

Eastern Han and beyond. To his credit, Sterckx acknowledges this limitation in the introduction and attributes it to the difficulties of dating the ideas one finds in early texts. In chapter four Sterckx also promises a future study on the evolving relationship between material virtue and wealth in the early period. The sudden jumps from one period to another can be somewhat disorienting, as when he follows up a discussion of a *Zuozhuan* 左傳 quotation in chapter five with Xu Gan's 徐幹 (170–217) *Zhonglun* 中論 without any mention of their vastly different circumstances. Even accepting the static nature of food and sacrificial culture, one wonders how it was that this culture managed to sustain itself amid the shifting sociopolitical, intellectual, and technological landscape of the early period.

As one might expect from a title with multiple commas, the unity of *Food, Sacrifice, and Sagehood* as a monograph feels less than organic. The further he moves away from his survey of food culture in chapter one, the clearer it becomes that Sterckx's primary interest is not food culture per se but ideas about spirits, sacrifice, sagehood, and the senses. Sterckx himself acknowledges this problem when he describes chapter four as a "pause" (p. 121) in the main argument. Consequently, there are several times in the book when food yields the stage to various other sensory phenomena. For instance, the requirement that sacrificial offerings be flavorless (discussed in chapter three) would seem to reflect a more general imperative to restraint and harmony that applies equally to music, dance, and the comportment of the ritual participants. And in chapter five's discussion of the cultivation of the senses, sight and hearing seem to matter much more than taste and smell. "Nourishing the spirit(s)" might have provided a better conceptual framework for these various interests.

Equivocations in Sterckx's account of the precise relationship between food culture and the world of ideas distract somewhat from the overall argument. There are moments in the introduction when Sterckx seems to argue that ideas about food gave rise to ideas about sacrifice and self-cultivation. However, he speaks in the same breath of food "metaphors" and "analogies" (p. 49) that were but a "language" or "vehicle" (p. 5) for the expression of values and ideas. More often than not, it is the logic of sacrifice and self-cultivation that dictates prescriptions about food. After all, Butcher Ding is the invention of a philosopher, not a description of early Chinese butchering practice. And despite Sterckx's emphasis on the continuities between the human and spirit worlds, he also shows how the most potent sacrificial offerings were simultaneously the most unappetizing to the human palate. That is a strange result if food and the physical experience of reality were really doing as much intellectual work as Sterckx implies. Sterckx might have even dispensed with the notion of a "food culture" altogether had he presented food as one of many physical objects invoked by early theorists as metaphors for non-physical or abstract phenomena like *shen* 神 (spirits) or *de* 德 (virtue) or the cultivated *xin* 心 (heart). Perhaps that is why Sterckx in the end of the book describes food simply as "a fruitful window" onto early thought and society, a "cultural object" that is itself "inscribed with intricate moral and social codes" (pp. 203–4).

Food certainly provides ample evidence for this more modest conclusion. Read as a survey of the symbolism of food (and cooking and sacrificial offerings and the senses), *Food* is a welcome contribution to the study of early Chinese thought.

MICHAEL HUNTER
PRINCETON UNIVERSITY

The Chinese Roots of Linear Algebra. By ROGER HART. Baltimore: JOHNS HOPKINS UNIVERSITY PRESS, 2011. Pp. xiii + 286. \$65.

This book is about *fāngchéng* 方程, a procedure in ancient Chinese mathematics for solving parallel equations with multiple unknowns. Roger Hart reconstructs *fāngchéng* in terms of modern linear or matrix algebra and shows that it involves methods associated with Leibniz (1646–1716), Seki Takakazu 関孝和 (1642–1708), and Gauss (1777–1855), but long predating those men. The material is dense and made more intractable by the fact that the original texts exist only as fragments in late collections

or in reconstructions later still. But the author, who holds higher degrees in mathematics and the intellectual history of Western learning in China, has produced a really meticulous display of philology and mathematical reconstruction. He succeeds in cleaning up a rat's nest of a subject and laying it open to the reader in a clear and precise form, without overreaching himself for attractive conclusions. Hart does offer much to think about, however—among other things, that Gaussian elimination and general solutions of systems of linear equations are ultimately of non-literate origin and attested in China some seventeen centuries before Gauss.

Our primary source for *fāngchéng* is the *Jiǔzhāng suànshù* 九章算術 (Nine Chapters on the Mathematical Arts) of second-century C.E. date. It survives in thirteenth-century fragments, materials collected in the fifteenth-century *Yǒnglè dàdiǎn* 永樂大典 (itself now also fragmentary), and an imperfect reconstruction by Dài Zhèn 戴震 (1724–77) based on those sources. It has been much studied and discussed since Dài Zhèn's time and especially in the past century, but never before with the detail of Hart's book. Excavated materials (from Zhāngjiāshān 張家山 in 1984) show us that the mathematics of parallel equations with two unknowns was being practiced in the second century B.C.E., although "*fāngchéng*" is not seen there. The term, meaning perhaps "[manipulating related] quantities on a board," survives in modern language to mean "equation" itself.

Hart's work is thorough, thoughtful, and effectively organized. The main conclusions are summarized in an introduction, together with a review of the historiographic import of the subject and an outline of the remaining chapters, all of which help the reader navigate the work. The final chapter restates the author's conclusions and elaborates a number of questions for further research. At the core of the book are five chapters treating three highly technical topics:

1. *yíng bùzú* 贏不足 'excess and deficit', or systems of two conditions in two unknowns, a simpler precursor to the full *fāngchéng* procedure;
2. recovery of *fāngchéng* itself and explication of it in detail;
3. the "well problem" (for which there is no Chinese name): solution of a problem with n conditions in $n + 1$ unknowns, which the author shows is the earliest evidence of determinantal calculation, predating the seventeenth-century work of Leibniz and Seki.

Each is handled with all the necessary attention to texts, transcription of mathematical content, and interpretation. Much helpful matter surrounds this core. Chapter two presents a concise, readable introduction to the modern mathematical ideas themselves, as well as an introduction to traditional Chinese mathematics; chapter three reviews the textual sources and their commentaries. There is also an extensive bibliography of pre-modern Chinese mathematical texts, and that is in addition to the regular bibliography of the book's sources. A number of problems and their solutions are transcribed, diagrammed, and annotated in detail, and an appendix offers a resumé of similar examples from the (non-general) solutions of the third-century Diophantus of Alexandria. The index is adequate if a little thin. As of this writing (September 2011), Hart has begun setting up a database of pre-modern Chinese linear algebra problems, solutions, and texts; it is on line at <http://rhart.org/algebra/>.

So much for material content. The historical import of this book is to illuminate one of the antecedents of modern mathematics in the Sinosphere. The immediate incarnation of the modern mathematical synthesis goes back to a quickening and cross-fertilization that took place around the decades when (I do not jest) coffee made its way into Europe on a broad scale. But it was not the first such synthesis and it was fed by many strains of tradition and transmission. Now, there is no question of finding vectors, affine transformations, decompositions, or other elements of the developed field of modern linear algebra in the records of *fāngchéng*. The chief ancient discoveries of which Hart provides evidence, other than augmented matrices themselves, are Gaussian elimination (c. second century C.E.) and calculation of determinants (c. 1025 and 1661 for two different kinds of solution). We would, of course, like very much to know how Leibniz and Seki may have been influenced by older Chinese learning. Hart is apparently at work on more focused investigation of that problem and here he makes no wild claims, beyond raising the question and providing a part of the hard evidence on which it must eventually be decided. He does observe that there is nothing to show that the techniques he has reconstructed actually originated in China, merely that they have come down to us in Chinese compilations. In particular,

nothing links the techniques intrinsically to any specific language or culture. Hart adds, provocatively, that it is not even clear that the people documenting them fully understood them.

This last observation raises the subject of the Chinese use of written symbols in the special context of mathematics and their relation to literacy. Mathematical quantities in the *Jiūzhāng suànshù* are represented as numerals rather than words for numbers. That is, they are expressed not with the Chinese characters for ordinary words (*sì* 四 ‘four’, *liù* 六 ‘six’, *bā* 八 ‘eight’, etc.), but rather in “rod-numeral” format (𠄎 ‘4’, 𠄎 ‘6’, 𠄎 ‘8’, etc.), which derives from the physical *chóu* 籌 ‘counting rods’ used in ancient times and which even survives in certain popular contexts today. Some abstract concepts are written in characters, representing ordinary Chinese words in application to mathematics:

shí 實 ‘seed, substance’ → ‘dividend in division’, perhaps ‘upper quantity’
fǎ 法 ‘method’ → ‘divisor in division’, perhaps ‘lower quantity’
mǔ 母 ‘mother’ → ‘primary quantity’
zǐ 子 ‘child’ → ‘dependent quantity’

(In Hàn phonology, all four words would have been checked syllables and each pair is in a single tone, but it is hard to find immediate significance in that fact.)

The Western reader may find it strange to see whole Chinese words in places where modern mathematics uses symbols and letters. But in the earlier West—in Greek texts and in Boëthius, for example—mathematics was written out in prose just as it was in traditional China. And even after symbols began to dominate European mathematics, the Roman and Greek letters conventionally used for naming variables and functions normally originated as abbreviations of real European words. Transparent conventions of this kind include *i* from *integer*, *n* from *number*, and *f* from *function*; many others can be identified with a little study. (More opaque perhaps are Σ and \int from Latin *summa* ‘sum’, π originally from περίμετρος ‘perimeter’, *x* for an arbitrary variable from Arabic *ṣifr* ‘zero’, the source of our *cipher* and earlier transliterated *xifr*.) Although these symbol-letters can be used abstractly, taking on meanings other than those named here, they came into being as abbreviations of actual words. A few abstract logical symbols also have origins as letters of the alphabet, emptied entirely of their linguistic content and then put to work as true abstractions. One such is \cup for ‘union (of sets)’, spun around to become the various set operators \cap ‘intersection’, \subset ‘(strict) subset’, and \supset ‘(strict) superset’ (and cf. logical \vee and \wedge). Another is Θ for ‘tight bound’ in asymptotic theory; it apparently represents no word but recalls *O* ‘bounded above’ and Ω ‘bounded below’, both standing for German *Ordnung* ‘order [of growth of a function]’, the bar in the middle of Θ being iconic for ‘bounded on both sides’. [Introduced without explanation in Donald E. Knuth, “Big Omicron and Big Omega and Big Theta,” *ACM SIGACT News* 8 (1976): 18–24; see p. 20.] The abstract, symbolic garb of modern mathematics and logic is rather new in the history of ideas. The choice of symbols usual in the modern mathematical synthesis situates its linguistic origin in European civilization.

What about *fāngchéng*? Hart argues (p. 50 and elsewhere) that it was originally carried out using counters on a board, to aid first visualizing the relationship among unknowns in two dimensions and then cross-multiplying values in different parts of the board, so to arrive at general solutions of systems of linear equations. He observes that the earlier Chinese sources for *fāngchéng* lack diagrams—most odd for a visual and manual method—and are written in difficult literary language. He says:

The translation of *fāngchéng* calculations into classical Chinese, modern English prose, or modern mathematical terminology renders these practices almost incomprehensible. (p. 191)

So he proposes that they were transmitted in written form by Chinese literati who lacked a full grasp of the mathematics but codified it in the kind of elegant language that their own social class valued. Hart considers *fāngchéng* to have been fundamentally a hands-on process invented and practiced by people who not only lacked abstract mathematical notation but were actually illiterate. He illustrates the procedures he has reconstructed with some 150 diagrams of counting tables, as well as in modern matrix and algebraic notation—and he considers the use of illustrations the key to his successful reconstruction. If so, it was a fine inspiration; it enables the reader to follow the presentation with much more clarity and ease than otherwise.

Learning in the modern world is a wide-ranging synthesis, and a non-European origin for any particular idea is not surprising. But it is sobering to think that two techniques for solving matrix calculations,

both considered standard today, could have been developed by non-literate people moving counting rods around with their hands. And that is where the hard evidence, together with some deductions that seem reasonable to this reviewer, now points.

Overall this book shows very careful work and clear presentation. If I have any single complaint, it is that individual Chinese words are not adequately indexed—but perhaps the author’s on-line materials will remedy that. It seems likely that Hart’s thoughtful, meticulous book will be the precursor to much fruitful study not only of pre-modern Chinese mathematics but also the roles of literacy and notation in its transmission.

DAVID PRAGER BRANNER
GROVE SCHOOL OF ENGINEERING, CITY COLLEGE OF NEW YORK

Hinduism and Law: An Introduction. Edited by TIMOTHY LUBIN, DONALD R. DAVIS, JR., and JAYANTH K. KRISHNAN. Cambridge: CAMBRIDGE UNIVERSITY PRESS, 2010. Pp. xvi + 303. \$90 (cloth), \$34.99 (paper).

As its title suggests, *Hinduism and Law: An Introduction* is an edited volume of essays that deal, in a multitude of ways, with both Hindu religious traditions and law, thereby elucidating the deep and pervasive connections between these two social phenomena. Although the volume’s editors do not specify why they have chosen to refer to the work as an introduction, the presumed reason is that it is explicitly intended to provide an “accessible analysis of the main features and periods of what has conventionally been called Hindu law, and of the interrelations between law and Hinduism more broadly, up to the present day” (p. 1). In this way the editors’ stated hope (p. 1) is that the work will contribute significantly to the vast body of scholarship already dedicated to exploring the complex intersections between law and religion outside of South Asia. In more concrete terms, the introductory character of the volume means that most of the essays contained therein are essentially surveys or summaries of specific topics related to Hinduism and law, such as the creation of Anglo-Hindu law and the system of caste-based reservations in modern India. When taken together, the specific subjects covered within the volume reflect a broad picture of Hinduism and law that certainly befits an introductory text. Moreover, all of the volume’s essays attempt to present Indian materials in a manner that is easily accessible to non-specialists. Thus, for instance, the contributors to the volume generally avoid quoting long passages from primary sources and often cite sources originally composed in Indian languages only in English translation.

At the outset, a brief introduction written jointly by the volume’s three editors establishes two points of fundamental importance to the book as a whole. Firstly, it explains and justifies the use of the terms “Hinduism” and “law” that together constitute the work’s self-proclaimed subject (pp. 1–7). Secondly, it explains the logic behind the overall layout of the book, which consists of sixteen “chapters” (the term used to denote the contributors’ essays) arranged into three parts. The six chapters that comprise the first part, which is entitled “Hindu Law,” all deal directly with either the pan-Indian tradition of Brahmanical jurisprudence known as Dharmaśāstra or closely related legal systems. The second and third parts each consists of five chapters. Rather than dealing simply with Hindu law, they treat what the editors refer to as “Hinduism and law” (p. 7). By this they mean that the chapters constituting the book’s second and third parts all do one of two things: a) They analyze connections between law and specific Hindu traditions that are not principally juridical, such as hermeneutics and Hindu nationalism, or b) they use insights from specific theoretical movements within Western academe, such as law and literature and performance studies, to shed light on aspects of Hindu law. Part II focuses on pre-modern sources, whereas part III focuses on colonial and post-colonial sources.

This elegant arrangement gives the volume a cohesion that is often lacking in edited collections of essays. And this cohesive quality is greatly enhanced by the fact that throughout the volume, the various chapters frequently refer to one another. Like any compilation of essays, however, *Hinduism and Law* should not be judged primarily on the basis of its subject-matter and organizational structure.