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Confucian Scholars and Specialized Scientific and Technical Knowledge in Traditional China, 1000–1700: A Preliminary Overview

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Abstract In this essay, I will provide a preliminary overview of the relation between the Confucian scholars and the specialized scientific and technical knowledge in traditional China. I will begin by analyzing various elements in the historical background of traditional China that had various different effects on the scholars' attitudes to the specialized knowledge—classical Confucian ideas and phrases, practical reasons, etc. I will then look at the actual examples showing the varying relations between the Confucian scholars and the specialized knowledge. I will end with a comparative look at the situation in the West, where there were developments both for separation and for convergence between general scholars and specialized scientific and technical knowledge. I will show that the relation, on the whole, was ambivalent in traditional China. Although there was some kind of separation of scholars from the specialized scientific and technical knowledge, the separation was not clear cut, and there was no solid ground for such separation; at times, there were convergences between the two. There was a wide spectrum of attitude among the Confucian scholars toward the specialized knowledge, varying according to different individuals, different periods, and different subjects.

Keywords Specialized subjects · Specialized knowledge · Specialists · Scholars · Confucian scholars · Intellectual interest · Practical utility

In modern society, we are faced with a clear, often severe separation of the specialized scientific and technical knowledge from the interest and understanding of general intellectuals.[1] This separation is so clearly and widely found today that people tend to assume this as the natural state that had existed all along. Yet, it was a

[1]C. P. Snow, for example, characterized this separation as a "two-culture" problem in his famous book (Snow 1959).

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rather recent phenomenon, a result of the specialization of science in the last few centuries. And, it was a uniquely Western phenomenon; it was not an event bound to happen in every culture in the course of its historical development. For example, such development did not take place in China—at least not to the degree it did in the West. In traditional China, and in the West before this process of separation took place, there was no reason for general intellectuals—scholars, writers, or "thinkers"—to exclude science, or knowledge about the natural world, from the range of their interest.[2] In this essay, I will examine the situation of the specialized knowledge, and the scholars' attitudes to it, in traditional China.

What I can do in the essay, however, will be only a sketch. This is unavoidable because the situation surrounding scholars and specialized knowledge in traditional China was very complex. In fact, all the words constituting the topic—"scholars," "specialized knowledge," and "traditional China"—are very complex. None of them represents a single homogeneous group, knowledge, or period. The expression, specialized knowledge, to begin with, refers to various different subjects which do not form a single whole. Subjects like calendrical astronomy (*li* 曆), harmonics (*lü* 律), mathematics (*suan* 算), and medicine (*yi* 醫) were often mentioned with other technical subjects like techniques (*gong* 工), agriculture (*nong* 農), and horticulture (*pu* 圃). Such a list routinely included subjects that cannot be called "scientific" today: divination (*zhanbu* 占卜), alchemy (*liandan* 煉丹), and geomancy (*fengshui* 風水), and such non-scientific subjects as criminal justice (行刑), financial administration (*caizheng* 財政), military strategy (*bingfa* 兵法), and taxation (*shuiwu* 稅務).[3] When we speak of the "specialists," the situation is even more complex, as we are faced with all sorts of people possessing various kinds of specialized knowledge and engaged in the activities involving such knowledge: artisans, craftsmen and peasants, functionary bureaucrats, various medical practitioners, and even scholars with specialized interest and knowledge in the above subjects. The term scholars also covers various kinds of people: Some were genuine scholars devoted to study and learning; some were career bureaucrats; some were landowners; some were engaged in mercantile, industrial, and other practical activities; some were teachers; and some were recluses. And, many of them were more than one of these at the same time. These scholars had vastly different predilections and inclinations and naturally had different attitudes to different subjects. Finally, the expression traditional China also covers a long time span over which great differences existed in the situation we examine.

To reduce the complexity of such a situation, I confine my attention in this essay to specialized scientific and technical subjects, to scholars devoted to Confucian doctrines and learning, and to the period after about 1000 when the distinct intellectual pattern of such "Confucian scholars" took shape. Yet, this does not solve the problem as there were various elements in the historical background of traditional China that had different effects on the scholars' attitudes to specialized knowledge. I will begin the essay by analyzing such elements: the classical ideas and phrases that were influential in forming scholars' attitudes to specialized subjects, practical reasons that scholars could not stay aloof from them. Then I will look at the

[2] There existed a separation in the Islamic world also, but that was between the Arabic, religious sciences, and the ancient, philosophical sciences. See Sabra (1996) and Berggren (1996, pp. 270–271).
[3] On the situation of such specialized subjects in traditional China, see, e.g., Kim (2000, Sec. 12.1).

actual examples showing the varying relations between scholars and specialized subjects and try to provide an overview of the relation between the Confucian scholars and the specialized scientific and technical knowledge in China between roughly 1000 and 1700. I will end with a comparative look at the situation in the West, where there were developments both for separation and for convergence between general scholars and specialized scientific and technical knowledge.

On the whole, I will try to provide a global picture with a minimum of detail. My sketchy discussion in this essay cannot properly depict the complex, multifarious situation of the scholars and specialized knowledge in traditional China as I will be forced to simplify—frequently oversimplify—the details that are extremely rich and very complicated, varying greatly from scholar to scholar, from subject to subject, and from period to period. I believe, however, that in spite of such inevitable deficiency, there is some value in trying out this sort of an overall picture.

1 Classical Sanctions to Become Generalists

There was a general tendency of Confucian scholars in traditional China to become generalists, which in turn had the effect of discouraging scholars' interest in specialized scientific and technical subjects. Some key ideas in the Confucian classics played important roles in this.

1.1 Dichotomy of "Above Physical Form" and "Below Physical Form"

First, there was the dichotomy of what is "above physical form" (*xing er shang* 形而上) vs. what is "below physical form" (*xing er xia* 形而下). This dichotomy can be traced back to the famous passage in a key Confucian classic, the *Book of Changes* (*Yijing* 易經): "What is 'above physical form' is called '*dao*' 道 (Way); what is 'below physical form' is called 'tools' (*qi* 器)." (*Xing er shang zhe wei zhi dao; xing er xia zhe wei zhi qi* 形而上者謂之道, 形而下者謂之器: "Xicizhuan" 繫辭傳, A12) There were other similar dichotomies of *li* 理 (principle, pattern, etc.) vs. *qi* 氣, *li* vs. "numbers" (*shu* 數), *li* vs. "tools" (*qi* 器), and so on.[4] These dichotomies inevitably influenced the Confucian scholars' attitudes toward natural phenomena and scientific knowledge.

According to such a dichotomy, *dao*, *li*, human nature (*xing* 性), mind (*xin* 心), and humaneness (*ren* 仁) (abstract and sublime concepts without manifest "physical forms" (*xing* 形)) belong to what is above physical form, whereas concrete things with tangible physical forms—mundane, particular, practical matters—belong to what is below physical form. It was commonly thought that what has physical form and is visible is easy to understand, whereas what is without physical form is difficult. Naturally, what is difficult to understand was thought to be important and thus worthy of further consideration, whereas what is easy to understand was

[4] On these various terms, see Ho (1985, chap. 1) and Kim (2000, chaps. 2–5). In Mencius (Mengzi 孟子), there even was an assertion that could be seen as a dichotomy of those who work with mind vs. those who work with hands: "Some work with mind; some work with [physical] force. Those who work with mind rule other people; those who work with force are ruled by other people." (3A4: "或勞心, 或勞力. 勞心者治人, 勞力者治於人")

considered obvious and even trivial. Such an attitude can be seen in the following remark of Zhu Xi 朱熹 (1130–1200), who, as the author of the so-called Neo-Confucian synthesis, exerted an overwhelming influence on the Chinese and East Asian intellectual world for many centuries:

> Things are easy to see; mind has no physical form or measure. The weight and length of things are easy to measure; the weight and length of the mind are difficult to measure. When a thing is in error, only [that] one thing is in error. When the mind is in error, myriad things are in error.[5]

Since most common natural phenomena are accompanied by tangible qualities and physical effects and thus belong to what is below physical form, it is understandable that they were thought to be obvious and were simply accepted in the way they were perceived; no further investigation was attempted beyond the surface of the phenomenal realities of empirical data. Thus, Confucian scholars were easily led to think lightly of natural phenomena and scientific knowledge about them. There even appeared a notion of a hierarchy between metaphysical and moral philosophies that are above physical form on the one hand and scientific knowledge and techniques that are below physical form on the other, which in turn gave rise to a hierarchical character to the distinction between generalist scholars and the specialists seeking knowledge of what were below physical form.[6] This hierarchical sentiment was instituted into the bureaucratic structure: generalist scholar–officials above the specialist functionaries, the former supervising the work of the latter.[7] At least, the dichotomies had the effect of justifying the separation of the subjects that are above physical form and those below physical form.[8]

1.2 Gentlemen Are Not Mere Tools

A phrase from the Analects (*Lunyu* 論語), another influential Confucian classic —"Gentlemen are not [mere] 'tools'" (*Junzi buqi* 君子不器, 2.12)—was combined with the above dichotomy, or hierarchy, of *dao* vs. tools, and formed the basis of Confucian scholars' attitudes toward the specialized subjects. The phrase, attributed to Confucius himself, was interpreted as meaning that to become a true "gentleman" (*junzi* 君子) one should pursue such high ideals like *dao*, *li*, and human nature (*xing*) and should not concern oneself with mere tools—concrete, practical, technical problems, and knowledge. In other words, a gentleman should not be confined to a narrow scope, performing instrumental functions as mere tools, but rather should aim at a broad learning and cultivation. This naturally led to the Confucian scholars'

[5] Zhuzi yulei 朱子語類, 51.5a. Earlier in the same passage, Zhu Xi expressed the same idea differently: "The error in things has no harm; the error in the mind has harm."

[6] Although the existence of the "literati physicians" (*ruyi* 儒醫) does show the acceptability of medicine as a subject for Confucian scholars, it was nevertheless unmistakable that their status was lower than that of the general Confucian scholars. See Zhu (2006).

[7] Thatcher Deane has even noted a conscious government policy of the Han 漢 period (206 BC–AD 220) to lessen the status of calendrical specialists vis-à-vis the generalist officials. See Deane (1989, p. 68).

[8] In editing the *Tianxue chuhan* 天學初函, the influential late Ming compilation of books on Western learning, Li Zhizao 李之藻 (1565–1630) divided them into two parts—the part on the *li* (*li bian* 理編) and the part on the "tools" (*qi bian* 器編), although in this case the distinction was between Western religion and scientific knowledge.

general neglect and even contempt for what they considered "mere tools", which included specialized scientific and technical subjects.

1.3 The "Small *dao*"

Another *Analects* passage (19.4) exerted a considerable influence on Confucian scholars' attitudes toward specialized subjects: "Even the 'small *dao*' (*xiaodao* 小道) must have what are worth 'looking at' (*guan* 觀). But if pursued too far, one may be bogged down. For this reason gentlemen do not 'do' (*wei* 爲) them." ("雖小道，必有可觀者焉. 致遠恐泥，是以君子不爲也.") By calling certain subjects as "small *dao*" and declaring that "gentlemen do not 'do' them," the phrase had the effect of discouraging Confucian scholars from engaging in the activities that can be considered small *dao*, which usually included specialized scientific and technical subjects.

2 Elements Conducive to Scholars' Interest in Specialized Subjects

While the ideas and passages discussed in the last section had the effect of discouraging scholars' interest in specialized scientific and technical knowledge, there were some elements in traditional Chinese history that facilitated scholars' interest in specialized subjects.

2.1 Ambivalence of the Classical Sanctions

To begin with, the actual situation surrounding the influence of those Confucian ideas and classical passages on the scholars' attitudes was not so simple. For example, alongside the tendency of separating *dao* and the tools and valuing *dao* over the tools, there continued to exist a tendency to take the two to be inseparable ("*daoqi buli*" 道器不離) and to consider them both important. Those who were inclined to this tendency maintained that *dao* exists in the tools, and that without the tools *dao* cannot exist. And, the same tendency existed concerning the other pairs like the *li* and *qi* 氣, *li* and numbers, and *li* and tools, as well—that the *li* cannot exist apart from the *qi*, apart from the numbers, or apart from the tools. Thus, to many Confucian scholars, not only the *dao* and what are above physical form but also the tools and what are below physical form, including the specialized scientific and technical subjects, were important and worth pursuing. Indeed, the unity of *li* and numbers, which was present in the Neo-Confucian thought ever since Shao Yong (邵雍, 1011–1077) and Zhu Xi, provided a powerful rationale for the inclusion of mathematics and calendrical astronomy into the Confucian learning. For, in this view, the study of the numbers (*shu*) could become the search of the *li* 理, the object of the Confucian learning.

The effect of the slogan that "gentlemen are not [mere] tools" was not so simple or one-sided, either. While it emphasized that gentleman should aim at a broad learning and cultivation, such broad learning and cultivation included the study of the natural world and the knowledge—if not the actual practices—of the techniques as well. Knowledge and speculation about the natural world, and about phenomena

and objects in it—"heaven-and-earth" (*tiandi* 天地), the "myriad things" (*wanwu* 萬物), and man (*ren* 人)—were not something to be avoided as mere tools, but rather were a legitimate part of gentleman's study and cultivation. What the slogan did was to warn the Confucian scholars against becoming a mere specialist confined to a narrow subject—be it scientific, technical, or other specialized subject. It did not exclude scientific and technical subjects from their broad interest and learning.

When it comes to the small *dao*, the ambivalent attitude is more explicit. The original *Analects* passage expressed both a positive attitude, namely that they "must have what are worth 'looking at,'" as well as a negative one, that "gentlemen do not 'do' them." Indeed, the ambivalence exists in the word small *dao* itself. For, while the character "xiao" indicates that it is minor, secondary, or less important, it is still called a "*dao*" and thus had a potential for inclusion in the Confucian learning. This ambivalence—seeing them not as something to "do", but still as something worth "looking at"—gave rise to many different opinions and debates among Confucian scholars concerning the proper status of the specialized subjects. For example, although Zhu Xi emphasized that one should study those specialized branches that he referred to as small *dao*, what he actually said clearly implied that they were not quite the real *dao*:

> The small *dao* are not heterodox; they are also "*dao*." It is simply that they are small. [Subjects] like agriculture, horticulture, medicine, divination and "the hundred techniques" also have *dao* and *li* in them. If one seeks *dao* and *li* only in the upward direction, they will not be comprehended. (*Zhuzi yulei* 49.2a.)

Also, there were different opinions among scholars as to which subjects belonged to the small *dao*. Calendrical astronomy in general was not included in the small *dao*, but it was considered by some to be one of them.[9] Medicine, agriculture, and techniques, on the other hand, were usually included in the list (Kim 2000: 246, 276).

2.2 Key Philosophical Concepts

Many of the specialized subjects were associated with important concepts of Confucian philosophy and thus were important for Confucian scholars of traditional China. Importance of the concept of "heaven" (*tian* 天), for example, made calendrical astronomy, the subject that deals with the physical heaven, important for Confucian scholars. Geography and geomancy, on the other hand, were connected with the other half of the term "heaven and earth" and were thus important. Importance of music as part of Confucian rituals made the related subject of harmonics also important. Similarly, importance of the *Book of Changes* and the ideas and diagrams in the classic could be translated into importance of the subject of "images and numbers" (*xiangshu* 象數), and divination and alchemy which used them. Alchemy, especially in the form of "the inner alchemy" (*neidan* 內丹), was related to the concept of *dao* because it was among the techniques practiced by those who seek the *dao*, the so-called masters of *dao* (*daoshi* 道士). Confucian scholars must have felt that the study of these subjects would help them understand the

[9] It was noted by an eighteenth century Korean thinker Hong Tae-yong 洪大容 (1731–1783): *Tamhŏnsŏ* 湛軒書, naejip 內集, 3.22b.

above-mentioned ideas and concepts. And indeed, they were interested in such subjects as calendrical astronomy, harmonics, geography, alchemy, divination, etc., which became important parts of their intellectual concern.

2.3 The Commentary Tradition and Standard Texts

Knowledge of various specialized subjects was present in the standard texts widely studied by the Confucian scholars. In particular, the scholars frequently commented upon natural objects and phenomena referred to in the ancient classics supposedly written by—or at least containing the intentions of—the sages. Sometimes, they made use of the specialized knowledge in their comments on such passages. The most salient examples are the two passages in the *Book of Documents* (*Shujing* 書經). One is from the "Shundian" 舜典 (Cannon of Shun) chapter: "Set in order the 'Seven Governors' (*qizheng* 七政: the sun, the moon, and the five planets) by the *xuanji yuheng* 璿璣玉衡." (*xuanji yuheng yi qi qizheng* 璿璣玉衡以齊七政). The other is from the "Yaodian" 堯典 (Cannon of Yao) chapter: "One year [has] 366 days" (*Ji sanbai you liuxun you liuri* 朞三百有六旬有六日). Many Confucian scholars presented detailed discussions of astronomical instruments and methods of placing intercalary months (*zhirunfa* 置閏法) in their comments on these two passages. The expression, "*xuanji yuheng*," usually interpreted as astronomical instruments, became such a common part of Confucian scholars' vocabulary that in the *Boxue hongru* 博學鴻儒 (Broad Learning and Great Scholars) examination during the Kangxi 康熙 (r. 1661–1722) period, the examinees were asked to write a rhapsody (*fu* 賦) on it (Chu 1994: 150–157) Commentaries on the "Yueling" 月令 (Monthly Ordinances) and the "Yueji" 樂記 (Record of Music) chapters of the *Record of Rites* (*Liji* 禮記) also contained discussions of specialized knowledge in the calendrical astronomy and harmonics. Important examples of passages from other classics that provided occasions for discussing specialized knowledge were as follows: the poetry titled "the Crossing of the Tenth Month" (*shiyue zhi jiao* 十月之交) in the *Book of Poetry* (*Shijing* 詩經); the phrase, "Multitude of stars pay homage to it [i.e., the pole star]" (*zhongxing kong zhi* 衆星共之), in the *Analects* (2.1); and the *Mencius* passage (4B26) about "the heaven's being high and the stars being far" (*Tian zhi gaoye*; *Xingchen zhi yuanye*. 天之高也. 星辰之遠也). Confucian scholars also discussed animals and plants whose names appear in the classics, the *Book of Poetry* in particular. There even emerged as a legitimate branch of classical scholarship a tradition of identifying and describing the plants and animals whose names appear in the *Book of Poetry*. (Needham et al. 1986: 463 ff.)

Standard commentaries of the above-mentioned classics frequently contained quite detailed discussions of specialized scientific knowledge, which became standard sources for such knowledge. Wang Yinglin's 王應麟 (1223–1296) compilation of astronomical passages from the classics and commentaries to them, titled *Liujing tianwen bian* 六經天文編 (Astronomical Compilations from the Six Classics), is a good example. In his introduction to the *Liujing tianwen bian* for the Siku quanshu zongmu tiyao 四庫全書總目提要 (Complete Books of the Four Treasuries, Annotated Catalogues), Dai Zhen 戴震 (1724–1777) said that the key topics of calendrical astronomy can be found in the Six Classics (*Liujing* 六經) (*Siku*

quanshu zongmu tiyao: 892). Scholars also frequently discussed knowledge about various techniques in connection with the "Kaogongji" 考工記 (Record of the Investigation of Techniques) chapter of the *Rites of Zhou* (*Zhouli* 周禮).[10]

There were other standard texts that contained discussions of specialized knowledge. The official dynastic histories (*zhengshi* 正史), for example, almost always included treatises on astronomy, calendars, harmonics, geography, as well as on rituals and music. These treatises contained a good deal of specialized knowledge in the related subjects and thus were the standard sources of such knowledge. There were also treatises written by scholars themselves discussing various topics of specialized subjects. The most famous examples were the *Tongdian* 通典 (Comprehensive Cannon) of Du You 杜佑 (735–812) and the Mengxi bitan 夢溪筆談 (Brush Talks of Dream Brook) of Shen Gua 沈括 (1031–1095), which contained knowledge of a wide range of topics in various specialized subjects. Numerous later Confucian scholars studied and cited these treatises.

Confucian scholars routinely studied the relevant portions of the above-mentioned commentaries and treatises, and their understanding at times reached a considerable level. Zhu Xi, for example, felt confident that he could make his own judgment as to which of the commentaries and the treatises were best for a particular subject or problem (Kim 2000: 251–252, 263). For example, he praised the subcommentary (*shu* 疏) of the "Yueling" chapter for its clear statement that heaven makes one full rotation plus one degree a day and the subcommentary on the "Shundian" chapter for its account of the structure of the heavens in general. He also mentioned the subcommentary on the "Yaodian" chapter in connection with the problem of the intercalary month (*runyue* 閏月). Another old source he valued highly was the astronomical treatise of the *Jin History* (*Jinshu* 晉書). Zhu Xi also spoke of weak points of some of the sources. For example, he criticized that "the calendrical treatise of the Former Han [i.e., *Hanshu* 漢書] is not as good as that of the *Later Han History* (*Hou Hanshu* 後漢書)." Concerning the knowledge of harmonics and music, he frequently praised the "*Lüshu*" 律數 (Pitchpipe Numbers) chapter (ch. 25) of the *Record of the Historian* (*Shiji* 史記), which, in his view, covered all the essential points.[11]

2.4 *Gewu*

The idea of *gewu* 格物 (investigation of things), the basis of the Confucian intellectual and moral endeavor from the Song 宋 (960–1279) times on, also provided an important motivation for scholars to study specialized subjects. Since the Confucian scholars took the term *gewu* to mean investigating "the *li* 理 of things" (*wu zhi li* 物之理) and since every "thing" (*wu* 物) in the world has its *li* which is a manifestation of the single universal *li*, i.e., the *li* of heaven (*tianli* 天理), every thing

[10] For example, Wang Anshi 王安石 (1021–1086) and Lin Xiyi 林希逸 (*jinshi* 1235) wrote a treatise titled "Kaogongji jie" 考工記解, and Dai Zhen wrote the *Kaogongji tu* 考工記圖.

[11] Indeed, Zhu Xi must have felt that this was what he had to do, for, having asserted the importance of the specialized subjects and the necessity to study them, he had to decide which texts were the best or correct ones to be studied, just as he did for the moral and social philosophies. On this aspect of Zhu Xi's "program of learning" in general, see, e.g., de Bary (1989) and Gardner (1990, p. 35 ff).

was worth investigating for them.[12] Zhu Xi, for example, said repeatedly that every thing or event in the world has its *li* and should be studied and understood (*Zhuzi yulei*: 15.4b, 18.22b, 34.33b, 116.13b, 117.12b).

Other expressions from the classics were interpreted in this spirit of *gewu*. For one, the expression, "broad study" (*boxue* 博學), again from the *Analects*,[13] became the goal pursued by many Confucian scholars. Zhu Xi, for example, used the emphasis on broad study in supporting his insistence upon studying and understanding everything.

> The way of the *Great Learning* (*Daxue* 大學) must begin with "investigation of things and extension of knowledge" (*gewu zhizhi* 格物致知) and then [move] to the *li* 理 of all under heaven. Of the books under heaven, there is none not to be "broadly studied" (*boxue*). (Huian xiansheng Zhuwengong wenji: 60.16b)

Another phrase from the *Analects* (14.37) had a similar influence: "study down below and attain up above" (*xiaxue shangda* 下學上達), meaning that one should start with concrete things that are clearly manifest and easy to understand.

This aspect of *gewu*, emphasizing the study of the concrete things, persisted in the period after Zhu Xi, although there came up occasional reactions, of the Wang Yangming 王陽明 (1472–1529) type for example. Scholars like Yang Shen 楊愼 (1488–1559), Li Shizhen 李時珍 (1518–1593), and Song Yingxing 宋應星 (1587–1666), who authored important books containing an extremely broad range of specialized scientific and technical knowledge, all resorted to the *gewu* doctrine in presenting various specialized knowledge in their books and emphasizing the importance of the study of such knowledge (Peterson 1998: 783–786). Indeed, many seventeenth century Confucian scholars used the *gewu* doctrine as a rationale for accepting Western scientific knowledge into the Confucian learning.[14]

2.5 Practical Utility

In addition to these conceptual, textual, or ideological factors we have dwelled upon so far, the practical utility of the specialized subjects also played a role in fostering scholars' interest in them.

Confucian scholars could not stay aloof from specialized subjects, because as potential officials ("scholar–officials"), they had to deal with—at least manage and supervise—many tasks involving scientific and technical problems: calendars, agriculture, military, survey, building, water control, medicine, etc. Thus, specialized subjects like calendrical astronomy, mathematics, agriculture, and medicine frequently commanded scholars' interest. Scholar–officials often produced hand-

[12] To be sure, they glossed the word "*wu*" as "events" (*shi* 事), and their discussions of *gewu* were weighted heavily toward moral and social concerns. But "the things"—concrete objects and phenomena—were not excluded from their conception of "*wu*," and thus, knowledge and understanding of natural phenomena and technical artifacts have a place in their *gewu* endeavor. For more on *gewu* and the concept of *li*, see Kim (2000, chap. 2).

[13] The expression "*boxue*" appears, e.g., in the *Analects*, 12.5, 19.6; *Liji* 禮記, 53.2a.

[14] Peterson (1975) and Zhang (1987, 1994). Zhang Yongtang even says that Fang Yizhi 方以智 (1611–1671) actually performed some "physical research" (*wuli yanjiu* 物理研究) as part of his *gewu* endeavor: Zhang (1987, p. 84 ff).

books on administration containing specialized knowledge of various subjects. It was because of the practical utility of the specialized knowledge that, even during the Burning of Books at the time of the First Emperor of the Qin (Shi Huangdi 始皇帝, 259–210 BC), books on medicine, pharmacy, divination, agriculture, and horticulture were excluded, and that during the sack of Kaifeng by the Mongols, the calendrical specialists in the Astronomical Bureau were saved.[15] Many late Ming 明 (1368–1643) scholars were interested in various subjects of practical knowledge as potential means to ameliorate the dismal conditions of the country (Bray and Métailié 2001: 323). That was why Xu Guangqi and Wang Zheng 王徵 (1571–1644), for example, were interested in technical things and problems, before they were exposed to Western scientific and technical knowledge of the Jesuits (Gernet 2001).

Among the various specialized subjects, it was calendrical astronomy that attracted the greatest attention from the Confucian scholars. Knowledge of the subject was needed for the essential task of the government to establish correct calendars, and thereby "granting [the correct] time" (*shoushi* 授時), because a correct calendar was a requisite sign assuring that the ruler was in accord with the "mandate of heaven" (*tianming* 天命). This had a clear political significance, both for the rulers and the officials. Astrology and divination were also closely connected to calendrical astronomy because the subjects frequently used knowledge and data of calendrical astronomy, and astrological and divinatory works were important tasks of the calendrical specialists working in the imperial astronomical bureau. It was because of such importance that successive dynasties tried to monopolize the knowledge of calendar making and even imposed bans on private study of calendrical astronomy (Sin 2007b).

Other specialized subjects also attracted Confucian scholars' interest owing to their practical utility. For example, it was mainly for its practical utility that medicine attracted scholars' interest. Maintaining healthy life and curing disease met the obvious need of the scholars themselves, their parents, and of their country. Thus, there were many Confucian scholars who were deeply interested in the knowledge, and sometimes practice, of the various aspects of medicine. The same practical interest can be seen from the widespread interest among Confucian scholars in the techniques of "nourishing life" (*yangsheng* 養生)—to keep health and to live long (Kim 2007). Agriculture was another subject in which there was a continuous interest of Confucian scholars, who normally considered agriculture as a basis of social order and welfare of the people and the country.[16] There, thus, were not just pragmatic but cosmological and moral reasons for emperors and officials to promote agriculture (Bray 2008: 330). "Encouraging agriculture" (*quannong* 勸農) was an important task for the scholar–officials, who frequently issued "proclamations for encouraging agriculture" (*quannongwen* 勸農文).[17] Moreover, most of the Confucian

[15] Guy (1987, p. 11) and Yamada (1978, p. 20). It is to be noted that in the destruction of the books on Western learning in the Chŏngjo 正祖 period (1776–1800) of Chosŏn Korea also, the scientific books were excluded.

[16] Indeed, agriculture was frequently referred to as the "*ben*" 本 (root, basis) or the "*benye*" 本業 (basic task). See, e.g., Bray (2008, pp. 321, 328).

[17] On the "proclamations for encouraging agriculture," see Kim (2000, p. 280) and Sudō (1962, pp. 45–48). Even the agricultural work of Xu Guangqi 徐光啓 (1562–1633) was derived mainly from his commitment to the official duty of "encouraging agriculture." See Bray and Métailié (2001).

scholars were landowners, some of them active in managing farms, especially when they were out of office. In this situation, many scholars authored agricultural treatises and handbooks, which for them became an "important minor genre" of writing (Brook 2001: 92–93). Related to agriculture, hydraulic engineering was another important subject in which many scholars showed interest.[18] Also important for officials, and scholars as potential officials, were various techniques. Architectural and military techniques were among the obvious examples, but techniques involving some key products under state's control—salt, silk, and porcelain for example—also attracted their interest.

Naturally, there were differences among the Confucian scholars in their attitudes to specialized subjects of practical utility, reflecting their individual intellectual predilections. An important factor underlying such differences was their official position. The attitudes of the officials in charge of practical tasks usually showed a more active interest in the relevant specialized subjects. They frequently showed attitudes close to those of the specialist practitioners. We can even see a kind of division of the scholars' knowledge: knowledge for statecraft skills vs. knowledge for the scholarly practice of self-cultivation (Bray 2007a: 46).

3 Scholars Interested in Specialized Knowledge

Given the various elements discussed in the last two sections, the attitude of scholars toward specialized knowledge in traditional China could only be very complex. Over the long period of traditional Chinese history, we see various aspects of both "separation" and "convergence" in the relation between Confucian scholars and the specialized scientific and technical knowledge.

There indeed were many Confucian scholars with interest in specialized scientific and technical knowledge. Some reached the level of the contemporary specialists in their knowledge of the subjects; some even wrote specialized treatises on them. Such scholars were not rare in early imperial period. Ever since Han, there were many scholar–officials actively involved in the debates over, and actual work of, frequent calendar reforms, and those who had mastered the specialized knowledge of such subjects as agriculture, medicine, and techniques (Jin 1998). In the Song, we can find many scholars with interest in scientific and technical knowledge (Le 2007). Indeed, most important scholars of the Northern Song period—Fan Zhongyan 范仲淹 (989–1052), Hu Yuan 胡瑗 (993–1059), Ouyang Xiu 歐陽脩 (1007–1072), Wang Anshi 王安石 (1021–1086), Sima Guang 司馬光 (1019–1086), and Su Shi 蘇軾 (1037–1101), who were officials most of the time—showed interest in various specialized subjects (Le 2007: 10–37). Not only the scholar–officials but also emperors showed interest in specialized knowledge, medicine in particular. Many Northern Song emperors had a deep interest in medical therapies and books (Goldschmidt 2004). Huizong 徽宗 (r. 1100–1125), for example, tried to attract Confucian scholars to study, and even to practice, medicine (Furth 2006: 435).

A number of Confucian scholars of the Song period mastered a broad range of specialized subjects and wrote treatises on them. The above-mentioned Shen Gua

[18] See Li Cho-ying's paper in this issue.

and Zheng Qiao 鄭樵 (1104–1162) are two major examples. Another notable example was Cai yuanding 蔡元定 (1135–1198) who wrote a treatise devoted to harmonics, titled *Lülü xinshu* 律呂新書 (New Book on the Pitches), which was circulated widely among scholars as it was included in the *Xingli daquan* 性理大全 (Great Compendia on Human Nature and Li). Many devoted themselves to the study of mathematics and attained a high level of mathematical knowledge. Some wrote the best mathematical treatises of the period. For example, both Qin Jiushao 秦九韶 (1202–1261), the author of the *Shushu jiuzhang* 數書九章 (Mathematical Book in Nine chapters), and Li Ye 李冶 (1192–1279), the author of the *Ceyuan haijing* 測圓海鏡 (Sea Mirror for Measuring the Circles), were scholars who had received classical Confucian education. Qin Jiushao, an official in late Southern Song, stated in his preface to the above-mentioned book that "numbers and *dao* are not of two [different] roots." (*Shu yu dao fei erben* 數與道非二本). Li Ye devoted himself so deeply to the study of mathematics that he feared the possibility of people criticizing him for "losing the [correct Confucian] will" (*sang zhi* 喪志).

As for Zhu Xi, his knowledge in specialized scientific and technical subjects did not reach the level of the above-mentioned scholars. But he also had a broad interest and a considerable knowledge in many specialized subjects and urged other scholars to study those subjects. This attitude of Zhu Xi had a great influence upon scholars after him. Because of his endorsement, the specialized subjects were considered legitimate for later Confucian scholars. True, there was narrowing down of scholars' interest in the period after him. The broad scope of Zhu Xi did not continue in the subsequent Confucian learning; his followers' interest narrowed.[19] It is important, however, that Zhu Xi did find a place for the specialized scientific and technical knowledge in his system of learning. This encouraged later Confucian scholars, most of whom were followers of his learning, to keep interest in, and study, the specialized subjects. Consequently, there continued to be some degree of convergence between the Confucian scholars and the specialized scientific and technical knowledge.

Such convergence was especially noticeable in the subject of calendrical astronomy. During the Ming, many Confucian scholars had interest in, and studied, calendrical astronomy, long before the Jesuits' introduction of Western astronomy aroused interest in the subject. In spite of the difficulty for scholars to gain access to astronomical books owing to the official ban on private study of the subject, there was a continuing interest among them in the astronomical knowledge.[20] The *Ming History* (Mingshi 明史 1974), for example, mentioned scholars like Zhu Zaiyu 朱載堉 (1536–1611) and Tang Shunzhi 唐順之 (1507–1560) as examples of those who "were knowledgeable in calendrical astronomy although they were not calendrical officials" (非曆官而知曆者) (*Mingshi*, vol. 31: 544). Xing Yunlu 邢雲路 (1549–?)

[19] Part of the reason may have been the breadth of the Zhu Xi corpus itself. It was almost as if, once Zhu Xi had produced a corpus of knowledge that covered everything, those who came after him did not feel the need to worry about problems other than their principal concern—morality and self-cultivation; everything else, including the specialized scientific and technical knowledge, was already there in Zhu Xi after all. This tendency is especially pronounced among the Korean followers of Zhu Xi in the Chosŏn 朝鮮 dynasty (1392–1910). Many of them devoted themselves to establishing the so-called established theory of Master Zhu (*Zhuzhi dinglun* 朱子定論), while showing little interest in the scientific knowledge coming from the West. See Ku (2004, chap. 5).

[20] Sin (2007a, pp. 25–26). From the mid-sixteenth century on, the thriving book publishers began to publish astronomical books to meet such a growing demand of the scholars: *ibid*., p. 27.

even said that calendrical astronomy (literally "the learning of calendars, images, and granting time" *lixiang shoushi zhi xue* 曆象授時之學) was "the basic task of us, the Confucian scholars" (*wuru zhi benye* 吾儒之本業).[21] This situation was noted by Matteo Ricci (利瑪竇, 1552–1610) who observed that "no people esteem mathematics as highly as the Chinese" (Gallagher 1953: 476). Of course, other specialized subjects, such as medicine, agriculture, and techniques, also attracted interest from various Confucian scholars.

4 Limited Convergence Between Scholars and Specialized Knowledge

On the whole, however, the convergence between scholars and specialized scientific and technical knowledge in traditional China was not complete. Typically, Confucian scholars were not fully committed to the study of the specialized scientific and technical subjects, which they often did not consider intellectually challenging. Nor did they consider those specialized subjects so difficult that they would be unable to understand them thoroughly even if they had tried.

Such an attitude could be seen from Zhu Xi. While emphasizing the need to study and understand specialized subjects, Zhu Xi did not hide his feeling that those subjects were secondary to the more important ones—moral and social problems. That was what he meant when he said repeatedly that one has to understand "the basis" (*ben* 本), or what is "great", before moving on to "small" matters. Zhu Xi also admitted that it was not necessary to try to reach a complete understanding of all the details of specialized subjects. He felt that he could fully comprehend them if only he tried, however difficult these subjects may have appeared. It was simply that these subjects did not command his full interest that he did not exert himself fully to studying them.[22] Zhu Xi did not have very high opinions of the specialists of these subjects, either. For him, they were mere functionary experts in the subjects which he did not try to master himself. He even blamed the calendrical specialists for the deviations of calendars from the actual motions of the heavens; in his view, they were merely busying themselves in observing, recording, computing, and predicting the motions in the heavens, seeking only to get numbers using expedient methods while not trying to understand the actual workings of the heavens, which the proper calendrical method should have aimed at (Kim 2000: 252–253).

This attitude of Zhu Xi more or less remained as the basic attitude of Confucian scholars in the subsequent period. On the whole, Confucian scholars remained scholars, with some intellectual curiosity in, but never fully committed to, the specialized knowledge. It could hardly have been otherwise because their main object was to get at the one universal *li*, "the *li* of heaven." Because this universal *li* is manifest in every thing and event of the world as the *li* of that thing or event, Confucian scholars had to study every thing and event, including the specialized scientific and technical subjects. Yet, the important thing for them was to reach the

[21] *Gujin lülei kao* 古今律曆考, ch. 65, "Bian Datongli zhi shi" 辯大統曆之失, cited in Sin (2007a), p. 39.

[22] Kim (2000, chap. 12, esp. pp. 245–250). For a subject that he really considered difficult and beyond his understanding, namely the internal alchemy (*neidan* 內丹), especially that of the *Cantongqi* 參同契, Zhu Xi indeed felt an intellectual challenge and exerted great efforts to master it. See Kim (2007).

universal *li*, rather than engaging themselves in the particular, individual *li*. The above-mentioned concern of Li Ye about the possibility of people blaming him for too much work on mathematics very well illustrates the usual attitude of the Confucian scholars towards the specialized subjects. Devoted study of a subject like mathematics appeared to them as "losing the [correct] will."

This kind of attitude was reflected in the situation of specialized knowledge in the civil examination, the importance of which for the intellectual standing of a scholarly subject in traditional China was beyond doubt.[23] To be sure, topics of specialized subjects were included in the civil service examination from early period, and especially during the Ming (Elman 2000: 461–481). Zhu Zaiyu 朱載堉 (1536–1611), for example, recorded the cases of 1497 and 1522, in which examinations were administered to recruit those who were well versed in calendrical astronomy among officials and their sons, students, soldiers, and even recluse scholars.[24] On the whole, however, specialized scientific and technical subjects never became a full-fledged part of the civil examination curriculum; they remained secondary subjects. And, as the result, there did not exist a satisfactory career prospect for the specialists of scientific and technical subjects in the government.[25]

What convergence there was between scholars and specialists was in one direction only: Scholars did have interest in specialized technical knowledge, but the specialist practitioners of the specialized branches themselves—artisans, craftsmen, functionaries, peasants, etc.—did not write about their trades. Nor was there, on the part of the specialist practitioners, a broadening of interest or a deepening of intellectual curiosity, of the kind that can be seen among the technical men of early modern Europe (Rossi 1970; Long 2001: chaps. 6–7). To be sure, there was a broadening of readership of the books on specialized subjects in the late imperial period. For example, there was a great increase in late Ming of officially sponsored compendia (*leishu* 類書) on classics, civil service, and statecraft, and of private practical encyclopedias on miscellaneous subjects including agriculture, health, and mathematics, which were read by literati, artisans, merchants, and clerks (Elman 2007). The topics discussed in these books were extremely broad, covering astrology, topography, medicine, mathematics, nourishing life, sericulture, plants, as well as dream interpretation, writing skills, and legal matters (Elman 2007: 136). But, there is no evidence of the specialist practitioners writing about the specialized knowledge of their own subjects; they were busy doing the work required for their trades.

[23] Elman (2000). Ferdinand Verbiest (南懷 1623–1688) seems to have fully understood the importance of the civil examination curriculum, as he tried to secure an imperial permission to include the scholastic philosophy in the civil examination along with the Confucian classics. See Standaert (2001, p. 608).

[24] *Shengshou wannianli* 聖壽萬年曆, appendix, quoted in Sin (2007a, p. 39). There is also of an instance in 1521 when officials were promoted a few ranks at a time because of their mastery of calendrical astronomy. *Wuzong shilu* 武宗實錄, 1521, 7th month, 6th day, quoted in Sin (2007a, p. 12). Although the Qing 清 dynasty (1644–1911) discontinued the practice, it was not because the subjects were considered unimportant, but because of the fear that the controversies involving calendars would create a political unrest. See Elman (2005, p. 133). Topics of calendrical astronomy is found in the civil examination questions of early sixteenth century Korea also. See Ku (2004, p. 74).

[25] Again, Verbiest keenly noted this in explaining the lack of able calendar astronomers in the Qing court. See Walle (1994, pp. 511–512). It is also interesting to note in this connection that some of the specialized subjects, notably medicine, frequently attracted scholars who failed, or were blocked from, the civil examination.

The inclination of the specialist practitioners to be secret about the craft knowledge of their trades may have had an effect on this situation. Physicians, usually belonging to hereditary physician households with craft secrets, tended to keep their medical recipes secret, till the Song dynasty examination culture and the spread of printing slowly changed the situation, which was culminated in the rise of medical case histories (*yi'an* 醫案) in late Ming (Furth 2007: 13–14). There must have been the same need for secrecy in subjects like alchemy, geomancy, and divination. Calendrical astronomers also showed a tendency to be secret about their specialized knowledge. Even government was not free from a secretive tendency concerning the specialized craft knowledge which they monopolized, as can be seen from the ban on the private study of calendrical astronomy during the Ming (although it was not tightly enforced) (Sin 2007b).

In this situation, most of the writing on specialized crafts was done by, and frequently for, the scholars. To be sure, some peasants' knowledge entered the scholars' writings on agriculture. The authors of the major agricultural treatises—Jia Sixie 賈思勰, the author of the sixth century *Qimin yaoshu* 齊民要術 (Essential Techniques for Common People), Wang Zhen 王禎, the author of the fourteenth century *Nongshu* 農書 (Agricultural Book), and Xu Guangqi 徐光啓 (1562–1633), the author of the seventeenth century *Nongzheng quanshu* 農政全書 (Complete Book of Agricultural Agenda)—all consulted farmers and craftsmen in composing their books (Bray 2007b: 541–542). But, this was far from specialist practitioners writing about their own trades. It is significant that the *Bencao gangmu* 本草綱目 (Outlines of Pharmacopoeia, 1578) of Li Shizhen, the *Taingong kaiwu* 天工開物 (Heaven's Work in Opening Things, 1634) of Song Yingxing, and the *Nongzheng quanshu* (1639) of Xu Guangqi, the three most important works of specialized knowledge in late Ming, were all written by scholars. Naturally, intellectual interest was pronounced in these cases, in which the scholar–authors included techniques and products for their and their readers'—often fellow scholars'—intellectual interest. Also, the medical treatises written by Confucian scholars, especially by the "literati physicians" (*ruyi* 儒醫) were not wholly for practical purposes; there was intellectual interest as well (Leung 2003; Furth 2006).

There were genres other than books and treatises in which scholars entered the realms of specialized subjects. Yet, the principal aims of these genres did not lie in the technical details, though they did contain technical information. Such disregard of technical details can be seen, for example, in the "proclamations for encouraging agriculture" (*quannongwen*) (Bray 2007b: 549). Sometimes, scholar–officials wrote poems to disseminate useful information—farming techniques, medical prescriptions, etc. Some scholar–artists drew illustrations of technical artifacts and processes. Yet, no significant technical improvements were described in these illustrations and poems. An independent genre, the so-called pictures of farming and weaving (*gengzhi tu* 耕織圖), emerged from such illustrations and poems. Usually traced back to Lou Chou 樓璹 (1090–1162), who first put together poems and pictures depicting the main processes of rice farming and sericulture, the genre flourished in the subsequent periods (Bray 2007b: 524–535; Zhongguo Nongye Bowuguan 1995). These pictures and poems, however, aimed more at the rulers and the elites than farmers themselves; their emphases were on showing the skills and the "toil and effort" of farming and weaving rather than technical details, thereby conveying a moral message to the members of the ruling class (Bray 2007b: 533–534).

The level of the Confucian scholars' knowledge in specialized subjects was usually not very high. Seldom was it the case that they reached the highest level of their time. Again, Zhu Xi is a representative example; although he studied many specialized subjects and attained a considerable knowledge in them, his understanding was never up to that of the specialists of his time. The level of knowledge in his commentaries often lagged behind that of his contemporary specialists by several centuries. For example, as the number of days in a year he continued to use 365.25, the number of the ancient *Sifenli* 四分曆 (Quarter Remainder Calendar), instead of 365.2425 already used by his contemporary calendrical specialists. Confucian scholars after him, mostly his followers, duly followed him in this respect as well because the calendrical numbers of the *Sifenli*, the calendrical system used during Later Han when the commentary tradition began, became canonical in the subsequent discussions of Confucian scholars. Nor was the interest in specialized scientific and technical knowledge widespread or common among Confucian scholars. A disciple's response to Zhu Xi's proposal for including subjects like calendrical astronomy, geography, music, and harmonics in the civil examination—that "there may be no [qualified] examining officer after all"—clearly shows that such was indeed the case.[26]

Our survey so far has shown a lack of full convergence between Confucian scholars and the specialized scientific and technical knowledge. This situation continued in the later period when Western scientific and technical knowledge was introduced to China. Qing writings on paper industry, for example, were mostly on hard work and moral values of such hard work, as Jacob Eyferth has noted. Some officials did write more details about the paper-making techniques; but, these were not read by practitioners. Many paper-making artisans neglected such written forms of knowledge, as they had developed other ways to reliably reproduce knowledge.[27]

5 The Situation in the West: A Comparative Look

Separation of the specialized scientific and technical knowledge from the general concern of the intellectuals began in Europe some time after the Scientific Revolution[28] and continued in a long, complicated process in which science became technically utilizable, big and expensive, intellectually difficult, and above all specialized. The process of separation proceeded along with the following two developments.

1. The emergence of the idea of "science" as a single area covering all knowledge about the natural world
2. The emergence of "scientists" as a separate, self-respecting group

These two events were preceded by an earlier development:

3. The convergence of, or breaking down of the boundaries between, the traditions of philosopher–scholars and the practitioners ("specialists") of various specialized subjects

[26] *Zhuzi yulei*, 109.8b. In fact, Shen Gua had made a similar observation: during the Huangyou 皇祐 period (1049–1054), the examiners gave a top grade to all the answers to a question on astronomical instruments

[27] See Jacob Eyferth's paper in this issue.

[28] On the situation during the Scientific Revolution, see, e.g., Hall (1959) and Rossi (1970).

It can be noted that this convergence was in a direction opposite to the events (1) and (2) that were in the direction of separation of the specialized knowledge. But, this apparent contradiction suggests that the separation was possible because of—and not in spite of—the convergence, of type (3), which, in turn, explains the fact that in the West specialization occurred not simply as "narrowing down" of the interest of the specialists—"scientists"—but as some kind of "broadening up," in which the specialists were taking over something from the mainstream learned culture of the scholars and incorporating them in their own domains.[29]

The specialists' self-respect for their own activity, the event (2), then, explains how the specialization of natural knowledge took place in the West with an eventual increase of prestige of both the knowledge and its practitioners, the result of which is that in the modern world science is in a status in many aspects more prestigious than non-science—humanities, arts, etc. This sort of development did not take place in China. If any degree of specialization of knowledge took place in traditional China, it did so with a decrease rather than an increase of prestige.[30] One difference in the hierarchy of learning in the West and China appears to be pertinent in this respect. While in the European medieval university structure the faculties of professions—law and medicine—stood as higher faculties on top of the faculty of philosophy,[31] the situation was more or less the opposite in China: Generalist philosophy always occupied an uncontested higher intellectual position above the specialized knowledge.

This different situation may shed light on the lack of the development of specialized professions in traditional China. Yet, it was not because of the lack of a model that such professionalization did not occur in traditional China. For the literati (*shi* 士) were a powerful group with clearly profession-like features that would have provided a good model for other professionalizing groups to emulate.[32] Indeed, the physicians, especially those called "literati physicians" (*ruyi*), modeled themselves on the Confucian literati in their learning, teaching, and transmission of the tradition (Chao 2000: 82–86; Leung 2003: 387–396; Furth 2006). We may consider, in this connection, the so-called middle people (*chung'in* 中人), a social class unique in Korea, which, in late Chosŏn period, came to monopolize the specialized scientific and technical activities. These "middle people" formed a closed and basically hereditary class of specialists, who, although looked down upon by the ruling *yangban* 兩班 class and given no roles in the major affairs of the society, nevertheless

[29] Rossi (1970) and Long (2001). Also, this may be the reason why we note in the modern science of the West both universalizing and specializing tendencies: As specialization proceeded in the eighteenth and the nineteenth centuries, individual scientific subjects got connected to one another, as the result of which there emerged the concept of "science" covering all the scientific subjects—the event (1).

[30] Cf. Elman (2005, p. xxix), where Elman suggests that in the seventeenth and eighteenth century China, mathematical sciences contributed to the rise of the social status of the Confucian scholars who mastered them. But this was largely because the practical utility of Western science had already been accepted by many Chinese scholars.

[31] On the situation surrounding the medieval universities, see, e.g., Kibre and Siraisi (1978).

[32] On such "profession-like" characters of the Confucian literati, see, e.g., Dardess (1983, chap. 1). Benjamin A. Elman actually uses the word "professionalization" in referring to a group of Qing scholars: Elman (1984, chap. 3).

enjoyed a great class stability and lucrative privileges associated with their specialized activities.[33]

Difference in the situations of the West and China in still another aspect, namely the supposed distinction between science and technology, may be significant for understanding the different developments of the relation between scholars and the specialized knowledge in the two cultures. For the bulk of the Western history from the ancient times till just a few centuries ago, science and technology were separate and followed separate paths. The connection between the two in the West began to take shape only around the time of the Scientific Revolution and has undergone a very complicated development to reach the modern situation, where they are closely connected to each other.[34] As we start to consider the Chinese situation, however, we are confronted with a difficulty from the outset, for it is not clear whether one can distinguish them in traditional China, or what is more important, whether the traditional Chinese themselves distinguished them.[35] Although there were many specialized subjects that we would now call "scientific" or "technical," these existed individually, as separate, independent subjects, and there was no sharp distinction between what were "scientific" and what were "technical". One may even wonder whether there was anything that can be called "science" or "technology" in traditional China.

The difficulty of making a distinction between science and technology in the Chinese case becomes clearer when we look at the following three dichotomies that are routinely used in attempting to distinguish the two.

1. Nature vs. man (natural vs. artificial)
2. Scholars vs. artisans
3. Intellectual curiosity vs. practical utility

None of these dichotomies work in dealing with the situation in traditional China.

First, while the Aristotelian dichotomy of nature vs. artificial—and its translation into the dichotomy of science vs. technical arts—dominated the Western mind till the time of the Scientific Revolution,[36] there was no clear distinction between nature and man in traditional China. To be sure, there was a sort of nature vs. man distinction, characterized by such pairs of Chinese characters as heaven (*tian* 天) vs. man (*ren* 人), and "the divine" (*shen* 神) vs. "the sagely" (*sheng* 聖). Natural phenomena were usually attributed to heaven. And, when the marvelous (or mysterious or superior)

[33] Many features of these middle people make it difficult to think of them as a "profession". For one, they were not specialists of a single specialized subject; they crossed over many branches—calendrical astronomy, harmonics, mathematics, divination, medicine, law, language skills, etc. Their specialty was not that of a subject, but of an occupation with a well-defined niche in the social and bureaucratic hierarchy of Chosŏn society. For brief comments and references on the middle people, see Kim (1998, p. 76). For more detailed studies, see Yŏnse taehakkyo Kukhak yŏn'guwon (1999).

[34] At present, the two have even combined into one kind of enterprise, frequently called "science–technology" or even "techno-science." In modern Chinese, they are even abbreviated as one word, "*keji*" 科技. On the complex development of the relation between science and technology in Western history, see, e.g., Staudenmaier (1985, chap. 3).

[35] Of course, the simple clear-cut distinction between science and technology is not possible even in the West, if one looks at the situation more closely. But still, such a distinction can be made at least in principle.

[36] Daston (1998). After the Scientific Revolution, one sees both a sharpening of the distinction of nature vs. man (from Descartes on) and a merging of the two (study of man as natural object).

aspect of natural phenomena was noted, it was referred to as "the divine" (*shen*). Technologies and cultural institutions, on the other hand, were supposed to have been established or inaugurated by the sages (*shengren* 聖人), the superior men who nevertheless were still men. For example, the famous chapter (B2) in the "*Xicizhuan*" 繫辭傳 (Commentary on the Appended Words) of the *Book of Changes* attributed the basic techniques of agriculture, fishing, making clothes, boats, and arrows, building houses, and so on to various ancient legendary sages. The techniques were also considered part of the "rites" (*li* 禮) and thus were discussed in treatises like the "Kaogongji" chapter of the *Rites of Zhou*. This led to something like the traditional Chinese own version of the "natural vs. artificial" distinction: natural phenomena attributed to heaven and the divine (*shen*) vs. human acts attributed to man and the sages (*sheng*). Yet, the distinction was not so rigorous. The attributes "heaven" and "the divine" were not confined to natural realm. The techniques also became at times associated with heaven and the divine (*shen*). Expressions like "the divine work" (*shengong* 神工) and "the divine technique" (*shenji* 神技) were frequently used to characterize supreme human skills. We even find the expression, "heaven's work" (*tiangong* 天工) in the *Tiangong kaiwu*.

Nor do the other two dichotomies work in characterizing the science–technology distinction in traditional China. We cannot simply associate science with scholars and intellectual curiosity on the one hand and techniques with artisans and practical utility on the other. As we have seen, practical utility came together with the intellectual curiosity in many traditional Chinese scholar' interest in specialized subjects. Most books of specialized scientific and technical subjects were written not by, or even for, the specialist practitioners, but by scholars out of intellectual interest, and for scholars. Also, Confucian scholars with their primary interest in the human problems frequently sided on the "artificial" while artisans frequently associated with Taoism, sided on the "natural".[37]

Numerous other differences in the situations surrounding the scholars and the specialized scientific and technical subjects—both their contents and the ways they were practiced—in the West and traditional China affected the relation in the two cultures between generalist scholars and the specialized knowledge.

6 Concluding Remarks

In the preceding sections, we have seen various aspects of the Confucian scholars' ambivalent attitudes to the specialized scientific and technical knowledge in traditional China. On the one hand, Confucian scholars did have interest in the specialized scientific and technical subjects and reached a high level of knowledge. But, their interest in the subjects were only secondary, which put limits on the intellectual, and social, status of the specialized scientific and technical knowledge. The specialized subjects were not fully accepted in traditional Chinese learning; nor was there a full convergence between scholars and specialized knowledge.

[37] On the affinity of Taoism with the natural world and the predilections of the Taoists in the scientific activities, see Needham (1956, pp. 33–164). In modern science also, there were both the "natural philosophical" and the "instrumentalist" aspects. See, e.g., Dear (2006, pp. 1–14).

It is significant, however, that Confucian scholars did not consider such a situation satisfactory. Many of them insisted that it is not right for them to neglect or ignore the specialized subjects. Zhu Xi both exemplified and influenced such an attitude. He believed that there existed a perfect knowledge of specialized subjects in the ancient times and suggested that ancient scholars studied, and had a high level of knowledge in, subjects like calendrical astronomy, mathematics, and music (Kim 2000: 254–255). Based on such a belief, Zhu Xi urged scholars to study such specialized subjects. This view was shared by many Confucian scholars of later times, who kept interest in, and studied, the specialized subjects. At least, they did not have an excuse for not studying and understanding the specialized subjects when their official duties, or social responsibilities, called for knowledge of such subjects; they did not shun the study and discussion of them.

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