calligra-

pher-copyists could use as their models the rubbings of monumental inscriptions, in which the great masters wrote standard script (*k'ai-shu*) and observed the precise format of equal space for each character in ruled verticle columns. Great calligraphy was not incompatible with those restrictions. Thus the calligraphy transferred to printing blocks tended to be, at its best, the fairly close echoes of the distinctive monumental styles of a few great T'ang calligraphers. Good professional calligraphers were capable of that. The norm continued to be observed throughout Sung, and into Yüan and early Ming. The great calligraphers whose models were followed varied, and in the thirteenth century the calligraphy of the last of the great individualistic stylists, Chao Meng-fu (1254-1322), for a time swept away competing traditions to dominate printing for a century or more. Throughout, the intimate relationship with calligraphy of the highest standards persisted. The quality of the craftsmen calligraphers hired for writing out the texts to be printed might vary considerably, as could the care and skill of the carvers. Yet standards were upheld. In Sung times some of the greatest calligraphers themselves deigned to transcribe texts for carving.

During the Ming dynasty (1368-1644) the standards of printing declined as volume swelled. Some excellent calligraphers performed for book printers, especially for the imperial printery in the capitals where the so-called palace editions (*tien pen, nei-fu pen*) were produced. But much printing did not observe the high standards established in the Sung. More often than not the distinctive features of the great school traditions in calligraphy were lost; craftsmen reduced those models to routinized derivations that are called "craftsmen's style" characters (*chiang-t'i tzu*). Whereas the calligrapher or the calligraphy tradition that underlay the style in any Sung book usually is quite obvious, craftsmen's characters are essentially without style. Still, they are calligraphy, not mechanically duplicated cast metal typography. (Even typography, which had a certain vogue in the Ming, mostly favored individually carved, wooden movable type, not metal type all cast from the same matrix.) Printing somewhat reduced individuality and weakened the liveliness of the original art of which it was a duplicated image, but it did not deprive Chinese books of their individuality, despite tendencies to standardize and to merge distinctive styles into more uniform "Sung dynasty characters."

As if in opposition to those degenerative trends in Ming printing at its

most ordinary, one can observe signs of the effort to reassert the importance of calligraphy in books. At first the trend appeared in the best books produced by connoisseurs, then became a fashion imitated by trade publishers. One practise was to devote the opening section of a book (sometimes the entire first volume in a larger work) to prefaces written often in the less formal scripts (*hsing-shu*, even *ts'ao-shu*) and carved in facsimile of the named calligrapher's own hand. Carving of informal or non-regularized calligraphy is called "*hsieh k'o*" (carved as written) and was by no means new. In fact, all printing blocks are carved as written, but the implication of the term is that the writing is not that of nameless craftsmen calligraphers, but conveys the immediate sense of the known writer's personal hand. This was taken up in middle and later Ming times with a new enthusiasm. The duller the routinized characters of the text became under the publishing trends of the day, the more the need may have been felt to insert personality and artistic tone into the frontmatter. Sometimes marginalia were added throughout a book, printed in a cursive hand with personal comments and asides, imitating the way a scholar might annotate the margins of his book as he read it. The actual annotated copy of a book that belonged to a famous scholar might be duplicated in facsimile, but in many cases those annotated books were simulated, the calligraphy and pungent comment lending flavor to attract the buyer. The fashion also grew in Ming and Ch'ing times to print an entire book in the real or simulated calligraphy of a great master, for example, the poetry collection of T'ao Ch'ien (365-427) as transcribed in the eminent calligraphy of Su Shih (1036-1101), or the *Four Books* in facsimile of the eccentric calligrapher Cheng Hsieh (1693-1765). We see calligraphy being drawn upon in many ways from mid-Ming times on, through the Ch'ing dynasty at least into the nineteenth century, to add liveliness and interest to books, and to transmit to the ever expanding readership of books a direct reminder of calligraphy's high claims on their aesthetic sensibilities. All of this was possible as long as woodblock printing technology prevailed.

First lithography, in the early nineteenth century, then before the end of that century the advanced European methods of typography entered China from the West. Although the particular demands of the Chinese script pose ever fewer problems for modern technology, the distinctive art of the Chinese book has become a thing of the past, to be treasured by antiquarians and studied by historians. It will amply reward those who pause to

examine the magnificent objects displayed in the exhibition for which this is the catalogue.

NOTES TO THE PREFACE

1. The terms in quotation marks, originally drawn from Erwin Panofsky and Susan Langer, are used in a different context by Max Loehr, "Chinese Landscape Painting and Its Real Content," *Rice University Studies* 59.4 (Fall 1973), p. 68.
2. The interested reader may turn to the essay "Introduction to Islamic Calligraphy" by Glenn D. Lowry, in Shen Fu, Glenn D. Lowry, and Ann Yonemura, *From Concept to Context: Approaches to Asian and Islamic Calligraphy* (Washington, D.C.: Freer Gallery of Art, Smithsonian Institution, 1986), pp. 102-09.
3. Joseph Needham has commented in a somewhat similar vein on Francis Bacon's well-known observation of the three most significant inventions "of obscure and inglorious origins"—namely printing, gunpowder, and the magnet (or magnetic compass, all three in fact Chinese inventions)—that "have changed the whole state and face of things throughout the world." See Joseph Needham, "Science and China's Influence on the World," first published in Raymond Dawson, ed., *The Legacy of China*, reprinted in Needham, *The Grand Titration*, 1969.
4. T. H. Tsien, *Paper and Printing*, in vol. 5.1 of Joseph Needham, *Science and Civilisation in China* (Cambridge: Cambridge U.P., 1985), p. 197.