

The Production of Written Knowledge Under the Rubric of *Jiyi*

Ya Zuo

Received: 7 October 2009 / Accepted: 31 May 2010 / Published online: 26 June 2010
© National Science Council, Taiwan 2010

Abstract This paper is designed to place technical knowledge within a context of less technical ideas. Shen Gua (1031–1095), a literatus and statesman who lived under the Northern Song (960–1127), possessed a strong interest in technical knowledge. In examining the category “Particular Skills” (*jiyi*) Shen Gua coined in his famed work *Brush Talks by Dream Brook*, my aim is to demonstrate that Shen Gua’s interest in technical knowledge was an integral part of his intellectual enterprise. His perspective and methods in acquiring the skills of particular kinds reveal his intellectual predilections as a literatus, whose livelihood and social status depended on his production of knowledge in written form.

Keywords Shen Gua · Written knowledge · Categories · *Jiyi* · Methods of acquisition

Chinese cultural elites are well known for a certain amateur ideal, distancing themselves from specialist norms of technical excellence. Less well known are the ways in which technical skills were folded into, disputed, and acknowledged in relation to mainstream cultural pursuits. Among Song literati, Shen Gua, a scholar steeped in Confucian education, distinguished himself by showing an insider’s familiarity with technical knowledge. In the present paper, I intend to discuss how such an interest was grounded in and enlivened by Shen’s cultural pursuits.

My departure point lies in a category: the “Particular Skills” (*jiyi* 技藝) in Shen’s famed work *Brush Talks from Dream Brook* (*Mengxi bitan* 夢溪筆談, hereafter *Brush Talks*). *Brush Talks* is a collection of jottings encompassing an encyclopedic range of topics; the entries are organized in 17 sections, each of which is preceded by a categorical label. *Jiyi* is the tenth category in this arrangement. Shen Gua assembled a diverse set of skills under the term *jiyi*, including architectural arts, chess strategies, mathematical methods, woodworking, and medicinal techniques.

Y. Zuo (✉)

Department of East Asian Studies, Princeton University, 211 Jones Hall, Princeton, NJ 08544, USA
e-mail: yzuo@princeton.edu

For each skill, Shen Gua composed a brief written description. These accounts, taken together, constituted a recognizable, effective textual presentation of the skills.

The matters treated in “Particular Skills” are curiously diverse, and the taxonomic boundary appears to be almost ineffable. My aim in this paper is to ferret out the hidden consistency that makes “particular skills” a viable category. Instead of a generally recognized category of knowledge, Shen’s jottings describe his thinking—to be specific, his perspective and methods in acquiring skills of particular kinds as a maker of written knowledge.¹ This complex thinking process involved collecting data from practice and observation, ordering technical details in meaningful sequences, tackling causal relations in terms of efficacy, excluding nonessential information (irrelevant events, biographical data, social bias, and so on), and, eventually, reporting effectively and analytically in clear language.

1 Shen Gua and *Brush Talks*

Before the plunge, let me make a brief detour to present an outline of Shen Gua’s life and of his widely known work, *Brush Talks*. Shen led the life of a peripatetic learner. He served the Northern Song for three decades, never ceasing to apply his voracious intellect to a wide range of fields. Upon retiring, he composed *Brush Talks from Dream Brook*, a record of the heterogeneous knowledge he had acquired over a lifetime of study.

To modern readers, Shen is best known for his extraordinary erudition in a wide range of intellectual endeavors, including literary composition, Confucian classics, astronomy, mathematics, cartography, physics, music, hydraulic engineering, architecture, art criticism, and geology. On the one hand, this scholar personifies the cultural erudition of centuries of mainstream Confucian scholars; on the other hand, he represents a singular moment in Chinese intellectual history, when “know-how” practical thinking based on critical experiential inquiries attached itself to the rock of Confucian classical scholarship. Shen combined these heretofore contesting intellectual impulses, producing a coherent epistemology.

Despite his novel achievement, Shen Gua remains both over- and under-researched. For many historians, he is less a historical figure than a fanciful idea—a person advancing modern science in middle-period China. Since early last century, a voluminous scholarship has been devoted to identifying Shen’s “scientific” contribu-

¹ My primary source, *Brush Talks from Dream Brook*, is an early literary work; it does not devote itself exclusively to any particular field of technical studies. The author did not compose the text under the sort of disciplinary constraints that exist in modern academia. The boundary between science and society explored by historians of science and sociologists was not yet established during the author’s age. Many modern sociologists of science have studied the production of written scientific knowledge. Charles Bazerman (1988), for instance, studied how social and rhetorical forces have shaped the experimental science article. Also, a number of sociologists have relied on written texts as their sources for investigating the purported tensions between the production of scientific literature and actual laboratory practices. While such works inspired my study of Shen Gua, my discussion of written knowledge is rather different from that found in previous studies. In the present paper, “written knowledge” simply means knowledge as recorded in a text. As a result, many significant issues discussed in the aforementioned scholarship are of little relevance to my case.

tions but has barely provided a sense of coherence in understanding his life.² Discussions of his thought have remained more or less isolated from major themes in Chinese intellectual history.

I intend to explicate some of Shen Gua's ideas in the context of his own times. He emerged during a transition in Chinese history. The eleventh century was characterized by a revival of Confucian learning and classical values. Literati, as a self-conscious group, succeeded the aristocracy as the sociopolitical elite. The open-mindedness of the day and the generous imperial patronage fostered competition among the literati interested in statecraft-oriented philosophical systems. Wang Anshi (1021–1086), Sima Guang (1019–1086), and Zhang Zai (1020–1077), thinkers who changed the course of intellectual history for the next centuries, drew together a constellation of ideas which radiated power and consequence.³ Shen's epistemology, a vigorous, inventive line of thinking, was rooted in the same soil.

Shen Gua led the typical life of a high-ranking bureaucrat.⁴ Born into an established elite lineage in Qiantang (modern Hangzhou, Zhejiang Province), he initiated his bureaucratic career directly under the influence of his father. In 1054, Shen received his first official appointment, registrar of Shuyang (in modern Jiangsu) county, through *yin* privilege because of his father's death. After securing his *jinshi* degree in the palace examination of 1063, Shen was recruited by Wang Anshi and played a part in the important reform known as the "New Policies" (1069–1085).

During this period, Shen was involved mostly in technical projects and creative designs in support of the New Policies. His work on astronomical instruments, state rituals, and hydraulics elicited praise from both Wang and the emperor, who appreciated Shen's unusual analytical mind and excellent common sense. In 1075 he was appointed fiscal grand councilor—the peak of his career.

A decade of engagement in technical projects fostered Shen's appreciation of creative material labor. Compared with other literati, he paid more attention to those who worked with their hands, not only because of an intellectual interest in understanding such work, but also due to his experiences working directly with court artisans. In an early piece on ritual music, for instance, Shen argued that the ancient world of the sages, filled with magnificent objects, would not have been possible without the participation of artisans and other commoners. As literati of his own time called for the restoration of the perfect ancient order, they should, Shen emphasized, not only revive "the regulatory systems (*fa* 法) of antiquity" in the sociopolitical realm, they should also attend to the material forms—"technology, implements, sizes, dimensions, and the colors black, yellow, blue, and red"—which were indispensable constituents of a perfect world (Shen 1896b: 19:7a).

Shen's penchant to frame material labor in a sociopolitical context stemmed directly from his vision as a Confucian scholar and his experience as a bureaucrat. He endorsed intelligent craftsmanship, appreciating its social value according to the model presented in a number of Confucian classics. In *The Rites of the Zhou* (*Zhou li*), for

² Most studies of Shen are by historians of science. To date, the essay by Nathan Sivin (1995) is the most lucid and concise survey of Shen's technical contributions.

³ For an introduction to the revitalization of Confucian teaching and major intellectual trends in the eleventh century, see Bol 1995, 176–211.

⁴ For concise biographical information of Shen Gua, see Zhang Yinlin 1936 and Zhang Jiaju 1962. For the most recent book-length account of Shen Gua's life and ideas, see Zu Hui 2004.

instance, artisans were regarded as one of the six major social groups in the operations of the state. The responsibility of them was to explore natural materials and develop designs based on their specific properties.⁵

At the same time, Shen discoursed on creative material labor to make sense of the administrative and technical drudgery he had slogged through. Self-consciously, he developed an intellectual persona that featured both cultural virtuosity and technical expertise. The credentials he presented—literary skills, classical erudition, administrative competence, and specialized skills in a number of fields—met Wang Anshi's expectations for a capable official.⁶ To use language a bit closer to his own, though emphatically a *literatus* known for cultural virtuosity (*wen*), he also possessed the expertise of an administrator (*li*) and the ingenuity of an artisan (*gong*).⁷ For instance, in an essay celebrating the opening of a new prefectural school in Hangzhou, Shen Gua presented the complementary roles that administrators and artisans might assume: “The artisans realized the exquisiteness; the administrators ensured the appropriateness. Addressing both the enormous and the diminutive, the twists and turns, they worked together to make the regulatory systems function perfectly” (Shen 1896d: 24:6a).

For Shen, reconstructing the ideal society required all three parties: visionary virtuosi who could decipher the classics, administrators with practical expertise and prudence in overseeing the projects, and artisans adept at bringing designs to realization. Shen saw intellectual possibilities in the work of *li* and *gong*, constitutive qualities that a mainstream cultural visionary could incorporate into his identity without worrying that he might degrade his mind.

Despite all his achievements in the political arena during the 1060s and the 1070s, Shen Gua failed to hang on to his position during the turbulent years of the controversial reform. Due to factional struggles, he received a series of demotions just after reaching the high point of his career. In the last decade of his life, Shen composed *Brush Talks* while living in seclusion by Dream Brook.

For any study of Shen Gua, *Brush Talks* is of paramount significance. It is a collection of jottings covering a wide range of topics, mostly drawn from Shen's recollections and personal observations. For many scholars, this text is the means to understanding its author, an explanation of why he matters at all. His legendary erudition is to a large extent constructed from a selective reading of *Brush Talks*, assigning many of the collected items to modern scientific categories.⁸ Even as the book has become a subject of intensive scholarly interest, it has been thoroughly misread.

⁵ Barbieri-Low (2007) provided an elaborate analysis of artisans as a classical trope in early texts, 48–53.

⁶ For a historical account of the interactions between Wang and Shen, see Zu Hui 2003.

⁷ This conceptualization was also a positive unraveling of the tension he frequently felt in the decade between 1054 and 1063 between the two identities, *wen* (cultural virtuoso) and *li* (administrator). This decade witnessed Shen Gua's struggles to detach himself from local administrative drudgery and proceed to a more intellectual life in the capital. Shen Gua revealed his commitment to the identity of a quintessential *literatus*, that is, a cultural virtuoso, in a number of his writings during the decade, for instance, see Shen Gua 1896a, c.

⁸ It is important to be clear about the constitution of *Brush Talks*. As we shall see from the contents, the majority of the book is intimately linked with the common cultural pursuits of *literati*, from the sartorial paraphernalia of officialdom to court rituals and music, philological discussions, and gossip. Entries on technical activities, in the sense of building, designing, healing, and the like, constitute a small portion of the book—which still captures the lion's share of the attention of modern scholarship.

Brush Talks is significant, but it is not the only key to unlocking Shen's life, nor does it represent Shen's attempt to demonstrate his intellectual versatility. It is not a systematic piece of work. By presenting the text as a chat between himself and the brush with which he wrote, Shen implied that the composition was a process of working with memories (Shen 1963: 19). As the materials first came to his mind (perhaps with the aid of previous written notes), they would be sporadic and inconsistent rather than organized or systematical. In other words, Shen allowed for a certain degree of randomness in choosing his materials. Also, earlier in his life, Shen composed a number of monographs on Confucian classics, court rituals, music, cartography, diplomatic missions to the border state, calendars, and medicine. Bearing in mind the completion date of *Brush Talks*, it should be viewed as an assemblage of sequels to his other works.⁹ Sequels, not reiterations—he intentionally avoided repeating himself. *Brush Talks*, therefore, conveys a piecemeal approach to experiential learning, not a portrait of a polymath.

2 *Jiyi*: A Strangely Diverse Category

One conspicuous feature of *Brush Talks* is its organization by categories. In its earliest surviving form (a xylograph made by a schoolteacher in 1166), the text contains 594 entries in total, which are organized into 17 categories and 26 chapters.¹⁰ As shown in Appendix A, this is not significantly different from the current arrangement in the modern standard edition.¹¹

At first sight, *jiyi* (the tenth category in both the early edition and the modern) may seem absurdly vague; unlike many other categories, it does not seem to have a stable taxonomic boundary. It encompasses 20 entries—in the arrangement of the current version of *Brush Talks*, items 299 to 318.¹² Subjects treated range from

⁹ Shen's other writings remain largely unexplored. Most are no longer extant, and yet surviving poems, memorials, essays, and correspondences have not attracted much attention. The main reason for this relative neglect is perhaps that these materials, which largely concerned themselves with the sociopolitical events that took place during Shen's life, shed no light on his "scientific" achievements. Nonetheless, they deserve careful scholarly examination by scholars: They go far to clarify his intellectual development. For a list of titles and brief introduction to the content of the lost works, see Hu Daojing (1956b) and Li (1999a).

¹⁰ The chapter-category arrangement mentioned here is the textual structure of the main text of *Brush Talks*, excluding its two sequels, *Bu bitan* 補筆談 (*Supplement to Brush Talks*) and *Xu bitan* 續筆談 (*Sequel to Brush Talks*). On those two works, see Hu Daojing (1963), 4–5.

¹¹ Thanks to the editorial changes made by generations of scholars, the total number of entries has increased to 609 in the standard modern edition.

¹² The *jiyi* section in the modern text includes 21 entries, items 298 through 318, but I believe that item 298, which has been taken as the first entry in this category since the Ming, belongs to the miscellany (*zazhi*) section. Its anecdotal narrative about a numerologist stands an odd exception among other entries, which are consistently accounts of particular techniques. Textually speaking, in the 1306 edition of *Brush Talks* (aka. *Yuan kan Mengxi bitan* 元刊夢溪筆談 (*Brush Talks from Dream Brook*, Yuan Edition)), the *jiyi* section starts with the current item 299, and item 298 does not exist at all (Shen 1975). In *Song chao shishi leiyuan* 宋朝事實類苑 (*Collection of Categorized Things in the Song Dynasty*), a *leishu* 類書 (collectanea of categorized knowledge) compiled between 1132 and 1145 by Jiang Shaoyu (dates unknown), where 18 out of 21 jottings from the *jiyi* section were cited, this entry is not seen either (Jiang 1981). For details of *Categorized Things* and the *Brush Talks* jotting preserved in it, see Appendix B. I argue that the placement of this item in the *jiyi* section is most likely the work of later editors.

architecture (299, 312) to calligraphy (316, 317), woodworking (303), mathematics (300, 301, 304, 306), chess strategies (302, 305, 310), printing technology (307), calendrical methods (308), medical procedures (309, 313, 314, 315, 318), and prognostication techniques (311). This range shows that Shen Gua grouped cerebral labor (mathematical skills, chess strategies, and so on) with manual labor (woodworking, architecture, and so forth).

The entries on cerebral labor have long been cited in the historiography of Chinese science. Shen included a number of innovative mathematical methods, such as a method for measuring circles and a method for calculating volume with interstices (entry 301). On a par with the conceptual activities, Shen Gua indiscriminately presented the skills in manual labor in the form of written knowledge, so that in the *jiyi* category a definitional distinction between cerebral and manual skills was nullified.

Some comparisons show that the content and diversity of Shen's *jiyi* category were unconventional during his time. The term *jiyi*, a generic designation of skills in general, is a commonly seen word. Categories labeled with *jiyi* or its variants also occur in contemporaneous writings, but they tend to have a different feeling. For instance, in *Taiping guangji* (*Comprehensive Records Compiled in the Taiping xingguo Era*), an imperially prescribed collectanea compiled in the late tenth century, the term *jiqiao* 技巧 (clever skills, a synonym of *jiyi*) leads the section on extraordinary, clever skills (Li et al. 1961). Most of the skills discussed belong to "architectural arts" and "mechanical designs." Moreover, many of them are not the explicable type of clever architectural or mechanical skills seen in Shen Gua's book, but singular, uncanny, and frequently unfathomable practices. Shen's *jiyi* is far broader than *Taiping guangji*'s *jiqiao*.

Jiyi is also peculiar inside *Brush Talks* in terms of its relation to other conceptual groupings. Some of the topics that turn up in this section are treated elsewhere in the book: Medicine, calligraphy, and painting, for example, are treated in individual sections. The overlap has led some scholars to suspect that these entries were mistakenly attributed to the *jiyi* category and should be moved (Zhang 1973: 2:31a–32b). I disagree. Shifting the relevant items (such as at least seven entries on medicine and calligraphy) would reduce the total number of entries in the section to 13 at most, making it tiny when compared with the other sections. Plus, as I explain in Appendix B, some circumstantial evidence from other texts supports the current arrangement, which probably reflects Shen's original design.

This means that an explanation is needed. What thread provides the consistency for the *jiyi* section? Such consistency is not determined by taxonomic groupings but rather by other forms of thought. As Daiwie Fu (2002) pointed out, the consistency in this category lies in the urge of the practitioner to pursue certain skills to their limits. With Shen Gua, the crucial decision is to look at his epistemological stance.

I argue that Shen's perspective, as well as his methods in pursuing the particular skills, amount to the adhesive that makes *jiyi* a viable category. This conceptual grouping is an analytical construct that came into existence as Shen acquired the skills and translated them into written knowledge. As I will argue in the next section, the category was less a matter of providing clear spaces for codified knowledge than they were of a place where Shen Gua exercised certain thinking processes.

3 Epistemological Categories in *Brush Talks*

Why did Shen Gua coin a category as peculiar as *jiyi*? How can we justify its singularity as well as its unusual consistency? Does the same justification also apply to all the other section headings in *Brush Talks*? The categories in *Brush Talks* are not the result of a taxonomy determined by conventional classification principles; they are epistemological categories shaped by Shen's personal beliefs and epistemological stance. In order to clarify the correlation and distinction between them, a discussion of the nature of epistemological categories in *Brush Talks* is in order.¹³

The practice of classifying knowledge became highly visible along with the proliferation of *leishu* 類書 (collectanea of categorized knowledge) that began in the Six Dynasties. Similar to modern encyclopedias, collectanea were divided into taxonomic categories so that fields of knowledge could be presented in a highly rational fashion. Trawling through all sorts of available texts, compilers divided these materials into voluminous categories, creating encyclopedic reference works, *leishu*.¹⁴ Large-scale, state-commissioned *leishu* usually encompassed a wide range of categories intended to cover "all knowledge." For instance, the colossal *Taiping yulan* 太平御覽 (*The Imperial Collectanea of the Taiping xingguo Era*), which was compiled between 977 and 982, featured 55 categories and 5,474 subcategories (Li et al. 1968). The system of categories reveals the ideal of providing an inventory of the known universe: from the realm of heaven and earth to the human world, from the imperial house to the bureaucracy, from the military to rituals, from belles-lettres to legal codes, from religions to numerology, from diseases to practical instruments, from clothing to food, from animals to plants, and so on and so forth (Guo 1967, 17–25). Each category was one constituent of the universe.

Middle-period literati—the writers and readers of *leishu*—soon extended the practice of classifying knowledge beyond the realm of *leishu*. Categories of classified knowledge became a framing device across different genres of text. In anthologies of literary writings, compilers arranged poems and rhymed-prose essays thematically according to their subjects; themes in the form of classified knowledge were adopted, in addition to the more traditional rhymes, formats, and dates, as new stuff of the compilers' organizing philosophy (Zhang 2008). For instance, after some refashioning by Northern Song literati, the works of the famed Tang poet Du Fu 杜甫 (712–770) were re-arranged under the headings of moon, star, flower, grass, bamboo, among 68 other categories (Du 1967).

Another major group of texts permeated by the classificatory approach was *biji* (jottings), a literary genre that flourished in the Song. Roughly speaking, a *biji* is a hodgepodge of brief anecdotes, comments, descriptions, and analyses jotted down

¹³ Daiwie Fu (2002) argued against comparing the classification of knowledge in *Brush Talks* to modern taxonomies. He also pointed out that the classification of knowledge in *Brush Talks* represents Shen Gua's general epistemological stance—a two-tiered theory of knowledge. See also Lei Hsianglin and Fu Daiwie (1993).

¹⁴ For basic information on *leishu* as a textual tradition, see Dai Keyu and Tang Jianhua (1981) and Yu Cuiling (2002).

with no attempt to include transitions, links, or overall theses. Sometimes translated as “notes,” “pen notes,” or “notebook literature,” *biji* represents a large body of texts produced over a long time, from the fifth century to the end of the nineteenth. Due to its multifarious content and lack of stable structure, *biji* remains a nebulous category; whether it constitutes a genre is moot (Bol 1995: 123–28). Motivated by different interests and questions, modern scholars have tended to define the nature of *biji* from certain angles rather than an integrated prospective.¹⁵

Some *biji* texts concentrate on single subjects, such as historical anecdotes, calligraphy, stones, or plants, to name only a few. Others encompass knowledge in multiple fields. Authors of such multifarious-content *biji* tended to organize the texts into categories, borrowing from *leishu* a taxonomic structure, down to the specific terms employed by the encyclopedic compilers.

Among the most famous Song *biji* is *Brush Talks*. Its categorical organization can hardly be overlooked, as shown in Table 1. The 17 categories, presumably assigned by Shen himself, have remained unchanged since the earliest surviving edition, that of 1166.¹⁶

There is, however, a significant difference apt to be overlooked between the categories found in *Brush Talks* and their counterparts in contemporaneous *leishu*. The taxonomic categories in *leishu* functioned as a control device to chart boundaries in existing knowledge; they were determined by the conventional rules of classification. The ultimate goal of a state-commissioned *leishu*, such as *Taiping yulan*, was the domestication of everything under heaven and the creation of a harmonious cosmic order. In order to achieve the goal, not only did the *leishu* compilers have to collect materials comprehensively, but they also needed to create an all-inclusive categorical framework. In this context, each category held a determinative taxonomic place for a group of things in the universe. The classificatory boundary was stable and the taxonomic criterion clear, for the categories represented order. Besides, the emperors' agenda to commission *leishu* compilations added a political aspect to the role of categories as control device. In the case of *Taiping yulan*, for instance, the ideological message was clear: creation of such a collectanea would bring a sense of unification to the newly found Song empire. Its categorical structure provided a standardized framework of perceiving the world for emperors, officials, and later on examination candidates, the talent pool of social elite.¹⁷

¹⁵ Herbert Franke, in the context of private historiography, noticed that the organization of *biji* was loose and that some authors wrote their jottings to supplement state-commissioned historical records (Franke 1961: 116–117). Yau-Woon Ma regarded brevity a definitional characteristics of *biji*, as in comparison with lengthier accounts in another literary form *xiaoshuo* 小說 (lesser sayings) (Ma and Lau 1986: 11). Alister Inglis also discussed the characteristics of *biji* in the comparison with the genres *xiaoshuo* and *zhiguai* 志怪 (accounts of anomalies; Inglis 2006: 108–109). Based on both content and structure, Fu Daiwie (2007), with the intent to discuss classification of knowledge, grouped all *biji* texts in three clusters, *biji* as a synonym of *xiaoshuo*, *biji* as a collection of categorized knowledge, and *biji* as a single-subject technical treatise. He provided a definitional description of each type.

¹⁶ Although this textual structure is consistent in all extant editions, information from *Supplement to Brush Talks* seems to suggest the existence of a 30-chapter edition. This edition has become the topic of intense speculation among generations of scholars. For a brief summary of the problem, see Hu Daojing (1956a), Li Yumin (1999b), and the appendix to Fu Daiwie (1993–1994.)

¹⁷ For some more concrete discussions of the political aims the state-commissioned compilation projects served, see Kurz (2001).

Of special note, *leishu* compilers were not concerned about the production of new knowledge: Their primary task was the organization of existing knowledge. Copy-and-paste was known as the conventional strategy of them (Haeger 1968: 450). The state-commissioned *leishu*, hence, were not original scholarly work. Viewed from this perspective, Shen Gua and *Brush Talks* were completely different. Comprehensive coverage was not his goal. Shen Gua included nothing but his own work in this text. He engaged with his materials more deeply than most *leishu* compilers: Not only did he offer many new insights, he also crafted every entry on his own without cutting-and-pasting from earlier texts. Shen was primarily concerned with production of new knowledge.

For a maker of new knowledge like Shen, categories resemble a control device less than they do a support apparatus. As Shen started composing the first entry, he embarked upon a relatively random journey in the edifice of his personal knowledge; signposts, therefore, were necessary to maintain stable working procedures. For this purpose, he might have arranged a series of folders, each labeled with a categorical term. As he finished a jotting, he would place it into the corresponding folder. The folders kept him from losing himself as he thought and wrote. On the day he finished, he had 17 folders lying out on his desk, in each of which clusters of jottings aggregated.

It was Shen Gua's own forms of thought, rather than conventional classifications, that these categories made manifest. Not only the subject matters treated were limited to his personal knowledge, but also, Shen's own methods of acquiring the knowledge played a decisive role in shaping these categories. Ways of obtaining knowledge was perhaps not an essential concern to *leishu* compilers in coining a categorical section, for they were not engaged in producing the knowledge themselves, but to Shen, it had a special salience. For instance, in the *bianzheng* (Identification and Proof) section, Shen Gua applied the approach of critical evidential inquiry to making sense of heterogeneous knowledge. *Jiyi*, is another example, where Shen Gua grouped together a set of inquiries not quite according to their subject matters, but rather according to the epistemological commonalities he noted in pursuing them.

4 Producing Written Knowledge in *Jiyi*

In what sense does “the production of written knowledge of *jiyi*” constitute a stable analytical category? As a producer of written knowledge, Shen Gua's acquisition of skills is a complex practice enacted in thinking processes that consistently recur. Among the processes are the collection of observational data, selection of details, ordering of steps, analysis of causality, elimination of unrelated information, and write-up. Despite the heterogeneity of the skills, these practices linger beneath the textual surface as repeated themes, which invoke the epistemological commonalities that lead to the integration of *jiyi*.

Shen's ability to produce written knowledge of *jiyi* depended on at least three factors. Like other literati, he knew how to write, and his livelihood and social status depended on his production of knowledge in written form. He also possessed knowledge of certain skills; he wrote about such topics both in specialized

technical monographs and, somewhat surprisingly, in *Brush Talks*, which is dominated by matters of general interest to a literati audience. Last but certainly not least, he wrote lucidly and precisely: even modern readers find his technical accounts quite clear.¹⁸

The uniqueness of this intellectual endeavor is only fully revealed when we compared it to others. Most writers of the day avoided deep engagement with technical activities. Even the minority who were interested did not often set their ideas down in written form. A small number of them left behind technical writings, which have become important sources for modern historical studies. Not all of these authors clearly communicated their ideas in writing to readers (including minds educated by modern science).¹⁹ Research of pre-modern texts attests to the existence of such difficulties. Even those literati who were interested in technical knowledge and in the mean time concerned with clarity in presentation sometimes allowed their political, philosophical, or esthetic biases to intrude into their written accounts—Su Shi (1037–1101), is one such example.²⁰ This made it harder to grasp the subjects they addressed.

Hence, the acquisition of technical knowledge and creation of recognizable written reporting undoubtedly represents the result of thinking. In technical activities of any kind, writing about the activities differs in significant ways from performing these activities (Myers 1990). Such a difference to a large extent determines that a maker of written knowledge would adopt a perspective and methods of acquisition

¹⁸ In the context of modern science, sociologists of science in recent decades have discussed the properties associated with the language of science, which constitutes a source of inspiration for my point here. While normative or canonical versions for the formatting of scientific writing emphasize that scientific language is uniquely characterized by its features of logic, clarity, and simplicity, there also arose a growing body of literature arguing that scientific language, just like its literary counterpart, also relies on rhetorical devices to produce scientific knowledge and reproduce the cultural authority of that knowledge. For a few classic discussions in the latter category, see Latour's (1987) "deletion of modalities" and Myers's *Writing Biology* (1990).

While I have been continuously enlightened by the new developments in this field, in my project, both canonical and sociological views of scientific language provide useful insights. I am not dealing with a bona fide piece of scientific writing, nor in the context of modern science; most subjects of dispute between the two sides are of little relevance to my argument. The normative/canonical paradigm provides me with convenient markers to tackle the consilience between Shen Gua's writing and modern scientific writing, and the sociological models keep me aware of the existence of an inescapable rhetorical artifactuality.

¹⁹ Modern comprehension is certainly not a legitimate criterion for evaluating the works of previous ages; however, a tacit, and yet inescapable limitation of textual studies, is that historians dig out from the ancient archives just the texts their cognitive preparation and contemporary interest induce them to seek. In my opinion, the popularity of Shen Gua as a research subject in the modern times is not only due to the brilliance, but also the intelligibility (on the part of modern readers) of his written work; the construction of him as a "scientist" reflects, among other things, the consilience between his ideas and modern scientific thinking.

²⁰ Though best known for his literary achievements, Su Shi also held a strong interest in technical knowledge (especially in medicine) and material objects. He was also concerned with effective and clear writing on technical subjects. Once, he lamented that even though the ancient authors preserved the dimensions of Zhou bronzes in great detail, their poor verbal presentations prevented contemporary readers from visualizing the actual shapes (Su Shi 2004: 71:2251–2252). Su Shi's interest in skills, technical knowledge, and material things was strongly affected by his esthetic values and moral concerns of self-cultivation. See Egan (2006, 182–188).

distinct from a practitioner who was not concerned with textual knowledge and textualization.

Shen Gua's entry on movable-type printing (item 307, Shen 1963: 178-79), for instance, reveals his unique thinking processes.²¹ As Shen wrote, first, the printer cut characters in sticky clay to form individual type pieces. Next, the pieces were baked in fire to become hardened. In the meantime, the technician prepared an iron plate covered with a mixture of pine resin, wax, and paper ashes. Then, the technician placed a frame on the plate and set in the type pieces one by one. Once the frame was filled, the entire thing was placed close to the fire in order to soften the paste on the iron plate. The printer then pressed a smooth wooden board to even out the surface of the block. Usually, two plates were simultaneously in use: While paper impressions were made from one, type was being placed in the other. Thus, by the time the printing of the first plate was finished, the second plate would be ready. Duplicate type pieces were prepared for commonly used characters. After printing was finished, the block was again baked near the fire to allow the paste to melt and then cleaned by hand, so the type pieces fell off easily and could be reused.

Now, let's look beyond the text and make an informed guess about how Shen produced this piece of writing. First, Shen, a literatus who presumably had no previous knowledge of the technical aspects of movable-type printing must have observed Bi Sheng (ca. 970–1051), the inventor of this new technology, as he worked. Shen was aware that Bi was a commoner, but he was not distracted by the class distinction.

Shen needed to gather visual information through his deliberate observation of Bi's performance. What he attained was raw visual data—the casting of clay types, the cutting of characters, the mixing of pine resin with wax and ashes, the placing of the frames close to the fire, and so on. Shen was no doubt greatly intrigued by the process. He observed carefully and reflected upon what he saw in order to understand how each discrete operation was performed, what purpose they served, and how one operation connected with another. Shen selected what he considered essential operations. He left those he saw as irrelevant acts out of the picture: For instance, he might have observed that Bi Sheng poked the sticks of burning wood before baking the types or that Bi spent some time in adjusting the types so that the lines of print would be straight and not dance up and down on the page. He might, too, have witnessed trials and errors, such as production of a wrong-sized type, but he decided that they were not significant in presenting the most efficient process. Shen then arranged the chosen operations in a certain order.

Eventually, Shen was ready to convert this mental sequence into textual form. Shen was not in the same position as Bi, who could present the technique with physical demonstration and perhaps a few spoken instructions. For Shen's purpose, a lot more different work was needed to be done. Shen identified the relevant components of the printing apparatus, describing them with telling modifiers: a piece of fired-clay type (as thin as the rim of a coin), a plate (made of iron), a wooden board (with a smooth surface), among other objects. Shen also chose appropriate verbs, such as to cast (clay types), to cut (characters), to mix up (pine resin, wax, and paper ashes), to put (the frame) close to (fire), so as to translate the physical operations into comprehensible textual form. Afterward, he arranged the operations

²¹ For translation and analysis of this entry, see Needham (1985, 201–203) and Sivin (1995).

sequentially, so that the reader would be able to understand them as interconnected and related in time.

In addition, he repeatedly alerted readers to special tips for increasing efficiency. Pressing the frame with a smooth board would make the block surface even and thus improve the quality of the final print. Also, Shen recommended the simultaneous preparation of two printing plates. He explained why the types should not be made of wood. Because wood might be of fine or coarse texture, wooden types tended to absorb too much moisture; moreover, they tended to stick in the paste and so were not easily reused.

As shown above, Shen Gua was not a passive spectator; on the contrary, his active engagement allowed him to obtain the knowledge on movable-type printing. Understanding and reporting on this process was in effect a coherent endeavor to construct a sequence of steps in textual form. From this perspective, writing about movable-type printing was rather similar to writing about mathematical operations. In entry 304, Shen wrote about the calculation of a large number, 3^{361} , which also required the translation of certain mental steps into textual form (Shen 1963: 181–82).²² In both the entry about printing and that about mathematics, he employed identical strategies. In both cases, he began by reflecting on the practice, then assigned definitions, drew up sequential paths, and asserted causality to a physical or mental operation.

Shen Gua's perspective in approaching the skills is greatly affected by his concern with causality. This is particularly revealed in his analyses of single operations in the *jiyi* section. These accounts are largely products of Shen Gua's causal reasoning. Instead of introducing a process from beginning to end, Shen focused on analyzing the principles behind single technical acts. In entry 303, for instance, he offered three tips for making an archery set (Shen 1963: 181; see also Umehara 1979: 174–76). To craft such an account, he drew on the experience of his older brother, Shen Pi (dates unknown), a skillful archer reported to have made his own equipment. This set, according to Shen Gua, was superior for a number of reasons: The bow was light, durable, strong, and easy to draw; the bowstring was durable, and its strength did not decrease over time, nor was it much affected by weather changes; the sound produced by releasing the bowstring was clear and resonant; and the bow held steady when the string was drawn.

After establishing the criteria for a proper archery set, Shen proceeded to describe three methods to satisfy them: making a durable bowstring, determining the best grip proportion, and coating the strings with the appropriate amount of glue.

He provided a two-step recipe for making a good bowstring. If the appropriate material, cow tendon, was dried in the sun and then soaked in glue, it would become tough, resistant to stretching. Before attaching the string to the bow, Shen wrote, the bow was to be bent against its natural curvature, permitting it to shoot further. As to the grip, Shen explained why it had to be made to his specifications: If it was too short, the bow would be easy to draw but weak; if it was too long, the bow would be strong yet very hard to draw. As to the use of glue, he suggested that it be applied

²² I should note here that mathematical calculations were perhaps easier for Shen to present in writing than the process of movable-type printing. Because of the accumulation of mathematical knowledge, a relatively large and precise vocabulary had been developed for mathematical operations.

thinly, because it was more vulnerable to the effects of weather than was cow tendon. A bowstring coated with only a thin coat of glue would last longer than one with a thick coat.

From the preceding example, it seems that causal analysis played a large role in Shen Gua's writing. Indeed, the identification of causal relations between a process and a product may have inspired him to take up his brush in the first place. Such analysis justifies the efficacy of certain operations as well as their sequential organization. Shen's obsessive inquiries into the why and how, whether he was looking at the making of a robust archery bow or at the calculation of large numbers, ran through the diverse activities he recorded.

Although to modern observers such causal analysis may seem straightforward and sometimes self-evident, we should not assume that the practitioners all reflected on such issues. Many practical workmen took the work as an end in itself, failing to grasp the etiology. For some of them, to implement a skill meant simply following an established practice: They repeated procedures as they had been taught, rather than questioning why or how a particular procedure worked.

Shen Gua's inclination to reflect upon skills and to probe the causality separated him from common practitioners. At several places in *Brush Talks*, both in the *jiyi* section and elsewhere, Shen mentioned his conversations with artisans, physicians, and court musicians. Eager to understand "why we should do this" in addition to "how we should do this," Shen Gua pressed the practitioners on their reasoning, but often he was disappointed.

For example, in entry 314, Shen discussed a seeming contradiction between two medical prescriptions associated with powdered stalactite (*zhongru*) and an herb called *shu*—what we now know as *Cirsium spicatum* (Shen 1963: 187). The first prescription used *shu* to cancel out the effects of the stalactite powder. According to the logic of this particular prescription, these two ingredients could not be used simultaneously: The net effect would be nil. The second prescription included *shu* as a component in a composite toxin called "five stone powder" (*wu shi san*), which also contained stalactite powder. In the face of this apparent contradiction, Shen Gua consulted some "experienced physicians" (*lao yi*), but none of them could offer an explanation. Eventually, he propounded his own hypothesis: In the second prescription, the herb functioned as a catalyst to activate the five types of stone powder, which were too condensed to work on their own. If a physician wished to use efficacious techniques, Shen wrote, he should resort to reflective thinking rather than blindly relying upon established recipes.

Many skills are a combination of technical knowledge and the ability to execute such knowledge; the latter is sometimes involved with bodily practices and thus rendered as a "tacit" aspect of skills.²³ In a few cases, Shen encountered the problem of tacit knowledge and apparently accepted that it could not be adequately recorded in written

²³ In Michael Polanyi's classic study (1974), he argued that a skill is "tacit knowledge" embodied in bodily practices so that it is difficult to formalize. To perform a skill, one needs not only a focusing awareness of the external object, but also a subsidiary awareness which speaks to one's sensory facilities. A skill cannot be transmitted by texts, because "the aim of a skillful performance is achieved by the observance of a set of rules which are not known as such to the person following them" (Polanyi 1962, 49).

form. For instance, in his entry on the blind calendrical expert Wei Pu (fl. 1070), Shen provided only a descriptive account of Wei's extraordinary ability to memorize data and use counting rods, without offering any verbal analysis (Shen 1963: 185).

In addition to data processing, step sequencing, and casual reasoning, the production of concise writings on skills also requires the elimination of extraneous information. In most of his writings about *jiyi*, Shen Gua kept social factors in background. Although he may not have been concerned with class distinctions when he was busy jotting down his technical insights, the written knowledge he produced (especially his entries on manual labor) offers historians valuable information.

Shen indiscriminately treated the practices of elites and nonelites as subject matters of written knowledge, unconsciously setting literati and artisans on a par. At least in terms of practical techniques, the two occupational categories were equal. Shen showed a sympathetic appreciation of original, clever skills and a connoisseur's sensibility in collecting them. In his records, each skill was a piece of original work bearing the name of its practitioners. A number of commoners appear in his records with full credit. From a historical perspective, people who would have never merited a mention in an elite work of history as well-drawn figures because they mastered the skills of their vocation. Shen's records of a number of individual workmen are the only surviving sources on these figures. Because of the written knowledge he produced, individual workmen such as movable-type inventor Bi Sheng, master carpenter and architect Yu Hao (fl. 970), and calendrical calculator Wei Pu have names and voices.

5 Conclusion

It was not easy to acquire a particular skill and set it down in written form. Only an orderly and focused chain of thought would lead one there. So Shen Gua began by making deliberate observations. Next, he posed questions to identify the causal relations in each operation he had observed. He then proceeded to tinker with individual steps in order to align them in a reasoned sequence. In the end, he took up a brush to craft a step-by-step presentation from which he had carefully winnowed out distracting information.

As Shen Gua thought and wrote about skills of particular kinds, his own process of reflecting on technical practices and shaping them into steps recurred; these recurrences invoked epistemological commonalities which invited him to group together items whose contents might otherwise be considered rather disparate. This led him to create a strangely diverse category, *jiyi*.

The recurring themes have a lot to do with the perspective and approach of Shen Gua as a maker of written knowledge. Shen's reliance on reflective observations (rather than osmosis), emphasis on causality (rather than repetition), and attentiveness to verbal clarity all reflect his intellectual predilections as a literatus. To himself, *jiyi* was not an aberration; it was a part of a larger textual undertaking. It afforded Shen Gua a place to apply certain analytical methods in a deliberate, ordered, and focused manner to engage a particular set of inquiries. We may easily dismiss it as some sort of idiosyncrasy on the part of Shen Gua. In precisely this, however, *jiyi* demonstrates how it could resist modern concepts of science, technology, or even the encyclopedic classifications in Shen's own time.

Acknowledgment This study originated in a paper delivered at the workshop entitled “Status and Skill: The Portrayal of Individuals in Chinese Historiography, 10th–18th Century” at the Max Planck Institute for the History of Science in Berlin, September 2009. I wish to thank the organizers, Martin Hofmann and Dagmar Schäfer, for their invitation, and to record my gratitude to Chu Pingyi and Dorothy Ko, among other participants, for their valuable comments and encouragement. I am grateful to the two anonymous referees for their many helpful suggestions on earlier drafts. My special thanks also go to Willard J. Peterson, Brigid Vance, and Jun Hu, who worked with me through several drafts of this work.

Appendix A

Table 1 Seventeen categories and 26 chapters in the modern standard edition of *Brush Talks*

<i>Gushi</i> 故事 (Precedents)	<i>Yiwen</i> 藝文 (Belles Letters)
Chapter 1, entries 1–30	Chapter 14, entries 245–62
Chapter 2, entries 31–41	Chapter 15, entries 263–73
<i>Bianzheng</i> 辨證 (Identification and Proof)	Chapter 16, entries 274–76
Chapter 3, entries 42–70	<i>Shuhua</i> 書畫 (Calligraphy and Painting)
Chapter 4, entries 71–81	Chapter 17, entries 277–97
<i>Yuelü</i> 樂律 (Musical Harmonics)	<i>Jiyi</i> 技藝 (Particular Skills)
Chapter 5, entries 82–110	Chapter 18, entries 298–318
Chapter 6, entries 111–15	<i>Qiyong</i> 器用 (Implements)
<i>Xiangshu</i> 象數 (Figures and Numeral Symbols)	Chapter 19, entries 319–37
Chapter 7, entries 116–42	<i>Shenqi</i> 神奇 (Divine Marvels)
Chapter 8, entries 143–50	Chapter 20, entries 338–56
<i>Renshi</i> 人事 (Anecdotes)	<i>Yishi</i> 異事 (Strange Occurrences)
Chapter 9, entries 151–82	Chapter 21, entries 357–87
Chapter 10, entries 183–88	<i>Miwu</i> 謬誤 (Errors [and Corrections])
<i>Guanzheng</i> 官政 (Policies and Administrative Issues)	Chapter 22, entries 388–400
Chapter 11, entries 189–212	<i>Jixue</i> 譏諷 (Wit and Sarcasm)
Chapter 12, entries 213–23	Chapter 23, entries 401–19
<i>Quanzhi</i> 權智 (Tactics)	<i>Zazhi</i> 雜誌 (Miscellany)
Chapter 13, entries 224–44	Chapter 24, entries 420–49
	Chapter 25, entries 450–79
	<i>Yaoyi</i> 藥議 (Medicine)
	Chapter 26, entries 480–507

Appendix B

Is the categorical organization of *Brush Talks* part of Shen Gua’s original plan or a later development? Is the *jiyi* category part of a deliberate design or a clumsy mistake made by later editors? In this, Table 1 has assembled some circumstantial evidences to address these questions. Although no direct evidence proves that Shen himself assigned the categories, they arise quite organically from the entries, and the weight of indirect evidence from other sources supports my hypothesis that these

entries were thematically organized by Shen. I am persuaded, in particular, that the categorization and arrangement of *jiyi* is Shen Gua's work.

Not all scholars have shared my view. One problem is the late date of the earliest surviving edition of *Brush Talks*. The book was completed during the 1080s to 1090s.²⁴ According to the informed guesswork of modern scholars, *Brush Talks* must have circulated as a printed text (or, less likely, as a manuscript) before Shen Gua's death in 1095. We know almost nothing about the book during the interval between the publication or circulation of the original copy and the 1166 edition. A handful of scholars (Zhang Wenhui, for instance) have therefore questioned the credibility of the book's current organization as a reflection of Shen's original thoughts (Zhang 1973: 2:31a–32b). They wonder whether the original edition was organized into chapters (and categories) at all. Might not categorization have been a later development?²⁵

As we look for clues, *Supplement to Brush Talks* (as I mentioned in footnote 10) provides useful information. Shen Gua did not complete *Brush Talks* in haste; after all, he took the time to draw up the *Supplement*. It is hard to assume that he would have done so with hundreds of entries in a chaotic, incomprehensible mess. Also, in the *Supplement* he directed that the new entries be inserted in certain parts of certain chapters—only a well-organized text made this possible.

Secondly, even though the earliest editions no longer exist, passages from them are preserved in the form of quotations in other texts. My strategy is to seek the earliest circumstantial evidence possible from these texts and narrow the gap between the original and the 1166 edition. I assume that if we find evidence of an organizational scheme that looks like that of the 1166 text in passages transcribed a relatively short time (a few decades at the longest) after Shen's death, we should rule out a later editorial intervention.

For instance, *Brush Talks* was extensively cited in *A Collection of Categorized Things from the Song Dynasty* (*Song chao shishi lei yuan* 宋朝事實類苑), a *leishu* compiled between 1132 and 1145 by Jiang Shaoyu (dates unknown). Jiang must have had access to an edition at least a few decades earlier than that of 1166. The procedure used in collating *leishu* tended to preserve the original form of the texts. As Fu Daiwie has also observed (Fu 1993–94: 35), the entries from *Brush Talks* cited in *Categorized Things* are not only preserved intact in terms of their content, but when multiple entries were cited, they are found in the same order as in the 1166 edition. We may therefore assume that at least one early edition of *Brush Talks* structurally resembled the current version.

More circumstantial information from *Categorized Things* helps us to confirm the arrangement of the *jiyi* section. Of the 20 entries in the *jiyi* section, 19 are included in *Categorized Things*. While entry 316 is not cited at all and 317 appears in Chapter 51, the rest are split into two clusters—eight jottings in one and ten in the other—and may be found, respectively, in Chapter 49 and Chapter 52. At this point, although it is hard to tell whether the two clusters belong together in the version of *Brush Talks* Jiang used, we do know that the vast majority of the *jiyi* entries we see today belonged to at most two groups in an early version.

²⁴ While most scholars of *Brush Talks* endorse Hu Daojing's judgment that Shen Gua composed the text (in 26 chapters) between 1088 and 1093, Li Yumin (1999b) proposed an alternative possibility, that Shen completed the 26-chapter version between 1082 and 1088, then a 30-chapter edition in the early 1090s.

²⁵ Daiwie Fu also responded to Zhang's criticisms in the appendix to Fu 1993–1994: 34–35.

To press this point a bit further, Chapter 49 of *Categorized Things* is labeled “Prognostications and Medicine” (*zhanxiang yiyao* 占相醫藥) and Chapter 52 is labeled “Calligraphy, Painting, and Skills” (*shuhua jiyi* 書畫技藝). This arrangement was the work of Jiang Shaoyu, the compiler. Does this mean that the two clusters were originally separated in *Brush Talks*? I doubt it. Entry 310, on the subject of chess strategy, is absurdly placed in “Prognostications and Medicine,” whereas entry 304, which is also related to chess, was placed in “Calligraphy, Painting, and Skills.” Such discrepancies show that the division into two clusters was awkward. It is likely, all things considered, that they always belonged to a single, rather broad section, and that Jiang divided the group himself in order to suit his own taxonomic categories. This implies that the edition used by Jiang, which we have assigned to the 1130s, corresponded more or less to the current version.

References

- Barbieri-Low, A. J. (2007). *Artisans in early imperial China*. Seattle: University of Washington Press.
- Bazerman, C. (1988). *Shaping written knowledge: The genre and activity of the experimental article in science*. Madison: University of Wisconsin Press.
- Bol, P. K. (1995). A literati miscellany and Sung intellectual history: The case of Chang Lei's *Ming-tao tsa-chih*. *Journal of Sung-Yuan Studies*, 25, 121–152.
- Dai, K. 戴克瑜 & Tang, J. 唐建華 (Eds.). (1981). *Leishu de yange* 類書的沿革 (*The evolution of collectanea of categorized knowledge*). Chengdu: Sichuan sheng tushuguan xuehui.
- Du, F. 杜甫. (1967). *Fen men jizhu Du Gongbu shi* 分門集注杜工部詩 (The collected poetry of Du Gongbu [i.e., Du Fu], with annotations). In: Z. Wang 王洙 & Z. Cigong 趙次公 (eds.), *Sibu congkan* 四部叢刊 (*Collectanea in Four Divisions*), first series. Taipei: Taiwan shangwu yinshuguan.
- Egan, R. (2006). *The problem of beauty: Aesthetic thought and pursuits in Northern Song dynasty China*. Cambridge: Harvard University Asia Center.
- Franke, H. (1961). Some aspects of Chinese private historiography in the thirteenth and fourteenth centuries. In W. G. Beasley & E. G. Pulleyblank (Eds.), *Historians of China and Japan* (pp. 115–134). London: Oxford University Press.
- Fu, D. (1993–94). A contextual and taxonomic study of the “divine marvels” and “strange occurrences” in the *Mengxi bitan*. *Chinese Science*, 11, 3–35.
- Fu, D. (2002). When Shen Gua encountered the “natural world”: A preliminary discussion on *Mengxi bitan* and the concept of nature. Manuscript.
- Fu, D. (2007). The flourishing of *biji* or pen-notes texts and its relations to history of knowledge in Song China (960–1279). *Extrême-Orient Extrême-Occident*, 27, 103–130.
- Guo, B. (1967). *Song si da shu kao* 宋四大書考 (The four great treatises in the Song). Taipei: Taiwan shangwu yinshuguan.
- Haeger, J. W. (1968). The significance of confusion: The origins of the *T'ai-p'ing yü-lan*. *Journal of the American Oriental Society*, 3, 401–410.
- Hu, D. 胡道靜. (1956a). Yinyan 引言 (Preface). In: D. Hu 胡道靜 (Ed.), *Mengxi bitan jiaozheng* 夢溪筆談校證 (*Annotated Brush talks from Dream Brook*). Shanghai: Shanghai chuban gongsi.
- Hu, D. (1956b). Shen Gua zhushu kaolue 沈括著述考略 (A brief study of Shen Gua's works). In: D. Hu 胡道靜 (Ed.), *Mengxi bitan jiaozheng* 夢溪筆談校證 (*Annotated Brush talks from Dream Brook*). Shanghai: Shanghai chuban gongsi. Vol.2: 1151–56.
- Hu, D. (1963). Jiaodian shuoming 校點說明 (Introduction). In: D. Hu 胡道靜 (Ed.), *Xin jiaozheng Mengxi bitan* 新校正夢溪筆談 (*Brush talks from Dream Brook, newly commented*). Beijing: Zhonghua shuju. 3–12.
- Inglis, A. D. (2006). *Hong Mai's record of the listener and its song dynasty context*. Albany: State University of New York Press.
- Jiang, S. 江少虞. (1981). *Song chao shishi lei yuan* 宋朝事實類苑 (*Collection of categorized things from the Song dynasty*). Shanghai: Shanghai guji chubanshe.

- Kurz, L. J. (2001). The politics of collecting knowledge: Song Taizong's compilations project. *T'oung Pao*, 87, 289–316.
- Latour, B. (1987). *Science in action*. Cambridge: Harvard University Press.
- Lei, H. 雷祥麟 & Fu Daiwie 傅大為. (1993). “Mengxi bitan” li de yuyan yu xiangsixin 夢溪筆談裡的語言與相似性 (The language and similarities in *Brush Talks from Dream Brook*). *Qinghua xuebao* 清華學報 (*Qinghua journal*), 23, 31–60.
- Li, F. 李昉 et al. (Eds.). (1961). *Taiping guangji* 太平廣記 (*Comprehensive records compiled in the Taiping xingguo era*). Beijing: Zhonghua shuju.
- Li, F. 李昉 et al. (1968). *Taiping yulan* 太平御覽 (*The imperial collectanea of the Taiping xingguo era*). Taipei: Taiwan shangwu yinshuguan.
- Li, Y. 李裕民. (1999a). Shen Gua de qinshu, jiaoyou ji yizhu 沈括的親屬, 交游及佚著 (Shen Gua's family, friends, and lost works). In: *Songshi xintan* 宋史新探 (*New perspectives in historical studies of the Song*). Xi'an: Shaanxi shifan daxue chubanshe. 274–89.
- Li, Y. (1999b). *Mengxi bitan* yu Shen Gua *Liangfang yanjiu* 夢溪筆談與沈括良方研究 (A study of *Brush Talks from Dream Brook* and Shen Gua's *Efficacious Prescriptions*). In *Songshi xintan* 宋史新探 (*New perspectives in historical studies of the Song*). Xi'an: Shaanxi shifan daxue chubanshe. 290–310.
- Ma, Y. W., & Lau, J. S. M. (Eds.). (1986). *Traditional Chinese stories: Themes and variations*. Boston: Zheng and Zui.
- Myers, G. (1990). *Writing biology: Texts in the social construction of scientific knowledge*. Madison: University of Wisconsin Press.
- Needham, J. (1985). *Science and civilisation in China, vol. 5.1: Chemistry and chemical technology: Pand printing*. Cambridge: Cambridge University Press.
- Polanyi, M. (1962). *Personal knowledge*. Chicago: University of Chicago Press.
- Shen, G. 沈括 (1896a). Da Cui Qun shu 答崔肇書 (In Response to Cui Qun). In: *Changxing ji* 長興集 (*Collection of long-lasting prosperity*), Wu Yunjia 吳允嘉 (Eds.), *Shen shi san xiansheng wenji* 沈氏三先生文集 (*Collected works of the three masters of the Shen clan*). Hangzhou: Zhejiang shuju. 19: 2b–3b.
- Shen, G. (1896b). Shang Ouyang canzheng shu 上歐陽參政書 (A Letter to Vice Grand Councilor Ouyang [Xiu]). In: *Changxing ji* 長興集 (*Collection of long-lasting prosperity*), Wu Yunjia 吳允嘉 (ed.), *Shen shi san xiansheng wenji* 沈氏三先生文集 (*Collected works of the three masters of the Shen clan*). Hangzhou: Zhejiang shuju. 19: 6a–7a.
- Shen, G. (1896c). Da tongren shu 答同人書 (In Response to a Fellow Literatus). In: *Changxing ji* 長興集 (*Collection of long-lasting prosperity*), Wu Yunjia 吳允嘉 (Eds.), *Shen shi san xiansheng wenji* 沈氏三先生文集 (*Collected works of the three masters of the Shen clan*). Hangzhou: Zhejiang shuju. 20: 6a–6b.
- Shen, G. (1896d). Hangzhou xin zuo zhouxue ji 杭州新作州學 (Congratulatory Address at the Inauguration of a New State School in Hangzhou). In: *Changxing ji* 長興集 (*Collection of long-lasting prosperity*), Wu Yunjia 吳允嘉 (ed.), *Shen shi san xiansheng wenji* 沈氏三先生文集 (*Collected works of the three masters of the Shen clan*). Hangzhou: Zhejiang shuju. 24: 2b–7b.
- Shen, G. (1963). *Xin jiaozheng Mengxi bitan* 新校正夢溪筆談 (*Brush talks from Dream Brook, newly commented*). Hu Daojing 胡道靜 (ed.). Beijing: Zhonghua shuju.
- Shen, G. (1975). *Yuan kan Mengxi bitan* 元刊夢溪筆談 (*Brush talks from Dream Brook* (Yuanth ed.)). Beijing: Wenwu chubanshe.
- Sivin, N. (1995). Shen Kua. In *Science in ancient China* (Ed.), *Researches and reflections* (pp. 1–55). Aldershot: Variorum.
- Su, S. 蘇軾. (2004). *Su Shi wenji* 蘇軾文集 (*The collected works of Su Shi*). 7 vols. Beijing: Zhonghua shuju.
- Umehara, K. 梅原郁 (Ed.). (1979). *Mukei hitsudan* 夢溪筆談 (*Brush talks from Dream Brook*), vol. 2. Tōyō bunko 362. Tokyo: Heibonsha.
- Yu, C. 于翠玲. (2002). Lun guanxiu leishu de bianji chuantong ji qi zhongjie 論官修類書的編輯傳統及其終結 (The textual tradition of state-commissioned collectanea of categorized knowledge and its termination). *Beijing shifan daxue xuebao* 北京師範大學學報 (*Journal of Beijing Normal University*), 6, 118–25.
- Zhang, J. 張家駒. (1962). *Shen Gua* 沈括. Shanghai: Shanghai renmin chubanshe.
- Zhang, W. 張巍. (2008). Lun Tang Song shiqi de leibian shiwen ji qi yu leishu de guanxi 論唐宋時期的類編詩文集及其與類書的關係 (Categorically arranged anthologies and collectanea of categorized knowledge in the Tang and Song dynasties). *Wenxue yichan* 文學遺產 (*Literary Remains*), 3, 56–62.

- Zhang, W. 張文虎. (1973). Shu "Mengxi bitan" hou yi 書夢溪筆談後 (First note after reading *Brush Talks*). In: *Shuyi shi zazhu* 舒藝室雜著 (*Miscellaneous works from the Shuyi Study*), vol. 1 (2: 29a–31b). Taipei: Wenhai chubanshe.
- Zhang, Y. 張蔭麟. (1936). Shen Gua biannian shi ji 沈括編年事輯 (A chronological biography of Shen Gua). *Ch'ing-hua hsueh-pao* 清華學報 (*Qinghua Journal*), 11, 323–58.
- Zhang, H. 祖慧. (2003). Shen Gua yu Wang Anshi guanxi yanjiu 沈括與王安石關係研究 (Shen Gua's association with Wang Anshi). *Xueshu yuekan* 學術月刊 (*Scholarship Monthly*), 10, 52–59.
- Hui, Z. (2004). *Shen Gua pingzhuan* 沈括評傳 (A critical biography of Shen Gua). Nanjing: Nanjing daxue chubanshe.