

***Picturing Technology in China: From Earliest Times to the Nineteenth Century.***  
By Peter J. Golas. Hong Kong: Hong Kong University Press, 2015. Pp. xxix + 205.  
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Since Joseph Needham's "Science and Civilization in China" (SCC) project, the topic of picturing technology has been discussed on many academic occasions. The author of the book under review, Peter J. Golas, wrote volume 5.13 of the SCC Series, on *Mining*. As professor of Chinese history at the University of Denver since 1973, he is a highly erudite specialist on the Chinese history of technology, and has made continuous and substantial contributions towards solving puzzles about Chinese technical drawings over several decades. His book is, therefore, much anticipated.

This substantial "history of premodern Chinese portrayals of technology" (p. xxiii) includes a good structure and a lively narrative that spans all the centuries it describes—despite the rather limited quantity of surviving early illustrated texts and paintings which the author was able to draw on to write the longer part of this history with. Golas roughly defines two epochs of Imperial China: from earliest times to the Song/Yuan dynasties, i.e. the fourteenth century—which he describes as an era of a "growing ability" to depict verisimilitude; and the Ming/Qing period, when "Chinese painters commonly eschewed techniques that might have led to the more accurate and effective portrayal of technological subjects" (p. xxiii). With regard to the background of the SCC project, at the beginning it seems as if Golas may be about to argue in support of the "Needham question." But no, this book instead makes a very convincing argument that there was one inclusive arena between Europe and China, an arena which one would like to see extended towards cultures of picturing technology in other parts of the world.

Golas begins his introduction by very clearly establishing the specific intellectual setting of Imperial China and asking several key questions: Did technology have a "place . . . in the Chinese mental landscape"? Why is it that the Chinese "never developed on any basis the concept of a special category of 'technical drawings'"? Why is there "no word for and therefore no concept of 'technology' in premodern Chinese"? He continues by questioning why the "Chinese never came to think in terms of 'technical drawings'" (p. xix) and, a related enquiry, what were the motivations and purposes of drawing in China, if not for technical precision and to understand machinery, as in Europe? These are the key questions that attentive readers keep in mind throughout the book.

Golas views China as a kind of alternative world to Europe. Since there was neither a general concept of, nor any term for "technology"—or any notion of "technical drawing" as such in Imperial China, picturing technology emerged in the category of *tu* 圖 as "templates for action" (p. xix, with reference to Francesca Bray)

rather than a drawing. Such *tu* spread an awareness of technical knowledge and skills, but primarily as a form of aesthetic reflection and depiction of morality, rather than as technical data. Chinese draftsmen did not usually depict their objects and crafts in order to explain technical principles or pictorially represent their knowledge and state of understanding. Instead, draftsmen were usually illustrators, painters, and artists within societies. Thus, the quality of pictorial representations of technology depended on their individual artistic skills. In many cases, the intention of a drawing was just to illustrate a subject in a rather casual manner—including objects which possibly neither the painters nor the readers had even seen. However, the history of painting was inscribed into (woodblock) printing, and it is against this development that Golas aims to “provide a kind of roadmap” (p. xxiv) of the history of technical drawing in China.

In chapter one, “Early Graphics in China,” Golas considers the first era of early—although scant—technological pictorial evidence. Tracing the visibility of artefacts in early Chinese characters, he points to early examples of precision, for example some significant aspects of bows, boats, or chariots that are captured in the work. These include the very particular stance and movement of a boatsman or a chariot driver; the tension in a taut composite bow; even a physical impression of speed. Such depictions of tangible elements became obsolete later on though, through the abstraction and simplification of Chinese characters and the ongoing development of material culture which transformed the characters into abstract scriptural carriers of meaning.

This brings a specific perspective on the possible developments of technical drawing in Chinese history into sight for the first time in this book. There was a craze for geometric ornamental design in early Han times which, due to its highly technically-developed execution, entailed what Golas identifies as the potential of systematic technical drawings. This potential was not immediately realized, however, because this kind of ornamental design fell out of fashion in the later Han period. Nevertheless, the author’s attention on such sidelines of the history reveals new and interesting research questions.

The chapter concludes with the other main early drawings and genre paintings which provided realistic representations of agricultural landscapes and farming technologies during Han times. Here Golas distinguishes between the literati paintings—which aimed to morally endorse agriculture—and portraits of “human productive work” (pp. 11–12) as idealized pictures of rural life. Golas reconstructs the settings in which they appeared. Such images were produced alongside depictions of everyday life for the netherworld in tomb paintings, and as images to promote state ideologies about the morally correct governance of, and recognition for, the rural population in a stabilized country. Thus, these images were intended to secure the future wellbeing of the world of the living, as well as the world of the dead.

With regard to the visibility of the working, acting body, such intriguing pictorial representations are “an artistic phenomenon rarely if ever seen in other societies” (p. 10). This points to the agency of the painter. For whatever reasons (i.e. status or conventions), Golas observes that these painters did not leave enough space to represent active individuals, but merely to represent small human figures as part of the landscape and technology. Nonetheless, active human bodies are visible in these early drawings, although from the perspective of the literati and professional painters, who would have been mere onlookers at the technologies, consuming idealized scenes of an imagined moral everyday of a past reality.

The history of drawing in Imperial China is faced with the problem that a considerable body of the surviving corpora—whether paper or other materials—has been censured and destroyed. Another challenge which makes this history even more complex is that of disappearing and reappearing materials in subsequent dynasties and diverse stories about surviving copies. A vast body of materials has been lost and it is only possible to roughly reconstruct some of these. Golas takes all such issues into consideration, at some points recounting almost detective stories of seeking evidence, including material that remained only in the imagination. He draws our attention to imponderabilities of this difficult-to-write history which have ultimately led him to carefully establish a broader historical framework and, thereby, to leave ample space for new discoveries and results which might refine his account.

In chapter two, “Han to Tang: Realism on the Rise,” Golas examines a formative era towards the golden age of the Song. He explores Chinese preconditions, as well as a gamut of technological developments and their potential for, or constraints around, technical drawing. Golas identifies an “overall Chinese approach to drawing” (p. 17) which deems brush and ink to offer a unique, perfecting technique, tool and stroke. Due to this historical choice, Golas considers it an opportunity—but also a kind of hindrance—that foreign drawing technologies became known but hardly informed local illustration at all. Brush and ink set the scene for drawing lines and arranging paintings spatially. This led to a preference for certain motives at the expense of others, and surely led to the development of particular Chinese “painterly skills” (p. 26).

The issue of mistakes made in copying manuscripts is a ubiquitous element of this history, continually creating new questions. This is just one of the many challenges faced by historians examining technical drawings of this era. Fading materials, an uncertainty about what has been lost and preserved—by which means—or about un-documented descriptions in later copies of books, only allow them to make partial reconstructions of former drawing technologies. Still, Golas finds several clearly-developing abilities in the pictorial representation of space and nature (p. 21).

His conclusion is that religious ideology—with a decline of Confucianism and emerging Buddhist influence—resulted in an “embalm[ed] technology” (p. 35) by Tang times which seems as fascinating as it is regrettable. Golas asserts that “Chinese painters never developed a notion of space as a measurable geometrical entity with the circle as the ideal form and the triangle as the master of measurements” (p. 21). This is in contrast to Europe, where Middle Age draftsmen had a wide range of tools and techniques at their disposal to create a “master drawing” (p. 27).

Alongside these scarce examples of printing and drawing, Golas considers testimonies, such as the famous Han and Qin grave models of buildings or chariots, or automata created to please the rulers. Did models—for instance, of a very detailed, refined bronze chariot from the Qin—require preliminary drawings to inform their construction? There is, in fact, no evidence of such drawings. Furthermore, there is no evidence that drawings were used to share the secret knowledge of the creators of these automata.

Although the Chinese have often been criticized for not seizing historical chances to develop technical drawing, there is ample justification to challenge a comparison with European ways. Is it reasonable to contrast a virtual “idolatry of the brush” (p. 27) with European drawing equipment? Perhaps referring to Egyptian, Iranian, and Indian technical drawing, or—as Golas occasionally does, to Japanese drawing—would highlight this better than comparing Chinese forms only to European ones. This is especially true since the European methods were themselves different from the rest of the world. Golas’s statement that “using drawings to work out mechanical ideas was seldom if ever attempted” (p. 31) in Imperial China raises the question of how else knowledge was transmitted and reflected on.

The main point to take from Golas’s account is that, on the eve of the Song ascension, Chinese technologies and society had matured—technically, ideologically, and organizationally—with regard to book printing and the technique of “pouncing,” to enable the production of refined images with a “new attention to detail” (p. 34) and, last but not least, with regard to the pictorial representation of space and nature. All of this provided a base for the next stage in history. By this point in the book, the attentive reader has already gained an incredibly rich basis for further reflection on issues like the bodily spatial situatedness and its relation to the pictorial representation of space, or the ways that ideology may have formed the bodily-aware drawing hand.

Golas begins chapter three, “Song and Yuan: A Golden Age,” by first returning to Han dynasty techniques of using tools to draw straight lines, which had been integrated into the well-developed art of painting by Song times. Golas credits the tenth century literati for paving the way towards using these “correct” forms of portrayal, such as *baimiao* 白描 (outline-painting) or *jiehua* 界畫 (ruled painting) for future book illustrations. Famous painters and paintings, not least the *Qingming*

*shanghe tu* 清明上河圖, were surrounded by controversies among the literati which debated the elegance of freehand brush stroke art as opposed to the ruler-supported accurate line-painting technique. Golas considers that the *jiehua* historically paved the way for precise technical drawing styles. In this respect, and viewed from the longer perspective of the dynasties that followed the Song, the *Qingming shanghe tu* emerges as a pinnacle of *jiehua* painting, before this style lost its appeal.

To understand Song technical drawing better, Golas draws on both ends of his subject matter. He asks about links between technical drawing for two purposes: understanding technology and transmitting technological knowledge. The enormous difference between Middle Age and Renaissance Europe and China leads Golas to look for Chinese works where personal craft or building technology knowledge was combined with technical drawing in the person of the painter. He finds only a few. Furthermore, the development of new technologies in Song times leads Golas to focus on outstanding volumes with technical illustrations, which should have been easier to distribute given the advanced Chinese woodblock printing at the time. Through his detailed descriptions of some of these examples, however, Golas shows that this was only partially true. A strong state interest led to a complex context of picturing technology in the publication landscape in Song and Yuan times. Focusing on a handful of volumes, Golas skilfully delineates this complexity.

In times of conflict within the Chinese territory and at its borders, the country's rulers were primarily focused on military technology. However, the state was caught between the conflicting needs to preserve its internal interests whilst also limiting the spread of knowledge. Golas asserts that the first volume he discusses, the *Wujing zongyao* 武經總要 (Collection of the Most Important Military Techniques), is the only surviving military technology manual of the time, and this version is a copy from a much later date. It confirms the constraints in publication and distribution, which "significantly inhibited advances both in military technology and the portrayal of weapons" (p. 46).

The second volume Golas considers is the *Xinyixiang fayao* 新儀像法要 (New Armillary Sphere and Celestial Globe System Essentials), which deals with cosmic order and time calculation. Golas notes that this work also suffered from the same restrictions. The surviving volumes probably had to rely on (lost) technical drawings to construct complex astronomical instruments like the famous armillary sphere. This attests to the potential of producing and sharing such pictures, but also reveals the measures taken by the state to inhibit their transmission (pp. 45–59).

Golas describes the third volume under discussion, the *Yingzao fashi* 營造法式 (Building Standards), as unparalleled in the later part of Imperial China. He investigates it against Chinese modular building practices, the oral transmission of craft knowledge, state interests in the representation of major buildings, and the

level of construction expertise held by the painters. Although Golas provides a novel and interesting contrast to Renaissance building drawings, I am not sure it helps to sharpen his argument. Nonetheless, it is instructive to understand that, while Europe was building cathedrals, China was developing a refined and enduring modular construction technology.

With regard to the fourth work, the *Gengzhi tu* 耕織圖 (Pictures of Tilling and Weaving), Golas focuses on an entirely different category of illustrations—that of a poem alongside pictures of agriculture and rural textile production. Its author was a magistrate who was keen to display “an ideal social contract” (p. 78, with reference to Bray) between the elite and the workers. These paintings shone a new light on rural work, by breaking the processes down into a series of single steps. This also created a new awareness about southern agricultural methods of that time. Golas views the *Gengzhi tu* as the precursor to the fifth work, the *Nongshu* 農書 (Agricultural Treatise) by Wang Zhen 王禎 and, thus, to “the first true technical drawings or blueprints in Chinese history” (p. 82).

While military and astronomic knowledge were considered sensitive within state knowledge monopolies, we learn that Song efforts to spread knowledge about new agricultural technologies led to different accounts. What was innovative about the *Nongshu*, published around 1313, was the attention it paid to agricultural tools, which were depicted in an unprecedentedly accurate style and were described in terms of form, shape, use, and construction. Because most peasants were illiterate, the literati were encouraged to “disseminate the practice” (p. 85, with reference to Bray). As well as displaying drawings of agricultural tools, work songs were also shared, with the aim of “making [peasants’] work a little easier” (p. 83). This, then, comprises an early attempt to disseminate knowledge through pictorial and verbal propaganda.

The woodblock printing technology of Song and Yuan times enabled treatises to become as widely shared as the state restrictions on certain topics would allow, and this proliferation often transformed works from this era into “standard accounts” which were relied upon by later dynasties. Some of these have never been surpassed. Golas insists that many of these artefacts also had a different impact. Because these “standard accounts” were constantly republished, they contributed to obscuring technical innovations in China as well as in Western images of China (p. 86).

Until this point, Golas has given the reader the impression that literati brush paintings were the norm in picture technology. In a short but useful intersecting chapter four, Golas describes how this painting evolved during the Song dynasty return to Confucianism. He describes the re-emergence of brush painting, now under “The New Confucian Paradigm” as a form of “Realism in Retreat” (p. 87) that was clearly visible in painting. With regard to the picturing technology used, the author sets the scene by noting how the literati changed from painting on silk to painting

on paper (p. 94), in line with the evolution of new painting aesthetics and numerous further refinements.

You may wonder how the story of picturing technology in Ming/Qing China could possibly be told in just a couple of dozen pages, especially because of the exponential increase in the amount of evidence available for scholarly research. Golas does not attempt to provide a complete overview of this complex story, but approaches this era from a different angle. He concentrates instead on the book which he considers one of the most influential and revealing, *The Exploitation of the Works of Nature* (*Tiangong kaiwu* 天工開物), to reconstruct the historical and societal setting, the audience, and the contemporary discourses that surrounded it.

In chapter five, “Late Ming and *The Exploitation of the Works of Nature*,” Golas presents a revised version of an earlier article.<sup>1</sup> Readers who are not familiar with Chinese history are likely to rub their eyes in astonishment when they read Golas’s description of late Ming society—particularly its book trade. The vibrant urban Imperial China book market competed for customers by including illustrations in its books, with illustrators ranging from professional painters to artists and carvers, who all produced differing quality images. Golas asserts that the attractiveness of bestselling pictures did not relate to their technical drawing though, because the readers of that time were not yet able to distinguish between their particular qualities.

This chapter focuses on “the most complete and competent account of traditional Chinese technology that had yet been written” (p. 97), the well-studied and well-known *Tiangong kaiwu*, published in 1637 by Song Yingxing 宋應星—a man who retreated to become a private scholar after failing the Imperial exams. Golas translates the title of his compendium as “The Exploitation of the Works of Nature,” which was written against the background of a particular “philosophy of technology.” Golas claims that this philosophy was transmitted by depicting a broad range of technologies—mainly for the educated elite, but also for the wider public and, especially, for customers who would buy the book. At that time, as Golas notes, the literati also made a living by selling their books. What is interesting here are the illustrations of these technologies, which have given rise to many debates among scholars in the field over recent decades, partly in relation to their inconsistencies and limitations. Golas summarizes the state of the art of current discourse, analysing the rather eclectic topics and drawings against the background of previously published works that covered similar themes, and in the general context of picturing technology

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<sup>1</sup> “‘Like Obtaining a Great Treasure’: The Illustrations in Song Yingxing’s *The Exploitation of the Works of Nature*,” in *Graphics and Text in the Production of Technical Knowledge in China: The Warp and the Weft*, ed. Francesca Bray, Vera Dorofeeva-Lichtmann, and Georges Métaillé (Leiden: Brill, 2007), pp. 569–614.

since the Song and Yuan eras. Golas attributes a new sensitivity to technological issues in late Ming times to the end of dynasty turmoils and an elite which was showing “a growing interest in scientific and technological knowledge that had practical applications” (p. 105).

Golas and others maintain that Song Yingxing’s illustrations should not be viewed as mere depictions of technology, but should be understood in relation to his “philosophy of technology.” This is not a straightforward endeavour. Song Yingxing does not portray single objects, as in the *Nongshu*, but humans using objects, which thereby passes on much more information and meaning to a perceptive reader. This chapter concludes by hinting at the aftermath of the publication and the innumerable ways that the book was subsequently quoted or copied.

In the sixth chapter, “Qing Developments: Roads Not Taken,” Golas describes China’s astonishingly fatalistic attitude towards developing opportunities in picturing technology, in the context of Chinese developments since the seventeenth century—its Imperial encyclopaedic interests, and the sciences, arts, and crafts gradually being brought from Europe through Jesuit influence. Here Golas returns to the initial assumed shortcomings of Chinese technical drawing in comparison to Europe, especially since the Renaissance. For a reader versed in the European history of technical drawing, this chapter considers both knowledge arenas—although indeed seems to play one off against the other. Golas contrasts Europe and China with regard to advances in military technologies and their depiction, including an ultimately minor Jesuit impact on Chinese technical drawing. He considers some exceptions in more detail. Golas here recounts the late Ming writer Wang Zheng 王徵 who did not see any need to change his Chinese way of drawing, even though he was in close contact with Jesuit missionary scholars. Golas particularly credits the exceptional court painter Jiao Bingzhen 焦秉貞 who, in early Qing times, received a commission to re-illustrate earlier works on tilling and weaving. Golas views his work as a revival of *jiehua*-painting, although it is clearly also influenced by Jesuit painting techniques, which differentiates his drawings from the early *Nongshu* paintings. Although Jiao Bingzhen never really deviated from the Chinese ways of painting, as he was protected by the emperor, his works became “admired especially for their effective use of Western linear perspective techniques that gave them a spatial sense new to Chinese painting” (p. 156). Golas observes that Jiao Bingzhen was an exception though, with most literati never coming to feel familiar with precise measuring or geometric representations in drawing. He notes that one field that was an exception to this were architectural drawings. This continually increased the information it provided about the techniques which were used in construction work in the nineteenth century Qianlong era (pp. 161–64).

Golas's framework proves useful at the end of the book, to recall the grand lines of Imperial China's picturing technology. He already previewed his conclusion in the Introduction, stating that "Chinese in traditional times never felt a need to try to understand the theoretical principles that underlay the functioning of machines . . . never isolated special qualities that should attach to a . . . satisfactory . . . drawing of a technical subject per se" (p. xxi). In his Closing Comments, Golas brilliantly draws his arguments together. He argues that China differed from Europe in several respects—the evolution of its interest in technical drawing, the moral and ideological impacts of pictures in China, and the enduring nature of text as the main medium for transferring information. In concentrating time and again on specific exceptional works, Golas contributes to an overarching understanding of what picturing technology was in Imperial China. We learn that readers in Europe and China made sense of, and valued, technical drawings in totally contrasting terms. Golas links the particularities of the Chinese history of picturing technology to several factors. These were: a remarkably enduring modular form of (agricultural) technology which depended on abundant manual labour; strong ideological preferences for publishing pictorial evidence of agriculture and textile production rather than other industries like mining, shipbuilding, nautical technologies and ceramics; and little interest in on-going innovations, especially in Ming/Qing times.

One wonders, in the end, if the literati and elite readers who Golas describes did not also in a way display their status as elites that were exempt from physical labour. And, if Golas is right, how did China cope with the relations between object—mind—language—drawing—thinking?

Golas concludes his book with the words: "in later imperial times at least, the Chinese preferred to put their best thinking into philosophy, art and other aesthetic and academic studies, to the relative neglect of technology. To this, their depictions bear witness" (p. 180).

If we extend "the Chinese" in this quotation with "elite," a different viewpoint arises. Perhaps we should reconsider the other side of this story—the persistence and continuity of technology and the perfecting of skills, or "the shock of the old," as Edgerton put it. But this would be a different story from that told within this carefully produced, clearly structured, well-written, well-illustrated (16 colour plates and 80 black-and-white illustrations), and elaborately annotated book, which is augmented by a substantial bibliography. Reading it is a true privilege.

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