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Francesca Bray, Vera Dorofeeva-Lichtmann, Georges Metailie (eds.), *Graphics and Text in the Production of Technical Knowledge in China: The Warp and the Weft*

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This book is a collection of eighteen papers that discuss how *tu* 圖 (technical images) and texts together conveyed a wide range of technical knowledge from cosmogram and religious talisman by 200 AD to illustrations of machines and coroners' charts by the nineteenth century. The title of this book indicates that both graphics and text are essential in conveying technical knowledge, just like the warp and the weft are inseparable. However, after browsing the table of contents, one may wonder why *tu* should be an independent research subject. The answer is not straightforward. In the shadow of Western drawings in the development in science, medicine, and technology, scholars tend to focus on the fact that Chinese technical illustrations lack accuracy and their failure in conveying scientific knowledge. The authors of this book are not satisfied with such a Euro-centric view. They feel that "scholars who were interested in *tu* usually adopted the perspective of classic history of science, which meant that certain important categories or dimensions of *tu* eluded their attention." Therefore, the editors intend to include the whole spectrum of *tu* rather than focus on sub-sets of technical knowledge. They argue that the study of *tu* should focus on its intended purpose and the function it served, rather than its shortcomings and failures.

The book categorizes *tu* by what the editors consider as the typology conceived by pre-modern Chinese thinkers: *tu* as symbolic mediation and as technical illustrations. The introduction reviews the modern *tu* studies and gives a short history of *tu*. It argues that what distinguished *tu* from other forms of graphic representation was that *tu* was an "encoding of knowledge which served as a template for actions." It asks the questions: "what types of *tu* are characteristic of a particular field of technical knowledge? How did they convey the philosophical preoccupations and practical goals of the specialists working in that technical field?

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How did they function cognitively as graphics, alone or in conjunction with other media?" (p.73) The chapters of the book answer these questions.

Part one of the book discusses *tu* as symbolic meditation. The first two chapters by Olivier Venture and Wolfgang Behr trace the origins of the character *tu* in the Shang and the Zhou dynasties and its original meaning as "positioning in space" and "display in an ordered, appropriate" way (p.128). The following three chapters examine *tu* as magico-religious symbols in the period from the Warring States to the Han Dynasty (roughly from fifth century BC to third century AD). Marc Kalinowski examines the sexagenary plane (prevalent from the Shang, thirteenth to eleventh centuries BC) and solid layouts of hemerological calculations, such as "cord–hook diagram" and the *Xuangong tu* 玄宮圖 (Diagram of the Mysterious Palace) in the *Guangzi* 管子 (the Writing of Master Guan). He argues that the graphic representation of sexagenary cycle, known as the *ganzhi* 干支 (steams and branches), was a means of positioning in space and time in the process of divination. Donald Harper explores the astrological manuscripts discovered in the Mawangdui 馬王堆 tombs (168 BC). He argues that *tu* was an encoded world that sages decoded and made accessible to society in material form. Wu Hung examines the ideal ritual structure of Mingtang 明堂 (Bright hall) and architectural drawings that represent Han dynasty cosmology. He contends that by building the former and drawing the latter, Han and later rulers were harmonizing the human with the cosmic order.

The third section of part one discusses text as *tu*. Vera Dorofeeva-Lichtmann suggests that *Shanhai jing* 山海經 (Itineraries of Mountains and Seas, compiled by the first century BC) should not be translated as a canonical work but as an itinerary, which contains a description of the inhabited world. Hence, contrary to later Chinese scholars' convictions, maps were not necessary. Griet Vankeerberghen argues that the *biao* 表 (Tables) of *Shiji* 史記 (Historical Records, completed in first century BC) reveals the author Sima Qian 司馬遷's intention to document an irreversible transition in history. Hermann-Josef Röllicke studies the Buddhist canon *Huayan jing* 華嚴經 (Avatamsaka-sûtra), arguing that it is organized according to a certain *mandala* structure (a kind of geometric pattern). It should be recited in its entirety and engrossment of time, and its own liturgical structure has to be ritually followed. Michael Lackner discusses *Yanji tu* 研幾圖 (Diagrams on the Fathoming of Initial Stages) in neo-Confucian treatises from the mid-Song to the Yuan. He contends that the illustrations formed by words not only supported a verbal argument but also an argument themselves.

Part two of the book discusses *tu* as technical illustrations. The first three chapters discuss the importance of the medium of *tu*. Vivienne Lo examines four items: a figurine excavated from the Shuangbaoshan 雙包山 tomb (118 BC), the moxacautery loci chart discovered at Dunhuang, the *Hama jing* 蝦蟆經 (Toad Canon, Lo does not date this material but presumably the Han dynasty, that is 202 BC–220 AD), as well as the *Daoyin tu* 導引圖 (Guiding and Pulling Chart) discovered at Mawangdui (168BC). She discusses how textual instructions and practical illustration were brought together. She suggests that texts and *tu* had to come together in order to understand the encoded knowledge. Alexei Volkov investigates the geometrical diagrams in traditional mathematical treatise the *Jiuzhang suanshu* 九章算書 (Computational procedures of nine categories, although Volkov does not date it, it was compiled in the Han dynasty, around the first century), arguing that the

Chinese mathematical diagrams of the first millennium were mainly focused on the representation of the general patterns of the transformations of the objects rather than the structure of the objects themselves. Yet, the loss of diagrams might have been the consequence of the Chinese imperial government's ban on the circulation the books related to numerology. He concludes that the interpretations of the diagrams in mathematical books had changed considerably throughout the history of mathematics. Michela Bussotti discusses the strength and weakness of block-printing technology. She argues that Chinese wood-block printing was not necessarily weak in presenting technical details. Although Chinese woodcut prints generally lack the precision in the visual description of objects, they were effective in printing countless books and prints of every kind and subject through till modern times.

The following four chapters explore the *tu* and text in technical treatises in the era of wood-block printing. Georges Métailié examines botanical treatises such as the *Bencao gangmu* 本草綱目 (Classification of the *Material Medica*), arguing that paintings (*hua* 畫) of plants are not necessarily more precise that illustrations in botanical treatises, however they certainly provide a deeper feeling of a living plant. Francesca Bray argues that the illustrations from the *Gengzhi tu* 耕織圖 (Ploughing and Weaving Illustrated) and the *Nongshu* 農書 (Treatise on Agriculture) would have served as the equivalent of blueprints, allowing government officials to introduce advanced technology to backward regions as a part of the statecraft tradition, although the illustrations were much invocations of a harmonious and productive social order as depictions of advanced technology. Peter Golas argues that the illustrations of the *Tianggong kaiwu* 天工開物 (Exploitation of the Works of Nature) tend to show craftsmen engaged in the process of using tools, and they do not emphasise on precise construction details of the tools and machines. The lack of precision impeded China's technological progress. Donald Wagner's short chapter shows that Song Yinxing, the author of the *Tianggong kaiwu*, did not always know the technology he wrote into the book, hence, his texts and illustrations did not always match.

The last section of part two discusses the influences from the West. Catherine Despeux argues that forensic illustrations of skeletons progressively improved from the thirteenth century onwards because of administrative needs. Even though the court had made an effort to standardize autopsy charts, Western influence only became obvious in the late nineteenth century because Chinese judges were only interested in dead bodies. Iwo Amelung contends that Western draughting techniques became prominent when the Qing government realized the superiority of Western mapping and surveying during the last 60 years of the dynasty.

However, the arguments leave some space for discussion.

Volkov's argument that the government ban caused the loss of pre-Song mathematical diagrams is not convincing, because legal bans might have caused inconvenience in circulation of numerological treatises but unlikely caused complete disappearance. If some of them have survived, why not the diagrams of the *Jiuzhang suanshu*? Volkov himself has pointed out a more creditable explanation: Chinese mathematicians did not consider diagrams essential in understanding mathematical questions (p.456). If the drawings were "transformative" rather than "structural," as Volkov argues, Chinese mathematicians might have just drew and redrew diagrams

in the process of calculation. Furthermore, he has also pointed out that modern authors and readers of geometrical treatises are expected to be aware of the discrepancy between the pure model and its graphical representation. There is no reason why pre-modern Chinese readers of mathematical treatises were not. Therefore, the question is how *tu* was drawn as they were and how much discrepancy between *tu* and the real objects was allowed by authors/readers of technical treatises.

Even though the issue of accuracy is one of the focuses of part two, this book does not intend to address these questions regardless of Busotti's brilliant paper about wood-block printing technology. Especially, I find Peter Golas's conclusion that "China produced a body of technical illustrations that not only showed very limited success in picturing technology of any complexity but ... also acted as a major impediment to technological creativity in late imperial China" (p.591–2) debatable.

The forms and conventions of the *tu* discussed in part one vary between subjects. They were produced and read by practitioners of divination, religious cult, history writing, and thinkers of Neo-Confucianism who would certainly create their own conventions. Modern researchers would be disinclined to comment on how they should be drawn. In part two, which discusses the knowledge that we now consider science and technology, drawing conventions become one of the focuses. In medical treaties, as shown by Vivienne Lo, pre-modern Chinese medical theory was defined by sense and sensuality, not the exact numerical measurement of the human body as we know of today. Illustrations could convey medical knowledge "precisely" as authors and readers intended them to be. However, treaties on machines were not intended to similar readership. As Francesca Bray and Peter Golas have told us, Ming–Qing technical treatises, such as the *Nongshu, Tiangong kaiwu*, were produced in the statecraft tradition, in which both the authors and readers were not necessarily practitioners of technology but government officials and social elites. They might have hoped to bring new technologies to the locality where they were not in use. To their eyes, the illustrations were "blueprints" in a broader sense when they decided on whether to sponsor reproducing new technologies according to the treatises. However, as Golas has told us, the construction work would fall into the hands of experienced artisans who could combine the information in the texts and illustrations with their own experience to produce "a version that would stand a good chance of operating effectively (p.587)." That is to say, artisans remained in command at the stage of creating, realizing, or imitating technologies and the machines they built would not be exactly as the illustrations in terms of shapes and dimension as long as they functioned as designed. Those illustrations were a rough guide, as Bray has pointed out (p.29), but not a direct technical instruction. Hence, authors/readers would find the *tu* informative enough.

However, accuracy would have mattered if artisans required their working drawings to bear technical details and produced objects with accuracy. In the process of creating, machine designers use free-hand drawings in visualizing machines or machines parts, because they are meant to be read by people within a small circle of trusted colleagues or even just the inventor him/herself. However, if production with accuracy is required, designers have to use clearly delineated drawings that convey accurate technical details to communicate with those who produce parts. I doubt that Chinese artisans, who learned their trade through the oral tradition, would have taken

this idea seriously. We need more research into how they worked and learned knowledge and skills. But, unfortunately, published Ming–Qing technical treatises are hardly adequate as the source. A similar principle may be applied to the research on the illustrations in materia medica treatises. Physicians and herbal collectors and vendors probably learned their knowledge through practical experience. The rough illustrations of the *Bencao gangmu* might have been less important in their practice. Hence, there was never a strong tendency to give out detailed and accurate technical information through visual communication.

On the contrary, art connoisseurs appreciated the sense of realness created by perspective and the minute details of plants, objects, human bodies, or street scenes (such as the famous *Qingming shanghe tu*, Riverside scene at the Qingming festival) in drawings and painting. Yet, artistic beauty, not the technical knowledge behind the images, was the focus. Hence, drawings and paintings (*xiang* and *hua*) contributed little to the spread of technical knowledge. They are like the artistic drawings and paintings of Renaissance Europe, when artists were interested in applying conventions such as shading and newly discovered Euclidean geometry to create the optical illusion of realness. Yet, just as Michela Bussotti has pointed out, "realistic perhaps, their works could prove equally useless for practical application" (p.481). If we must compare with the West, the sharp difference is that, since Renaissance, European artisans, shipwrights, and architects (some of them, like Michelangelo, were artists) discovered the practical application of drawings in the process of production. They used drawings that applied the conventions invented by artists and carried detailed technical information to instruct artisans to produce objects accordingly. From the sixteenth century onwards, draughtsmen and geometricians further developed the conventions and defined the visual illusion with mathematical precision. This gave birth to modern mechanical drawings, which has been essential in industrial production since the Industrial Revolution.

In short, this book is a major contribution to the study of Chinese technical images. It inspires deep thoughts and future research agenda. Yet, it is highly specialized and poses a challenge to readers who would like to understand *tu* as a whole. They may have to pick parts of the book that interest them.

A minor point is illustrations are put at the end of every chapter and the color plates are put at the end of the book. Readers have to flick back and forth in order to read the texts and the illustrations at the same time. Not only does this arrangement create inconvenience but also adds difficulties for readers to fully absorb the authors' arguments since the illustrations are actually the focus. Besides, the publisher seems to have some difficulties in dealing with Chinese characters. Simplified Chinese characters are mixed up with the full form such as p.114, 199, 200. In some cases, wrong characters are printed either due to typing errors (p.29, 46, 道(導)引, 53, 345 落(洛)書), or coding problems (p.524, 543, in which *wen* 聞 has become 犉, and in p. 487, 492 *gang* 綱 has become a character that cannot be found on my computer.)