



International Journal of Arts and Technology

ISSN online: 1754-8861 - ISSN print: 1754-8853

<https://www.inderscience.com/ijart>

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DOI: [10.1504/IJART.2026.10081541](https://doi.org/10.1504/IJART.2026.10081541)

Article History:

Received:	19 June 2026
Last revised:	03 July 2026
Accepted:	11 July 2026
Published online:	23 October 2026

A new exploration of the causes behind the square-based structure of Chinese character outlines

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Abstract: Why Chinese characters came to be organised within approximately square writing cells remains disputed. This article develops a design-historical account that distinguishes the linguistic unit represented by a graph from the spatial organisation of the graph itself. It proposes four analytical possibilities – phoneme-, syllable-, morpheme-, and word-level writing units – and asks which of these were available to Chinese writing at different historical stages. Drawing on published linguistic, palaeographic, and design-historical studies, the analysis treats recording principles, glyph modification, writing tools and surfaces, textual layout, cultural preferences, and printing as interacting enabling conditions rather than independent or sufficient causes. The evidence supports a cautious interpretation: the square configuration was neither an automatic consequence of semantic writing nor a purely cultural preference. It emerged through the gradual regularisation of clustered graphs within changing linguistic, material, and institutional settings. The article therefore offers a conceptual framework for comparing graphic regularisation across writing systems, while acknowledging that the relative contribution of each condition requires corpus-based historical testing.

Keywords: Chinese characters; glyph outline; square configuration; writing systems; design history.

Reference to this paper should be made as follows: Dai, M. and Li, H. (2026) 'A new exploration of the causes behind the square-based structure of Chinese character outlines', *Int. J. Arts and Technology*, Vol. 16, No. 10, pp.1–15.

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1 Limitations in existing discussions on the square configuration of Chinese character outlines

Scholars have long discussed why the character outline of Chinese characters adopted a square configuration, and a number of explanatory models have been proposed. For instance, Wang Ning advances the theory of ‘semantic construction selection’, arguing that “the square form is an inevitable feature arising from semantic construction”. Lu Zhongfa (Wang, 2013) proposes the theory of ‘glyph simplicity’, maintaining that “the outline expressing each semantic element in Chinese characters is relatively simple. As a result, Chinese character glyphs formed through parataxis also tend to remain simple, which constitutes the fundamental reason why Chinese characters have consistently preserved a square configuration”. Meanwhile, Sun Xuefeng (Lu, 2009) attributes the emergence of the square configuration to ‘constraints and coordinative selection in arrangement’, arguing that it resulted from the gradual optimisation of arrangement patterns through countless processes of constraint and coordination.

Beyond these structural explanations (Sun, 2020), some scholars have emphasised the role of cultural preference. Li Ping, for instance, argues that “the square-based features of Chinese characters are manifestations of the ancient Chinese preference for square forms”. Li (2002) likewise observes that traditional Chinese geographical thinking tended to impose square and symmetrical patterns on objects whose actual boundaries were often highly irregular and internally heterogeneous. For example, in ancient China, fields were square, houses were square, city walls followed square layouts, and even the grids used in mapping and drafting were typically square-based (Li, 2016).

Although these explanations are persuasive to varying degrees, each also has certain limitations. The theory of ‘semantic construction selection’, for example, regards square configuration as an inevitable consequence of semantic construction. Yet both hieroglyphic writing and the Dongba script also rely on semantic construction, while their character outlines are not square-based. The theory of ‘glyph simplicity’ argues that Chinese characters maintained a square configuration because their glyphs are relatively simple. Alphabetic writing, however, is in fact far simpler in form than Chinese characters, yet its character outlines do not assume square-based forms. Similarly, the theory of ‘constraints and coordinative selection in arrangement’ attributes square configuration to repeated processes of adjustment and optimisation in character arrangement. Yet all writing systems undergo continual experimentation in arrangement, and such experimentation alone cannot adequately explain the emergence of square configuration.

From a design-historical perspective, these accounts leave one prior question unresolved: whether the character outline of Chinese characters inherently possessed the possibility of a square configuration in the first place. Without such a design possibility, factors such as semantic construction, glyph simplicity, or cultural preference could not serve as meaningful explanatory factors.

This article therefore treats square configuration as an analytical possibility rather than a predetermined outcome. Any discussion of the origins of the square configuration of Chinese character outlines must first clarify whether the character outline of Chinese characters allowed for the design possibility of square configuration. Only then can one meaningfully examine the factors that led this design possibility to be selected and realised in the historical development of the script.

1.1 Approach and scope

This is a conceptual and comparative historical study based on published scholarship and selected palaeographic examples. It does not provide a comprehensive corpus or a quantitative test of causal effects. The examples are used to examine whether the proposed framework is historically plausible, not to estimate the relative weight of individual factors. Accordingly, terms such as enabling condition and contribution indicate compatibility with a historical development; they do not establish necessity or independent causation. Comparisons with other writing systems are heuristic and should be tested through matched corpora in future work.

2 The square configuration of different structural units in writing systems and the basic conditions for its realisation

Current scholarship offers three principal interpretations of the square configuration of written characters. One defines it in terms of the square configuration of the external outline itself, namely, the requirement ‘to maintain a two-dimensional square form in both vertical and horizontal dimensions’ (Wang, 2013). Another defines it as the capacity to be inscribed within a square grid, that is, ‘taking the ability to fit a compounded character into a square space as the basic principle’ (Qiu, 2013). Finally, a third interpretation emphasises the assignment of a fixed area to a linguistic structural unit, stating that “Chinese characters are called square characters because the glyph combines a number of strokes within a fixed area to represent each sound unit in language” (Wei, 2013).

The first two interpretations may essentially be regarded as one, since both concern the external formal properties of the glyph. The third interpretation, although likewise referring to a ‘fixed area’ and thus still addressing external form, introduces another crucial dimension of square configuration through its emphasis on the correspondence between square configuration and linguistic structural units.

In fact, it is precisely through this correspondence that writing systems with superficially similar square forms can be meaningfully distinguished. Therefore, the question raised earlier – whether Chinese character outlines possessed the design possibility for square configuration – cannot be adequately addressed without first determining which linguistic structural unit the Chinese square configuration corresponds to.

Language consists of two distinct structural levels: the phonological level and the grammatical level. At the phonological level, linguistic units are hierarchically organised from smaller to larger units, such as phoneme, syllable, and foot. At the grammatical level, language is composed of sound-meaning units, which likewise form a hierarchy from morpheme and word to phrase and sentence.

For a writing system to achieve precise linguistic representation, it must select particular structural units as the basis of recording (Ye and Xu, 2010a). From the perspective of the phonological level, the recording method may choose either the phoneme or the syllable as its fundamental unit. From the perspective of the grammatical level, it may instead select the morpheme or the word. Correspondingly, at the level of character outline design; there exist two possible forms of square configuration at the phonological level: the square configuration of phoneme units and the square

configuration of syllable units. At the grammatical level, there likewise exist the square configuration of morpheme units and the square configuration of word units.

It should be noted, however, that this square configuration is defined in relation to the linguistic units of the language being recorded. When the corresponding linguistic unit differs, the possibility of such a square configuration may no longer exist. Hangul, for example, exhibits the square configuration of syllable units: each syllable is configured as a square. At the level of the phoneme, however, not every phoneme can be represented as an independent square unit. Moreover, square configuration at the phonological level and at the grammatical level refers to two distinct classifications of linguistic units, although some overlap may occur. Tangut script, for instance, may be understood as exhibiting the square configuration of syllable units at the phonological level and the square configuration of word units at the grammatical level.

What deserves closer attention, however, is that these four types of square configuration are subject to specific conditions in terms of both linguistic characteristics and the principles of character formation; they cannot be realised unconditionally.

At the level of phoneme units, the square configuration does not impose any special linguistic requirements. In terms of character formation, however, the writing system must record the sounds of the language at the level of the phoneme. If the chosen phonological unit exceeds the phoneme, the square configuration of phoneme units cannot be implemented.

For syllable units, by contrast, character formation imposes no particular restrictions, but linguistic conditions make the square configuration of syllable units difficult to realise in inflectional languages. Writing systems associated with inflectional languages must accommodate grammatical categories such as gender, number, case, aspect, and mood in actual use. This means that the written form of a word often changes in actual use, involving the addition, deletion, or substitution of certain components.

For morpheme units, the requirements regarding character formation are similar to those for phoneme units: the unit being recorded must be the morpheme rather than the word. Although in many languages a morpheme is often equivalent to a word, there are still cases in which certain morphemes do not constitute words. Consequently, a square configuration of morpheme units can only be fully realised if the writing system records the language at the level of the morpheme.

At the linguistic level, two conditions must be met. First, for reasons similar to those applicable to syllable units, such a structure is difficult to achieve in inflectional languages. Second, it is also difficult to realise in languages that are predominantly multisyllabic. Human languages may be broadly divided into monosyllabic and multisyllabic languages according to the correspondence between morphemes and the number of syllables. In languages dominated by multisyllabic words, the correspondence between morphemes and phonological units is often unstable, making the realisation of a square configuration at the morpheme level highly constrained. For example, in English, a morpheme may correspond to a single syllable, as in *book*; to more than one syllable, as in *mother*; or to less than one syllable, as in the *-s* of *books*. Because the number of corresponding syllables is variable – and variable syllable numbers also imply variable phoneme numbers – it is difficult to achieve a uniform square configuration (Ye and Xu, 2010b).

For the square configuration of word units, character formation imposes no particular constraints, but two linguistic conditions are involved. The first resembles the conditions discussed above for syllable units and morpheme units: it is difficult to realise in

inflectional languages. The second parallels the case of morpheme units: in languages dominated by multisyllabic words, it is also difficult to implement the square configuration of word units. In such languages, regardless of whether the correspondence between writing and language at the phonological level is based on phonemes or syllables, words are generally formed through the compounding of a varying number of syllables. A form composed of unequal numbers of components is therefore unlikely to achieve a unified square configuration in the character outline of the corresponding linguistic unit.

The foregoing analysis indicates that although four possible types of square configuration may be identified at the phonological and grammatical levels, their actual implementation is subject to specific conditions relating both to the language being recorded and to the principles of character formation employed.

3 The design possibilities of the square configuration of Chinese character outlines and the factors behind their selection

In its early stage, the Chinese language recorded by Chinese characters was predominantly monosyllabic and was an isolating language. In terms of character formation, the relevant unit of phonological recording was the syllable. On the basis of the four types of square configuration discussed above and their basic conditions for realisation, Chinese characters theoretically possessed three design possibilities: the square configuration of syllable units at the phonological level, and the square configuration of morpheme units and of word units at the grammatical level.

Yet the mere existence of a design possibility for the square configuration of a given linguistic unit does not mean that this possibility will necessarily be put into practice. English, for example, corresponds to phoneme units at the phonological level and therefore possesses the possibility of the square configuration of phoneme units. In the written form of English, however, this possibility was not actualised. Given that Chinese characters possessed design possibilities for the square configuration of multiple linguistic units, the following questions arise: did Chinese characters put these possibilities into practice? If so, which linguistic units were selected for square configuration; and what factors contributed to these choices?

The very designation of Chinese characters as ‘square characters’ indicates that this possibility was indeed actualised. In the course of their historical development, Chinese characters continuously reinforced this possibility by drawing on the inherent advantages of the square form itself, together with factors such as the recording method, the modification of glyph form, writing tools and media, early application of writing, and cultural preference. As a result, the three design possibilities of square configuration – syllable units at the phonological level, and morpheme units and word units at the grammatical level – were each implemented.

The first factor concerns the driving role of the recording method, which can be observed in several respects.

One such respect is the correspondence between Chinese characters and whole pronunciations in the language; that is, the glyph corresponded directly to the pronunciation of a word as a whole, without mediation through spelling (Boltz, 2000). This established the basic graphic pattern of ‘one form, one sound’, which made the

implementation of square configuration formally convenient and laid the foundation for the square configuration of syllable units at the phonological level.

A second respect is that parataxis in semantic construction freed the arrangement of Chinese character components from the constraints of pictorial representation, thereby increasing the design flexibility of the character outline and facilitating the selection and implementation of a square configuration.

In the early stage of semantic construction in Chinese characters, the method adopted was form-based semantic construction, a method that constructs meaning through the meaning inherent in the form itself. For example, the graph ‘鹿’ (He 37432) was itself an image of a deer and thus contained both the graphic form and the meaning of ‘deer’, making it readily connectable with the semantic content of ‘鹿’ and enabling it to function as a record. The graph ‘解’ (Chen 97, ‘to cut apart; to dismember’) constructed a scene of butchering an ox through concrete images representing an ox, a knife, ox horns, and blood; this scene corresponded to the semantic content of ‘解’ and thereby achieved recording.

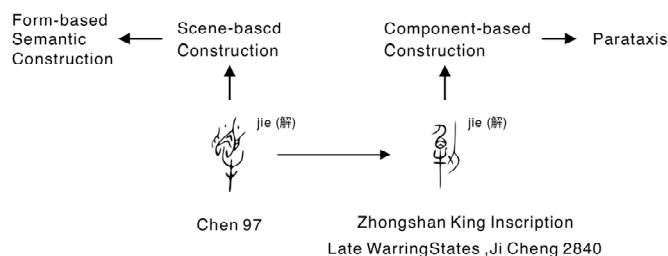
In this mode, the character outline assumed a clustered configuration, creating an initial possibility for square configuration. However, the position and shape of the components in these graphs were strongly constrained by the concrete objects and scenes from which their forms were derived. As a result, character outlines remained diverse, and the clustered configurations of different early graphs displayed a relatively low degree of formal uniformity.

The emergence of parataxis broke through these constraints. Parataxis constructs meaning by combining the meanings represented by individual component forms, so that ‘forms mutually reinforce one another’. For example, the oracle-bone form of ‘听’ (𦔻 Yi 5522; He 7768, Bin group) consists of ‘ear’ and ‘mouth’: the mouth speaks, the ear receives, and the two components are compounded to construct the meaning of ‘listening’.

This method broke free from the constraints of concrete objects or scenes and liberated both the form and spatial arrangement of character components. Their layout no longer had to reproduce an object or a scene, but could instead be arranged freely according to design needs. In the small-seal form of ‘解’, mentioned above, the components remained basically unchanged, yet their spatial arrangement no longer reproduced the scene of butchering an ox. Instead, they were freely arranged and distributed (Figure 1). This means that, at the level of semantic recording, the design of the character outline acquired a corresponding degree of autonomy.

A third respect concerns the emergence of phono-semantic formation, which further strengthened the possibility of formal uniformity in the character outline and created the conditions for a unified square configuration. Phono-semantic formation is a method of character formation that records language by integrating sound and meaning. Its basic form may be described as ‘half semantic form, half phonetic form’: one part of the graph records pronunciation, while another records meaning. This means that the components of the glyph became relatively fixed, and that different characters came to share a greater number of common components. Under these conditions, achieving formal uniformity in the character outline became correspondingly easier, providing an indispensable foundation for the realisation of a system-wide square configuration.

Figure 1 Changes in the component arrangement of the character ‘解’ (see online version for colours)



A fourth respect concerns the emergence of synthetic compounding through the combination of individual characters, which brought about a shift in square configuration at the grammatical level. As Chinese shifted from a predominantly monosyllabic pattern toward a predominantly disyllabic one, Chinese characters likewise shifted from a primary reliance on the creation of individual characters to a primary reliance on the compounding of existing individual characters to form words. Correspondingly, the linguistic unit recorded by Chinese characters shifted from the word to the morpheme. Thus, although Chinese characters retained the square configuration of syllable units at the phonological level, at the grammatical level they underwent a transition from the square configuration of word units to the square configuration of morpheme units (Zhou, 2011).

Second, the realisation of square configuration in the Chinese character outline was further supported by the modification of glyph form.

Early glyph forms offered little advantage for realising square configuration and had difficulty achieving overall uniformity in external form. For example, inscriptions on the Da Yu Ding from the Western Zhou period already show the practice of writing within ruled squares, reflecting a clear pursuit of square configuration. Yet the final result was far from ideal: the characters in the inscription varied considerably in size and often extended beyond the boundaries of the squares. This outcome was directly related to the glyph forms of the period.

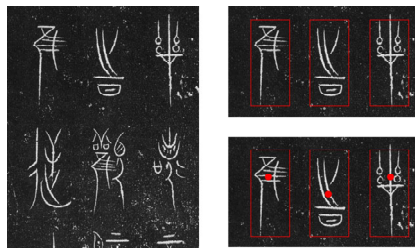
On the one hand, character components were relatively complex, and there was not yet a strong awareness of adjusting them according to spatial constraints. The component ‘木’, for instance, whether appearing as an independent graph in oracle-bone forms or later small-seal forms, or serving as a component within other characters, remained basically the same in form. Little attention was paid to modifying its specific shape to control the size of the character outline.

On the other hand, the basic elements of the glyph – namely, its strokes – were predominantly curved. This made the characters visually intricate and was not conducive to controlling the character outline in writing.

Among the inscriptions from this period that display highly regularised external contours, such as the inscriptions on the three vessels of King Zhongshan, the regularity was in fact the result of careful ‘crafting’. The achievement of a regularised character outline came at the cost of certain internal component arrangements, particularly the positioning of the character core. In the inscriptions of King Zhongshan, the cores of the characters often vary markedly in vertical position when two characters are placed side by side.

Even in the Qing dynasty, masters of seal script such as Deng Shiru and Zhao Zhiqian attempted to adjust these extreme differences in core position by varying the thickness of seal-script lines or by shifting line-dominant structures. Strictly speaking, however, the results were not especially significant. The plasticity of the core position remained limited, making it clear that a more mature square configuration, characterised by greater flexibility in core positioning, was necessary.

Figure 2 In the inscription of Zhongshan Wang Fanghu (partial), the outer contours are relatively uniform, whereas the centres of gravity of the characters vary in height (see online version for colours)



Note: The rubbing of the inscription is adapted from Figure 881(2) in *Selection of Inscriptions on Shang and Zhou Bronzes*, compiled by the Shang and Zhou Bronze Research Group of the Shanghai Museum.

The turning point came with the clerical transformation. Through this process, originally complex pictographic glyphs were transformed into less pictorial and more symbolic forms, creating an opportunity to reshape both the strokes of characters and the layout of their components. More importantly, the improvements in rapid writing brought about by the clerical transformation reveal a clear awareness of arranging components and strokes within a square. Square configuration thus became a design requirement, and its development was advanced at the level of writing practice.

In terms of stroke transformation, a preference emerged for short strokes, while lines with multiple turns were avoided. Lines with three or four turns, common in seal script, were completely abandoned. In terms of directionality, the eight directions of the Mi-pattern grid became the basic orientations, allowing every part of the square form to be used without waste. In effect, these were the same stroke orientations later codified in the 'Eight Principles of Yong'.

Component transformation followed a similar logic. In addition to forming components directly from these modified strokes and then combining them into characters, more refined line configurations were also developed in response to specific spatial constraints. The '木' component mentioned above, which had previously shown little awareness of adjustment according to spatial limits, now received a completely different set of corresponding arrangements in the reorganisation of component layout: in left-right structures, it tended to be tall and narrow; in top-bottom structures, it tended to be flat and square; and when used as a left-side component, its right-falling stroke was written as a dot. These changes were clearly adjustments produced by the constraints of the character outline. They represent, in effect, a concern with spatial interlocking and avoidance, and they reveal a highly explicit awareness of square configuration.

Figure 3 Comparison of variations in the same component across seal script, clerical script, and regular script



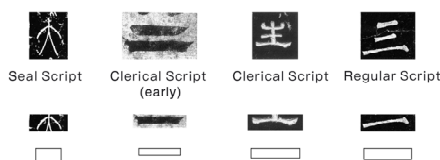
Notes: The component mu (木) shows no clear evidence of deliberate adjustment in its oracle-bone forms. In small seal script, apart from differences in size, its stroke details remain largely unchanged. In regular script, however, both the size and stroke details of the component are modified. For instance, although fen (焚) and sen (森) both contain paired mu(木) components, subtle stroke adjustments are made according to whether the components appear in the upper or lower part of the character.

Of course, in clerical script, the square configuration of the character outline appeared in multiple forms and was not limited to the shape of a regular square. One reason was that the transformation of glyph lines into strokes – that is, the process of stroke formation – had not yet been fully completed. Stroke formation affected not only the shape of components; more importantly, the different strokes it produced, each with its own formal characteristics, directly influenced the eventual determination of the character outline.

Compared with later Han clerical script, early clerical script did not yet show a pronounced use of bozhe strokes, the flaring and sweeping stroke features characteristic of mature clerical script. Since these strokes occupied relatively little space, and techniques of spatial interlocking and avoidance were also applied, characters could quite easily assume a flat-square form. In excavated ancient clerical-script glyphs, however, the strokes often tend to incline in actual writing, or certain strokes are frequently exaggerated. As a result, relatively few glyphs display a genuinely flat-square outline; more often, they appear square or even rectangular. In other words, because of differences in everyday writing preferences, the square configuration of early clerical script was in fact diverse.

By the time of Han clerical script, bozhe strokes had become conventionalised, and the space occupied by strokes increased. Character outlines therefore appeared more often in a square form. Even though everyday writing practices still varied, the character outline was already dominated by the regular square form. By the stage of regular script, the basic strokes had become fully established. Although the bozhe strokes of clerical script had disappeared and strokes were mostly linear, the use of pressing and lifting techniques meant that the space required by strokes did not in fact change substantially. The regular square form thus became the 'standard' character outline in regular script (Figure 4).

Third, the suitability of writing tools and media for square configuration also played a driving role, as represented by the writing brush and bamboo slips.

Figure 4 Differences in the space occupied by strokes across different character forms

To begin with, the writing brush was particularly compatible with this structure. It is not especially suited to English-style linear script; more precisely, the movement characteristics of the writing brush impose certain limitations on the writing of such forms. Writing is, to some extent, a process of drawing lines. As a soft-tipped instrument, the writing brush is characterised by the rebound and reversal of the brush tip during writing. Within a certain spatial range, turning movements and pauses are more readily accommodated, facilitating the execution of clustered forms. In this sense, the clustered form of Chinese characters is better suited to brush writing than the linear configuration of English.

This also helps explain why, during the clerical transformation, Chinese characters did not show signs of developing toward an English-style linear form, even though the transformation was motivated by the pursuit of speed and convenience in writing. Later forms such as Zhangcao script, modern cursive script, and even wild cursive script – especially wild cursive script – displayed a high degree of freedom in glyph formation. Yet the glyphs still largely retained a clearly clustered form. This was certainly intended to preserve the basic features of Chinese characters, but the writing preference associated with the writing brush should also be regarded as an important factor.

Like the writing brush, bamboo slips also show a strong compatibility with square configuration. Bamboo slips were usually narrow and small. Among the excavated examples bearing writing, most are only 0.6 to 0.7 centimetres wide, with the narrowest measuring as little as 0.3 centimetres (Pian and Duan, 2006). According to ordinary assumptions, in such a narrow space, it might seem more convenient to write simple English-style linear glyphs than the far more complex block-like glyphs. If bamboo slips had been written horizontally, this might indeed have been the case. Yet the ancient choice was to write from top to bottom. Under these conditions, writing linear glyphs within a narrow space was constrained in execution.

In terms of writing execution, a very narrow vertical writing space may appear to impose severe lateral restrictions, yet it is not strictly bounded. Whether the slips were bound before writing or written before being bound, their left and right edges differed from the lines of a grid drawn on a large blank surface: the writer did not need to worry about exceeding the boundaries of a square. These lateral limits instead functioned as a kind of open space. Indeed, in many excavated bamboo slips, strokes written to the left and right extend directly beyond the edges of the slip. This pattern suggests that vertical writing on bamboo slips was clearly more compatible with square configuration than with linear glyphs.

A more direct mechanism by which bamboo slips promoted square configuration was in the modifications they induced in the position and form of character components within a narrow writing space. In glyphs that extended disproportionately in the horizontal dimension, certain components were omitted, or others were repositioned, thus producing configurations approaching a square configuration (Liang, 1959). For example,

the graph ‘校’ occurred in a left-middle-right structure in an early stage, 𣎵 (Yi 4157). Later, one ‘木’ component was omitted, giving rise either to atop-bottom structure, 𣎵 (He 29149), or to a left-right structure, 𣎵 (Shui, Xiao 56). In the case of ‘典’, the two hands were moved downward, transforming the graph from a left-middle-right structure, 𣎵 (He 33020), into a top-bottom structure, 𣎵 (He 35412).

The graph ‘刖’, whose original meaning is ‘to cut off the feet’, refers to a form of corporal punishment in antiquity. Its graphic form depicts a frontal human figure with one long foot and one short foot, together with either a knife, 𠂔 (He 6002), or a hand holding a saw-like object, 𠂔 (He 6003), in the act of sawing off the foot. The form was arranged obliquely and was visually unbalanced. In the Shuihudibamboo slips, it was changed into a clear left-right structure, 𠂔 (Shui, Wei 9).

The important role of the writing brush and bamboo slips in the development and refinement of Chinese character forms gave them considerable influence over the selection of glyph forms and configurations. They therefore likely contributed to the establishment and stabilisation of the square configuration of Chinese characters.

Fourth, the modes of application of writing in early writing also exerted a significant influence.

This factor is easily overlooked. A comparison with hieroglyphic writing, another ancient writing system, makes clear the important role played by modes of application. In the practical use of hieroglyphic writing, the determination of the character outline was often constrained by external spatial conditions. Considerable adjustments were therefore required to accommodate the spatial demands of specific writing contexts. In wall paintings, for instance, the final line of a written text might either lack sufficient space or fail to fill the available space. To address such situations, hieroglyphic writing developed a flexible strategy in the number of components used in character formation: phonetic signs could either be omitted or written out. This gave rise to a distinctive design of phonological correspondence, namely the phonological complement (Rogers, 2016).

A phonological complement repeats phonological information already expressed in a preceding sign. In the most common case, a preceding multi-consonantal sign is followed by a single-consonantal sign that reiterates part of its phonological value. Such complements are not pronounced, and their use is optional. This greatly increased the flexibility of character outline design and facilitated the spatial arrangement of glyphs, thereby contributing significantly to the visual organisation of hieroglyphic writing. For example, when only limited space remained at the end of a text, the phonological complements of certain words could be omitted; when additional space needed to be filled, they could instead be written out. In this way, a visually complete layout with no unused writing space could be achieved more readily.

This use of phonological complements, however, directly influenced the selection of character outline forms in hieroglyphic writing. Since the length of glyph forms was variable, a uniformly square-based configuration of the overall outline was unlikely to emerge. By implication, if Chinese characters had been subject to similar practical demands in their early application, their development toward square configuration might have followed a different path, even if the possibility of square configuration had existed.

Fifth, square configuration was consonant with cultural preferences.

In this respect, Chinese characters possessed a distinctive advantage. Certain ancient concepts and practices allow us to identify not only the conceptual origins of

square-based thinking in Chinese characters, but also the formal origins of their square configuration. For example, the Han cultural conception of Round Heaven and Square Earth reveals a conceptual source for the preference for square forms. Similarly, the diagram of ‘two cords and four hooks’, formed under the ancient idea of the ‘four directions’, shows a formal connection with the later Mi-pattern grid and nine-square grid used in Chinese character writing (Needham and Ronan, 2023).

To some extent, the square-based configuration of Chinese characters may be understood as a graphic reflection of these ancient cultural features. In other words, it may be regarded as a cultural choice. This corresponds to the view, discussed above under the explanation of ‘cultural preference’, that ‘the square-based feature of Chinese characters is precisely an expression of early Chinese communities’ preference for square forms’ (Li, 2002).

Sixth, square configuration possessed inherent formal advantages that made it especially compelling.

Beyond its compatibility with cultural preferences and with the characteristics of writing tools and media, the square form also offered other advantages. These advantages gave it considerable appeal in the selection of the character outline and constituted an internal impetus for the development of square configuration in Chinese characters.

The first advantage lies in semantic construction. A four-directional, centre-converging configuration is particularly conducive to semantic construction, and the square form is a typical example of this configuration. As Vico observed, ‘all early peoples used hieroglyphic writing to express meaning, and this was a common natural necessity’ (Vico, 1989). Form-based semantic construction is the basic method of semantic construction in pictographic writing: the relative positions of components above, below, to the left, and to the right can represent relations among entities. For this reason, writing systems now referred to as ancient scripts generally display a configuration in which their constituent parts converge toward the centre.

Such a configuration is not necessarily square-based, nor does it inevitably develop into square configuration. Nevertheless, it provided the square form with an initial advantage in the selection of the character outline. The square configuration of Chinese characters may therefore be understood as the further regularisation of this early four-directional, centre-converging configuration.

The second advantage is the high spatial efficiency of the square form. As has been observed, ‘in the combination of individual units, the square, with all edges being straight, can reduce the gaps between individual units to a minimum and thus save space to the greatest possible extent. It is said that there was once an idea abroad to cultivate square-shaped fruit, the purpose being simply to maximise the usable capacity within transport containers’ (Liu, 1999). In fact, one reason why most packaging boxes on the market adopt a square external form is that the square form provides greater capacity and can effectively reduce costs when applied on a large scale. This high efficiency was clearly well suited to the frequent compounding of numerous components in early form-based semantic construction, and thus made the square form highly attractive.

The third advantage is that the square form provides greater flexibility and adaptability in textual arrangement. The regular and uniform square configuration allows individual Chinese characters to be arranged sequentially into texts without theoretical restriction in any direction: vertical, horizontal, and even diagonal arrangements are all possible. Unlike the rectangle, the square has equal length and width; whether arranged horizontally, vertically, or diagonally, it does not impede readability. A rectangle, by

contrast, must be rotated if arranged vertically, which means that the direction of reading must also change accordingly.

In actual use, the rectangular forms produced by English words vary greatly in length. In vertical arrangement, the spatial waste caused by such variation in form, together with reduced reading fluency, presents a clear problem. Square form Chinese characters do not have this limitation. Moreover, this flexibility also enables considerable adaptability in arrangement, as seen, for example, in the multiple reading orders of palindromic poems.

This advantage of flexible arrangement corresponded to the early need to experiment with different modes of textual application on various media, something that linear arrangement could not achieve. Although early oracle-bone inscriptions already exhibited what Hu Houxuan described as follows – ‘the writing and carving of divinatory inscriptions all followed fixed conventions’ 20 – there were also many exceptional and variant cases. Liu Yuan, in *A Preliminary Discussion of the Line Arrangement of the Huayuanzhuang East Oracle-Bone Inscriptions from Yinxu*, summarises such arrangements as broken-line layouts and three-sided frame patterns, which differ entirely from conventional line arrangement (Liu, 2005). Strictly speaking, without the flexibility and adaptability afforded by square form, such exceptional and variant arrangements would not have been possible.

The fourth advantage is that the square form is more compatible with human visual perception. Studies of vision suggest that the visual cortex of the human brain is analogous to a physical force field, in which the distribution of forces tends toward the most regular, symmetrical, and simplified structure, thus facilitating visual balance. The square is precisely such a structure (Arnheim, 1984). This provides an explanation for the widespread use of square forms in everyday objects.

Additional factors also contributed, one example being the stabilising effect of printing. Before the emergence of printing, the square configuration of Chinese characters may still have exhibited a degree of variability. After the emergence of printing – especially with the development of movable type, in which characters were produced individually – this variability was effectively eliminated, and the square configuration of Chinese characters was thereby further stabilised.

4 Conclusions

This article has reframed the square configuration of Chinese character outlines as a problem of historical regularisation rather than a single-cause outcome. Its main conceptual contribution is to separate the linguistic unit represented by a writing sign from the spatial envelope in which that sign is organised. Within this framework, early Chinese writing can be examined in relation to syllable-, morpheme-, and word-level units without assuming that these categories remained stable throughout its history.

The available examples suggest that no single factor adequately explains the emergence of the square writing cell. Recording principles created a clustered graphic organisation; changes in component structure increased spatial flexibility; brushes, bamboo slips, scribal practices, and later printing shaped the material conditions of regularisation; and cultural preferences may have reinforced, rather than initiated, the resulting convention. These mechanisms should be treated as interacting and historically uneven.

The argument remains bounded by the selective and qualitative nature of the evidence. A stronger causal account would require a periodised corpus, explicit measurements of glyph proportions and component placement, and comparisons conducted under the same criteria across writing systems. The framework offered here is therefore best understood as a testable historical-design hypothesis: Chinese characters became increasingly square not because squareness was inevitable, but because linguistic, graphic, material, and cultural conditions repeatedly made that organisation workable and reproducible.

Acknowledgements

This study was supported by the General Project in Art Studies of the National Social Science Fund of China (Project No. 23BG143).

Declarations

All authors declare that they have no conflicts of interest.

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