

# *Dōng* 東 ‘East’ and the Chinese “Indian Circle”

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The Chinese character 東, writing a word meaning ‘east’, is shown here to have arisen in connection with the use of the vertical gnomon in the determination of cardinal direction. The simple geometric procedure involved—by Al-Bīrūnī (973–1048) termed the “Indian Circle”—is attested across a number of other early cultural contexts, and has a Chinese history traceable from classical-era technical treatises such as the “*Kǎogōng jì*” 考工記 to sixth-century commentary to the mathematical text *Shùshù jìyí* 數術記遺. Evidence offered below constitutes the first direct indication for such a practice in second-millennium BCE China.

## REORIENTATION

Chinese characters are used to write words, and as far as we know always have been. A natural first hypothesis when we discover Character X to represent Word Y in the earliest available materials, therefore, is that this observed relationship represents the original state of affairs. In the case of the character shown just below, early inscriptions show it to write the Old Chinese (OC) word \*tōŋ ‘east’ (with neither character nor associated word much changed to the present). Perhaps, then, this odd shape was crafted with precisely the word \*tōŋ ‘east’ in mind:

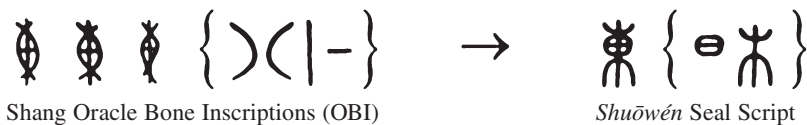


This interpretive direction is reflected as early as the *Shuōwén jiězì* 說文解字 of around 100 CE, where we find the claim that the character 東 depicts “the sun in a tree” 日在木中.<sup>1</sup> A few modern proponents continue to see in the glyph the rising sun, a tree (sometimes the mythological “sun-tree” *Fúsāng* 扶桑), or the spring as the season of Wood (*mù* 木) and the East within Han-era Five Phases correlative cosmologies.<sup>2</sup> However, as is now widely recognized, these suggestions do not bear paleographical scrutiny. Early inscriptions on bone and bronze from the late second to the early first millennium BCE show clearly that the resemblance of 東 to glyphs writing the words *rì* 日 ‘sun’ and *mù* 木 ‘tree; wood’ was the result of formal reanalysis of an earlier arrangement consisting of only four interlocking lines, two curved and two straight:<sup>3</sup>

1. Attributed to a Guān Pǔ 官溥, presumably a close contemporary of Xǔ Shèn 許慎. See *Shuōwén jiězì* 說文解字, *Sìbù cóngkān chūbiān* 四部叢刊初編, 67.6-1, 9a.

2. See Chén 2009.

3. See for instance Sagart 2004: 65, to whom I also owe the idea to apply the historical linguistic concept of “reanalysis” to the historical epigraphical situation. Note that the form shown above (a pre-imperial pottery character from Lǐ et al. 1999: 6:2) has already been affected by such a reanalysis.



As claims for an original relationship with \*tōŋ ‘east’ thus seemed less likely, most twentieth-century investigators took a different approach: perhaps this character was devised not to write \*tōŋ ‘east’ but some (approximate) homophone, only later to be adopted to write ‘east’ on the basis of phonological closeness. Parallel processes are certainly well attested. A pitfall here, however, is the tendency to latch onto a favored interpretation of graphic form and in so doing to lose sight of the more essential matter of words. As regards 東, sure enough, we are told simply that the character’s OBI forms bear a resemblance to early renderings of 束 ([1] and [2] below), writing \*lhok (> *shù*) ‘bind; bundle’, or to two characters found in Western Zhou bronze inscriptions ([3] and [4] below), which may be predecessors of a character 囊 and further relatable to 囊, writing \*tʰâk (> *tuó*) ‘bag; bellows’.<sup>4</sup> Apart from the fact that both ideas are based on already dubious formal claims, it has long been clear that neither \*lhok ‘bundle’ nor \*tʰâk ‘bag’ will qualify as a “near-homophone” of \*tōŋ ‘east’, meaning that the idea of early rebus borrowing never so much as gets off the ground. I confine here to an ungainly footnote some consideration of the logic of these older analytical directions.<sup>5</sup> The takeaway is that the persistence—indeed, the increasing inviolability—of the linguistically unmoored ideas that 東 first depicted a bundle or a bag is an embarrassment not for these ideas’ originators but for the current generation of researchers, as we have thus far failed to leverage ever more sophisticated historical phonological tools toward a critical reevaluation of this and many other of our field’s conventional wisdoms.

Note that the problem is one of methodological rigor and not specifically with the idea that 東 might at first have been a drawing of a tree or a bag or a bundle, suggestions regarding which the only proper a priori attitude is neutrality. Neither is there any a priori reason to consider favorably the current proposal that this character instead reflects an “Indian Circle”-type geometric method for the determination of due east—a return to the old assumption that

4. Below, [1] and [2] are OBI forms; [3] and [4] are from the *Sàn Shì pán* 散氏盤 and the *Máo Gōng dǐng* 毛公鼎 (both Western Zhou) respectively:



Preceded by an asterisk (\*) throughout are the OC reconstructions of Schuessler 2007, themselves based on Baxter 1992. For the word *shù* ‘bind; bundle’, see Schuessler 2007: 473. Modern approaches reconstruct OC voiceless lateral initials in this class of words (Schuessler’s \*lh-).

5. Regarding 束, reference to *shù* (< OC \*lhok) 束 ‘bind; bundle’, with its written character at first incorporating 木 [1] or 禾 [2], began with Lín Yiguāng 林義光 (d. 1932). While rejecting the idea of an original formal connection between 束 and 日, Lín maintained the idea of a link between 束 and 木, claiming on this basis that “束 and 束 are the same character, [while the words] *dōng* and *shù* have associated [OC initial consonant] sounds and belong to compatible [rime] groups”; Lǐ et al. 1999: 6.3. Neither the paleographical nor the phonological suggestion should be acceptable to modern investigators. Reference to *tuó* (< OC \*tʰâk) 囊 ‘bag, bellows’ is due to Xú Zhōngshū 徐中舒 (1898–1991), who cast aside 木 and instead suggested that “束 [was] the ancient form of 囊,” and also that “bags (*tuó* 囊) are for putting things (*wù* 物) in. Things (*wù*) were in later periods called *dōngxī* 東西 ‘things’; *dōngxī* is a permutation of the sound of [the word] *náng* (< OC \*nâŋ) 囊 ‘bag’”; see Yú et al. 1996: 4:3011, where two characters are elided which appear in the context of Dīng Shān’s 丁山 quotation of the remarks as presented in Lǐ et al. 1999: 6.4. Clearly, no proposed early word ‘bundle’ or ‘bag’ (still less medieval *dōngxī* ‘thing’) is up to the linguistic task at hand. Newer analyses remain stuck in these ruts, unfortunately. The hybrid solution in Takashima and Serruys (2010: 55–57) proposes “a bundled mat in which things are placed with a carrying rod in the middle bound with cord, rope or packthread,” for instance.

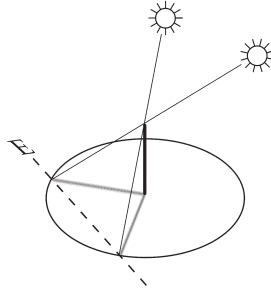


Fig. 1. The use of a circle to capture equal and opposite gnomon shadows and thus the east-west line.

the relationship between 東 and the word \*tōŋ was “first love” for both.<sup>6</sup> I do hold that this approach offers a refreshingly sharp account of early character structure. However, a more fundamental virtue is simple avoidance of violence against widely agreed paleogeographical and linguistic fact. Also crucial, and considered in conclusion, is that this direction allows us to explain for the first time a few mysterious reapplications of the form 東 within early character coinages that are known not to have been licensed by phonological proximity.

#### FULL CIRCLE

The earliest known description of the “Indian Circle” method for determination of the east-west line by use of the vertical gnomon appears within the *Kātyāyana-śulbasūtra* (ca. third century BCE) in relation to construction of sacrificial altars.<sup>7</sup> The key passage is translated as follows by Michio Yano:

Driving the gnomon into the levelled (ground), and drawing a circle with the rope whose length is equal to the gnomon (length), one drives two pegs at (the intersections of) the two lines where the shadow of the tip of the gnomon falls. This is the east (-west) line.<sup>8</sup>

This simple but ingenious procedure takes advantage of the fact that the movement of a vertical gnomon’s shadow over the course of a day displays a symmetry across the meridian that reflects that of the sun’s apparent path across the sky. Given a circle centered on the gnomon, then, the two points at which the tip of the shadow is observed just to meet the circle will define a line running due east and west. This idea is illustrated in Figure 1 above, a simplified re-rendering of the depictions of Yano (1986: 18 fig. 1) and Liú (1999: 16 fig. 1).<sup>9</sup> Mid-morning sun is here shown at top, mid-afternoon sun at right.

We can easily imagine on this basis the construction of a perpendicular (north-south) line by means of a set square, or through bisection of the angle separating the two key shadows above by one or another means.<sup>10</sup> It is the initial establishment of the east-west line,

6. The etymology of the word \*tōŋ ‘east’ is a separate question; I am content at present to suppose that Xǔ Shèn and Sagart (2004: 69, 74–76) are correct that the word is related to *dòng* 動 ‘move, stir’.

7. See Ōhashi 1997: 83.

8. Yano 1986: 18, where original Sanskrit and English translation are presented in parallel; parenthetical insertions are Yano’s.

9. All three diagrams represent circumstances around the winter solstice.

10. The *Kātyāyana-śulbasūtra* and many later texts offer such extensions: the *Pañcasiddhāntikā* of Varāhamihira (sixth century CE), for instance, proceeds to fix a north-south line via intersections of arcs centered on the two points established above (Abraham 1997: 385; Neugebauer and Pingree 1971: 38–39).

however, which defines the Indian Circle, so designated by the Persian polymath Al-Bīrūnī (973–1048) in his treatise on the mathematics of shadows.<sup>11</sup> The use of such a procedure was hardly restricted to early India: in addition to modern applications, there is the description from Vitruvius (fl. 70–15 BCE) of a Roman tradition with Greek precedents, for example, while several scholars have considered the possibility that such a technique was used in Old Kingdom Egypt for alignment of the Great Pyramids or associated structures.<sup>12</sup>

Of particular interest here are several more and less straightforward Chinese parallels to the Indian Circle, considered systematically in the 1999 study of Liú Dùn 劉鈍. Liú opens with an anecdote from commentary to the mathematical text *Shùshù jìyí* 數術記遺 (ca. sixth century CE) relating an exchange between the legendary Róng Chéng 容成 and a nameless (and directionless) backwoodsman (*chuānrén* 川人).<sup>13</sup> While no comment is made on levelness of surface (a critical factor in the method's precision), we otherwise find in Róng Chéng's instructions a neat medieval Chinese counterpart of Figure 1 above in all its essentials, ending with a determination of the meridian via fixing of a midpoint:

One must set vertical a wooden pole to serve as gnomon, tie a rope to the gnomon, and then draw the rope around the gnomon so as to mark out a circle on the ground. Just after the sun has risen, the shadow will be long and extend outside the circle, [but] it will grow gradually shorter over the course of the morning and enter the interior of the circle. Stand by at the northwestern quadrant and mark the point where the shadow first enters the circle. In the afternoon, the shadow grows to extend outside the circle. Stand by at the northeastern quadrant and mark also the point at which the shadow first exits the circle. The positions of these two marks give due east and west. From the midpoint [of the chord defined by these marks] toward the gnomon gives due south and north. 當豎一木為表，以索繫之表，引索繞表畫地為規。日初出影長則出圓規之外，向中影漸短，入規之中。候西北隅影初入規之處則記之。乃過中影漸長出規之外。候東北隅影初入規之處又記之。取二記之所即正東西也。折半以指表則正南北也。<sup>14</sup>

The question which Liú moves to address (while acknowledging the clear possibility that the *Shùshù jìyí* here or elsewhere was in part heir to traditions of Indian origin) concerns evidence for such a procedure within the earlier Chinese textual record. Sensibly, he places in first position a well-known but elusive passage from the “Kǎogōng jì” 考工記, a technical manual long transmitted as a chapter of the *Zhōulǐ* 周禮 (ca. third century BCE) but often considered to date to the early Warring States or late Spring and Autumn period.<sup>15</sup>

11. See Abraham 1997: 386 for Al-Bīrūnī and his *Ifrād al-maqāl fī amr al-zīlāl* (Exhaustive Treatise on Shadows).

12. Hence Pankenier's 2011: 38 reference to “nearly ubiquitous methods for achieving cardinality involving observations of the sun's shadow using a gnomon.” For the Indian Circle procedure as it survived in the Islamic tradition in relation to finding the *qiblah* ‘direction [of prayer]’, see Nasr 1976: 93. For Vitruvius and his *De architectura*, see Morgan 1914: 26–27. For Egypt, see Isler 1989, which proposes that the Great Pyramids may have been aligned to the cardinal directions using the Indian Circle; Neugebauer 1980 had earlier presented an idea similar in its essentials. For a more speculative reference to the Indian Circle in an attempt to account for the high degree of precision with which European Neolithic (Corded Ware, Bell-Beaker) burials prove to have been aligned to the cardinal directions, see Schmidt-Kaler and Schlosser 1984: 183.

13. Liú (1999: 15–16) reports that the *Shùshù jìyí* is traditionally but probably erroneously attributed to the Eastern Han mathematician and astronomer Xú Yuè 徐岳 (ca. 185–227), and that the text itself, in addition to the commentary, is now often considered the work of Zhēn Luán 甄鸞 (535–566).

14. *Shùshù jìyí*, *Huáilú cōngshū* 槐盧叢書 24.1, p. 3b.

15. For a new translation and annotation of the “Kǎogōng jì,” see Wenren 2013. As regards time and place of origin, Liú (1999: 19), while noting the diversity of opinion, presents the fifth century BCE and the state of Qí 齊 as an emerging scholarly consensus, consistent with Wenren's view (2013: xxiii–xxiv).

The builder, in raising the city, uses a line to make level [lit. ‘(make as) water’] the ground and uses a [plumb-]line to set upright a gnomon, observing via its shadow. [They] make a circle, identifying the sunrise shadow and the sunset shadow, and then draw so as to join [these two shadows] together with the sun’s shadow at culmination at center,<sup>16</sup> at night checking [this arrangement] against the pole star [or polar stars] to fix dusk and dawn. 匠人建國，水地以縣。置槓以縣，眡以景。為規識日出之景與日入之景。晝參諸日中之景，夜考之極星以正朝夕。<sup>17</sup>

The text is at least clear in its references to a “sunrise shadow” and a “sunset shadow,” which in theory would provide the symmetry required for the construction of an east-west line. The same stipulation appears in the description of the *Zhōubì suàn jīng* 周髀算經 (ca. first century BCE), where reference is more specifically, and reasonably, to the sunrise and sunset shadow tips.<sup>18</sup> But as many have noted, observations so timed meet with problems in practice: variation in the altitude of the local horizon will mean differences between the altitude of the sun at sunrise versus sunset, for instance, and the long shadows of early morning and late afternoon are relatively poorly defined. As such, it is not unreasonable to speculate, along with Liú and Wenren, that the reference of the “Kǎogōng jì” text to “construction of a circle [or circle(s), circular arc(s)]” (*wéi guī* 為規), absent in the *Zhōubì*, points to an Indian Circle-type effort at circumvention of these practical difficulties.<sup>19</sup> But the description is more ambiguous than either of these authors would allow. Is reference really to a circle centered on the gnomon?<sup>20</sup> It is not so easy to say, not least because we find no precise statement regarding the function of that circle with respect to observed shadows. Probably, the extent to which the “Kǎogōng jì” procedure really resembled that described by Kātyāyana must remain an open question.

However, we do have the associated commentary of Zhèng Xuán 鄭玄 (127–200 CE), as far as I am aware not addressed in previous studies. Zhèng concerns himself precisely with the practical problems of sunrise and sunset observations, and with the role he supposes the *guī* 規 of the “Kǎogōng jì” text to have played in resolving them. For present purposes, whether Zhèng’s account is faithful to the intentions of the original authors is not particularly important. While this passage, from the second century CE, is not explicit in every detail, it appears to me to stand as the earliest available unmistakable description of a Chinese “Indian Circle”:

The tips of the [gnomon] shadows at sunrise and at sunset give due east and west. On top of this [to speak of] “making a circle [or circles] to identify [the shadows]” is a contrivance

16. Literally, “draw [so as to] join them as a threesome with the shadow of the culminating sun [i.e., of the sun at local noon].”

17. “Kǎogōng jì,” *Zhōulǐ* 周禮, *Sībù cóngkān chūbiān*, 14.12, 15a–b.

18. This passage, also considered by Liú, is clearer; the translation of Cullen (1996: 192) is as follows: “When the sun first rises, set up a gnomon and note its shadow. When the sun sets, note the shadow again. The line between the two ends fixes east and west, and if one splits [the distance] between them in the middle and points to the gnomon it fixes south and north” 以日始出，立表而識其晷。日入，復識其晷。晷之兩端相直者，正東西也。中折之指表者，正南北也；see *Zhōubì suàn jīng*, *Sībù cóngkān chūbiān*, 389.2, 8a.

19. Wenren’s (2013: 95 incl. fig. 21.1, 177–78) interpretation of the text speaks of initial construction of a circle and then generation of the east-west line from the intersections of sunrise and sunset shadows with this circle. This could be what the authors had in mind. If so, however, while perhaps in practice more straightforward than locating shadow tips, this would be a no more rigorous means of capturing symmetrical points, as the problem of the altitude of the local horizon remains.

20. Coming to this point in the text, translations are quite different. Compare, for instance, Steinhardt (1990: 33), Pankenier (2013: 129–30), and Wenren (2013: 95), who render *guī* 規 as “circle,” to Cullen (1996: 115–16) or Xu (2000: 33), who have “compass” and “determinator” respectively.

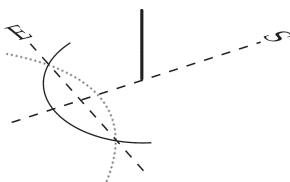


Fig. 2. A reconstruction of Figure 1, with the tip of the winter gnomon shadow tracked over the course of the day yielding a hyperbolic arc; as above, two intersections with a circular arc centered on the gnomon define the east-west line.

[in response] to the difficulty of achieving precision.<sup>21</sup> If, beginning at sunrise, one marks the shadow's tip, continuing thus through sunset, at completion [one] will have produced [the arc of] a circle.<sup>22</sup> One then assesses [the space] within the two termini of the shadows and encloses this within a circle [or circular arc]. The intersections of these circles [or arcs] give [the necessary] precision. Measure the length between the two intersections and bend in the center so as to point to the gnomon; this gives due south and north. 日出日入之景，其端則東西正也。又為規以識之者為其難審也。自日出而畫其景端，以至日入既則為規。測景兩端之內規之。規之交乃審也。度兩交之間中屈之以指臬，則南北正。<sup>23</sup>

We see that the commentary provides for *two* “circles,” where the “*Kǎogōng jì*” text as traditionally understood describes only one (of what sort being unclear). Zhèng Xuán thus offers, in principle, precisely the same “Indian Circle” presented by Kātyāyana and Róng Chéng—but both of those descriptions called first for construction of a gnomon-centered circle such that marking of the two points at which the shadow tip crossed the circle was all that was required for determination of the east-west line. Zhèng's more rough-and-ready instructions to first track the shadow-tip over the course of the day so as to produce a circular (actually hyperbolic) arc, with the gnomon-centered circle (or arc) constructed after the fact as an operation on that shadow path, make for an interesting practical difference.<sup>24</sup> If we consider just the portions of the latter circle relevant to the fixing of intersections, Zhèng's procedure can be captured in a diagram like Fig. 2 above.

Zhèng's discussion provides for a more nuanced view of the history of the Indian Circle as reflected within the Chinese textual tradition. But more importantly for my purposes, the passage allows us to see the possibility that just such a straightforward procedure could well have existed at much earlier times, to be preserved in the form of an element of the Chinese

21. “Contrivance,” because a gloss, included as part of Zhèng's *zhù* 註 commentary but here and elsewhere remarking upon that commentary and thus presumably a later interpolation, suggests that *wěi qí nán shěn* 為其難審 features a (common) case of the character (為) used to represent the word *wěi* 偽 ‘contrive’.

22. The sense that the arc traced out by the gnomon shadow-tip was circular is common to the early Indian and Chinese traditions.

23. This text is also at *Sìbù cóngkān chūbiān*, 14.12, 15a–b.

24. For a basically identical diagram featuring such “shadow tracks,” see Abraham 1997: 385 fig. 1, from Neugebauer and Pingree 1971: 38 fig. 11, but note the different orientation as well as other potentially distracting features. It is easy to find modern layman's instructions for determination of the local meridian which feature the same illustration; see for instance Blateyron 2016: 22–23, 25.



script itself. Zhèng’s account, after all, reads as long-standing folk-wisdom—and there is increasingly clear archaeological evidence for the use of the vertical gnomon in contexts as ancient as late Longshan Táosì 陶寺, ca. 2,000 BCE, in modern-day southern Shānxī province.<sup>25</sup> As regards the great majority of the earliest available forms of 東, consisting of two shallow, opposing arcs intersecting at two points, with these points connected by a vertical line and with a second line set perpendicular to and bisecting the first (see part 1 above), it is difficult to conceive of an explanation any more precise or complete than that directly suggested by Figure 2.

As specialists in the early script are painfully aware, there is in general no direct, contemporaneous evidence for suggestions regarding character origins (certainly in the present case there is none for “bag,” etc.) In conclusion, then, it is essential to seek support for the current proposal by reference to reapplications of the form 東 within other early character coinages not of the “phono-semantic” type. Unlike with “tree,” “bag,” or “bundle,” here it proves possible to offer clear accounts of a number of previously unexplained orthographical facts.

The word *chén* (< \*drən) 陳 means ‘set in line, lay out, arrange’; the derivative *zhèn* (< \*drəns) 陣, in etymological terms ‘that which is set in line’, means ‘layout, array (n.)’ and is frequently more specific ‘battle array’.<sup>26</sup> At early periods such words were written with forms like 陳, consisting of 東 in combination with, on the right-hand side, a formalized representation of a “tool-wielding hand” 攴; more complex 陳 also appears. The choice of 東 as the basis for this early coinage was apparently not phonologically motivated, nor are the semantics of ‘east’ themselves sufficient to explain the character’s reapplication to write a word meaning ‘set in line’. Instead, an adequate explanation of the character 陳 has awaited a demonstration that the depictive motivation underlying the graphic form 東 itself bore some direct relation to “setting in line.” The idea presented above provides such: consider the process of determining the east-west line, or the larger architectural possibility of “setting [things] in line,” which that process would have prefigured.

The word *liáng* (< \*raŋ) 量 means ‘measure, assess’; the derivative *liàng* (< OC \*raŋh) 量, in etymological terms ‘that which is measured’, is ‘a measure (n.)’. These words were written from early periods with the form 東 in combination with, at the top, a closed shape often taking the form of a conventionalized representation of the sun 日. Again, the choice of 東 here could not have been phonologically motivated, nor could the meaning ‘east’ itself account for the reapplication. An adequate explanation of the character 量 has awaited demonstration that the graphic form 東 itself bore some direct relation to “measurement”: consider the sun’s role in the process of fixing direction described above, or better, the possibility of assessing the position of the sun (as around the equinoxes, when sunrise is due east) with respect to cardinal directional guides already established via such a process.

Finally, the character 重, writing the words *chóng* (< \*droŋ) 重 ‘layer; repeatedly’ and *zhòng* (< \*droŋʔ) ‘heavy’, also deserves brief mention as it has been considered something of a feather in the cap of the “bundlers”: it has been suggested that the character at first depicted a person, 人, carrying on his or her back a (heavy) “bundle,” 東. While in this case we still lack clear early exemplars, this much looks wrong. The specific bronze inscriptional characters at issue, with 人 separate from and with its “back” to 東, cannot in light of form have been ancestral to 重, and in any case occur in isolation as clan insignia (*zúhuī*

25. For the Táosì evidence, see Pankenier 2013: 29.

26. Compare at Schuessler 2007: 184.

族徽).<sup>27</sup> The first unambiguous inscriptional antecedents of 重, by contrast, show 東 with its central vertical stroke oddly bent at the top.<sup>28</sup> If this character was not simply a phonosemantic coinage (and the curious design suggests it was not), perhaps its creators wished to evoke the *layers* of the heavens, most naturally understood by reference to the eastern horizon. The sky was in early eras perceived in terms of just such layers, with the sun and other orbiting bodies confined in summer months to strata anchored north of east, in winter months to strata lying south of east.<sup>29</sup>

Martzloff, while pointing to the centrality of the gnomon in early Chinese calendrical astronomy and mathematics, has remarked upon the difficulty of locating continuity between prehistoric and later practices.<sup>30</sup> Early writing itself, apparently including the character 東, will prove to be a bridge across this gap. However, the picture is by no means so simple as a single “Shang” fountainhead spilling toward later distribution and diversity. First of all, early technologies need not have been unitary (or even very new). The “Kǎogōng jì” passage above refers to “checking [results] against the stars,” for instance, reflecting a simultaneous interest in solar and stellar methods which unites early Chinese descriptions with early India (Yano 1986: 17) and ancient Egypt (Nell and Ruggles 2014). Indeed, while considering celestial polar methods likely for alignment of Shang tombs and other ritual edifices (well known to respect directions slightly east of geodetic north), Pankenier (2013: 101–2 incl. n. 43) also remarks upon the closer cardinal alignment of minor associated structures. Still further, it is significant that a number of elements of the Chinese script concerned with formative calendrical astronomy, perhaps first taking the form of non-glottographic icons, now appear to antedate by multiple centuries the late second millennium BCE OBI.<sup>31</sup> A Shang origin per se thus need not be incautiously presumed for 東 or other hypothesized members of such an astro-calendrical toolbox. Whatever the chronological and geographical specifics, this emerging human mastery of the cosmos by the visual symbol and ultimately the written word apparently had the Heavens feeling rather caught out, with Daoist legend telling of “millet raining from the skies and spirits howling in the night”—a reaction which, all things considered, seems reasonably proportionate.<sup>32</sup>

27. A related problem for the “(heavy) bundle on the back” idea is that the meaning ‘heavy’ is secondary; the adjective as used in the bronze inscriptions and the *Shī jīng* 詩經 means ‘doubled, layered’.

28. The inscriptional form in [5] is from the *Yà chóng zhì* 亞重觶 (Shang). Contexts for the rest, all from the Warring States period, are the [6] *Shāng Yāng liàng* 商鞅量; [7] *Chūn Chéng Hóu hú* 春成侯壺; and [8] *Ān Yì xià guān hú* 安邑下官壺.



29. See, e.g., Cullen’s (1996: 184–87, 221–23) examination of the seven *héng* 衡 of the *Zhōubì suàn jīng*. Also recall references like that of the *Chǔcí* 楚辭 to “[this cosmos] round and nine-layered / who laid out and measured it?” 圓則九重，孰營度之; “Tiān wèn” 天問, *Sìbù cóngkān chūbiān*, 578.3, 2b; as well as the god Chóng 重, personification of the layers separating the human realm from the upper heavens in the *Shàng shū* 尚書.

30. Martzloff 1997: 368.

31. See Pankenier 2011 as well as Smith 2011, 2012.

32. See *Huáinánzǐ* 淮南子, “Běnjīng xùn” 本經訓, *Sìbù cóngkān chūbiān*, 426.8, 4a (昔者蒼頡作書而天雨粟鬼夜哭).

#### REFERENCES

- Abraham, George. 1997. Gnomon in India. In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin. Pp. 384–86. Dordrecht: Kluwer Academic.
- Baxter, William H. 1992. *A Handbook of Old Chinese Phonology*. Berlin: Mouton de Gruyter.



- Baxter, William H., and Laurent Sagart. 2016. *The Baxter-Sagart Reconstruction of Old Chinese (Version 1.1, 20 September 2014)*. Updated January 10, 2016 and accessed December 24, 2016. <http://ocbaxtersagart.lsa.umich.edu>.
- Blateyron, François. 2016. *Sundials and Astrolabes: User Manual of Shadows Pro Version 4.0*. Updated January 2, 2016 and accessed December 29, 2016. <http://www.shadowspro.com/download/User-ManualEN.pdf>.
- Chén Yǎwén 陳雅雯. 2009. Shuō ‘dōng’ 說「東」. *Chéngdà Zhōngwén xuébào* 成大中文學報 2009.27: 153–90.
- Cullen, Christopher. 1996. *Astronomy and Mathematics in Ancient China: The Zhōubì suàn jīng*. Cambridge: Cambridge Univ. Press.
- Isler, Martin. 1989. An Ancient Method of Finding and Extending Direction. *Journal of the American Research Center in Egypt* 26: 191–206.
- Lǐ Pǔ 李圃 et al., eds. 1999. *Gǔwénzì gǔlín* 古文字詁林. Shanghai: Shanghai jiaoyu chubanshe.
- Liú Dùn 劉鈍. 1999. ‘Róng Chéng zhī fāng zhī shù’ hé ‘Yīndù yuán’ fāngfǎ 「容成知方之術」和「印度圓」方法. *Hàn xué yánjiū* 17.1: 13–32.
- Martzloff, Jean-Claude. 1997. Geometry in China. In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin. Pp. 368–72. Dordrecht: Kluwer Academic.
- Morgan, Morris Hicky, tr. 1914. Vitruvius, *The Ten Books on Architecture*. Cambridge, Mass.: Harvard Univ. Press.
- Nasr, Seyyed Hossein. 1976. *Islamic Science: An Illustrated Study*. London: World of Islam Festival Trust.
- Nell, Erin, and Clive Ruggles. 2014. The Orientations of the Giza Pyramids and Associated Structures. *Journal for the History of Astronomy* 45.3: 304–60.
- Neugebauer, Otto. 1980. On the Orientation of Pyramids. *Centaurus* 24: 1–3.
- Neugebauer, Otto, and David Pingree. 1971. *The Pañcasiddhāntikā of Varāhamihira, Part II: Historisk-Filosofiske Skrifter* 6.1 Part II. Royal Danish Academy of Sciences and Letters. Copenhagen: Munksgaard.
- Ōhashi, Yukio. 1997. Astronomical Instruments in India. In *Encyclopaedia of the History of Science, Technology, and Medicine in Non-Western Cultures*, ed. Helaine Selin. Pp. 83–86. Dordrecht: Kluwer Academic.
- Pankenier, David W. 2011. Getting “Right” with Heaven and the Origins of Writing in China. In *Writing and Literacy in Early China: Studies from the Columbia Early China Seminar*, ed. Feng Li and David Prager Branner. Pp. 19–50. Seattle: Univ. of Washington Press.
- . 2013. *Astrology and Cosmology in Early China: Conforming Earth to Heaven*. Cambridge: Cambridge Univ. Press.
- Sagart, Laurent. 2004. The Chinese Names of the Four Directions. *JAOS* 124: 69–76.
- Schmidt-Kaler, Theodor, and Wolfhard Schlosser. 1984. Stone-Age Burials as a Hint to Prehistoric Astronomy. *Journal of the Royal Astronomical Society of Canada* 78.5: 178–88.
- Schuessler, Axel. 2007. *ABC Etymological Dictionary of Old Chinese*. Honolulu: Univ. of Hawai‘i Press.
- Smith, Jonathan. 2011. The *Di Zhi* 地支 as Lunar Phases and Their Coordination with the *Tian Gan* 天干 as Ecliptic Asterisms in a China before Anyang. *Early China* 33–34: 199–228.
- . 2012. The Old Astronomical Significance of the Glyph 𠩺 and the Word Sù < \*Swats. *JAOS* 132: 41–60.
- Steinhardt, Nancy Shatzman. 1990. *Chinese Imperial City Planning*. Honolulu: Univ. of Hawai‘i Press.
- Takashima, Ken-ichi 高嶋謙一, and Paul L.-M. Serruys, eds. 2010. *Studies of Fascicle Three of Inscriptions from the Yin Ruins (Yīnxū wénzì Bǐng biān yánjiū* 殷墟文字丙編研究), 2 vols. Taipei: Institute of History and Philology, Academia Sinica.
- Wenren, Jun. 2013. *Ancient Chinese Encyclopedia of Technology: Translation and Annotation of Kǎogōng jì* (The Artificers’ Record). New York: Routledge.

- Xu, Yinong. 2000. *The Chinese City in Space and Time: The Development of Urban Form in Suzhou*. Honolulu: Univ. of Hawai'i Press.
- Yano, Michio. 1986. Knowledge of Astronomy in Sanskrit Texts of Architecture (Orientation Methods in the *Īśānaśivagurudevapaddhati*). *Indo-Iranian Journal* 29.1: 17–29.
- Yú Xǐngwú 于省吾 et al., eds. 1996. *Jiǎgǔwénzì gǔlín* 甲骨文字詁林. Beijing: Zhonghua shuju.

## EDITIONS

- All *Sìbù cóngkān chūbiān* 四部叢刊初編, ed. Zhāng Yuánjì 張元濟 et al. Shanghai: Shāngwù yìnshūguǎn, 1919–1922, rpt. 1929:
- Chǔcí* 楚辭, trad. Qū Yuán 屈原 (fl. ca. 300 BCE), comm. Wáng Yì 王逸 (fl. ca. 100 CE).
- Huánán hóngliè jiě* 淮南鴻烈解, Liú Ān 劉安 (179–122 BCE) et al., comm. Xǔ Shèn 許慎 (ca. 58–147) and Gāo Yòu 高誘 (fl. 160–220).
- “Kǎogōng jì” 考工記, ca. fifth century BCE, transmitted within *Zhōulǐ* 周禮 (ca. third century BCE), comm. Zhèng Xuán 鄭玄 (127–200).
- Shuōwén jiězì* 說文解字, Xǔ Shèn 許慎 (ca. 58–147), comm. Xú Xuàn 徐鉉 (916–991) et al.
- Zhōubì suàn jīng* 周髀算經, ca. first century BCE, comm. Zhào Shuǎng 趙爽 (third century CE) et al.
- Shùshù jìyí* 數術記遺, trad. Xú Yuè 徐岳 (fl. ca. 200 CE), modern opinion Zhēn Luán 甄鸞 (535–566). In *Huáilú cóngshū èrbīān* 槐廬叢書二編, ed. Zhū Jǐróng 朱記榮 et al. Wúxiàn 吳縣: Zhūshì Huáilú jiāshù 朱氏槐廬家塾, 1887.