Rethinking the "Needham Question": Postprint of an Interview with Research Fellow Zhang Bochun

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Date: 2018-01-09T00:00:00+00:00

Abstract

Full Text

The Needham Question: An Interview with Researcher Zhang Baichun

Journal of the Chinese Academy of Sciences: British historian of science Joseph Needham once posed this question: "Why was it that between the 1st century BCE and the 15th century CE, Chinese civilization was more effective than Western civilization in acquiring natural knowledge and applying it to practical human needs?" In other words, why did modern science not emerge in China? Such questions have attracted long-term attention among Chinese intellectuals.

When China's War of Resistance against Japanese Aggression reached a strategic stalemate, British biochemist Joseph Needham came to China as director of the Sino-British Science Cooperation Office. He surveyed several provinces in China's rear areas, visited numerous research, educational, and industrial institutions, did his best to provide them with assistance and secure aid, and developed a strong interest in China's ancient civilization. After returning to Britain, Needham discussed with Cambridge University Press the plan to write and publish a history of Chinese science. As the project unfolded, he pondered: "Why was it that between the 1st century BCE and the 15th century CE, Chinese civilization was more effective than Western civilization in acquiring natural knowledge and applying it to practical human needs?" That is to say, if the application of science in ancient China was at such a high level, why did modern science appear in Europe rather than China? In fact, Chinese scientists such as Ren Hongjun and Zhu Kezhen, as well as German-American sinologist Karl Wittfogel, had raised similar questions even before Needham.

Needham focused primarily on China, but some historians have applied this question to other non-native regions of modern science, such as India and the Arab world. In recent years, research on the diversity of scientific and technological traditions has led some to question the premises and logic of the "Needham Question."

Journal of the Chinese Academy of Sciences: How should we understand the connotation of the "Needham Question"? Can Needham's so-called "application of natural knowledge" be understood as technology?

Zhang Baichun: Scholars both Chinese and foreign have offered many perspectives in response to the "Needham Question," each with their own insights. As early as the New Culture Movement period, scholars compared Chinese and Western cultures, with some reflecting on and critiquing Chinese cultural traditions, pointing out defects in the traditional knowledge system and various social factors that hindered scientific development.

If we understand Needham's question only literally, it seems to suggest that because ancient China was highly effective in applying natural knowledge (scientific knowledge)—that is, highly accomplished in technology—it should have produced modern science. However, from a logical perspective, this formulation is questionable. Technology and science were related in ancient times but belonged to two distinct knowledge traditions. Well-developed ancient technology that met practical needs did not necessarily lead directly to transformations in scientific knowledge. In the origins and long-term development of human civilization, technological inventions often preceded the formation of scientific knowledge. People's observation and understanding of natural phenomena generally experienced a process from intuitive knowledge to empirical knowledge, and then to theoretical knowledge. For example, balance scales were already a major weighing tool in China during the Spring and Autumn and Warring States periods, and unequal-arm balances may have even appeared. At that time, Chinese sages had not yet proposed a qualitative explanatory principle of the lever, but this did not affect the widespread application of balance scales. The balance scale was the instrumentalization of empirical knowledge, not the application of scientific theory (the lever principle). In fact, many ancient technologies could hardly be considered applications of science; technological practice contributed to the formation and sublimation of scientific knowledge. Knowledge reached a more advanced stage when it became theorized.

Another example: as early as 8,000 years ago, Chinese ancestors had mastered the technology of brewing alcoholic beverages, but it was not until modern times that scientists understood the chemical reaction mechanisms in the brewing process. This also illustrates that lagging scientific development did not necessarily hinder technological improvement and widespread application. Therefore, leadership in technology (or so-called application of natural knowledge) did not necessarily lead to the emergence of modern science. In ancient times, the scholarly tradition of science and the craftsman tradition of technology had not yet combined, and the interaction between technology and science was much slower

than people imagine today. In contemporary times, science and technology have merged and permeated each other, forming a larger system, but they still retain their respective characteristics.

Of course, this does not mean that ancient China never achieved major scientific accomplishments—whether in understanding nature according to the internal logic of knowledge or in theoretical summaries to meet social needs, China had outstanding performance, producing an advanced mathematical system and astronomical calendrical science.

Journal of the Chinese Academy of Sciences: Needham agonized over why modern science did not emerge in China. So how did modern science emerge in Europe?

Zhang Baichun: In the past, people took for granted two inconsistent claims—that ancient China had great inventions but did not produce modern science, and that medieval Europe was dark but then experienced the Renaissance and scientific revolution. The reasons for the emergence of modern science in Europe are extremely complex, and there are already many related international works. The emergence of modern science is closely related to Europe's theoretical knowledge tradition and its transformation. Both ancient China and ancient Europe achieved outstanding accomplishments in invention and creation, forming their own knowledge traditions and civilizations. Ancient Greece achieved outstanding accomplishments in science and technology, with scientists such as Aristotle, Euclid, and Archimedes constructing classical scientific theoretical systems. Although the Roman Empire was inferior to ancient Greece in scientific theory, it achieved excellent results in engineering technology. Between the 14th and 16th centuries, Europe experienced the Renaissance, which facilitated the liberation of individuality, thought, and creativity, bringing prosperity to science and art and providing cultural conditions for the birth of modern science.

The emergence of modern science was also closely related to scientists' concern with practical problems. Scientists extracted key theoretical questions from practice and conducted systematic investigations. For example, in the 16th-17th centuries, engineers, craftsmen, and gunners improved gunpowder and selected reasonable cannon structures and firing angles to enhance power and accuracy. Galileo and other engineer-scientists analyzed ballistic problems and provided quantitative theoretical explanations. Guided by problems of ballistics, falling bodies, and pendulums, mechanics separated from mathematics and grew into a leading independent discipline in modern science. Galileo combined experimental and mathematical methods to form new methodology and research paradigms. Newton unified Galileo's research on the laws of object motion with Kepler's research on celestial motion, completing the construction of classical mechanics and writing the immortal work *Mathematical Principles of Natural Philosophy*. The scientific insights from Copernicus to Galileo to Newton led to the transformation of the scientific system, marking the formation of modern science—a major turning point in the history of science.

After the 18th-century Industrial Revolution, the invention of the steam engine and the 19th-century application of electromagnetism greatly promoted the development of productive forces and the formation of industrial society, accompanied by the great development of natural science. We need not agonize over the fact that modern science did not emerge in China. Many countries that did not experience scientific revolutions have caught up from behind, achieving major breakthroughs in science, technology, education, and innovation, and gradually moving toward industrialization and modernization. The modern scientific revolution began in the Italian Peninsula, while Italy only became a nation-state and accelerated its industrialization in the 1860s.

Journal of the Chinese Academy of Sciences: How should we understand the relationship between Confucian culture and foreign science and technology, as well as the establishment of modern science in China?

Zhang Baichun: Ancient China was an introverted agricultural society, and its more than 2,000 years of development and achievements benefited from Confucian culture. Confucianism emphasized humanities and society, which helped govern the country and maintain stability. Xi Zezong believed: "Confucian thought is not harmful to the development of science and contains many beneficial elements." The conflict between traditional Chinese science and Confucianism was significantly weaker than the conflict between early modern science and Catholicism.

However, the status of Confucianism did indeed affect the growth of other scholarship. Since the Han Dynasty implemented "dismissing the hundred schools of thought and exclusively venerating Confucianism," Confucianism became the official ideology for maintaining order, which likely compressed the development space and opportunities for other scholarship. The imperial examination system, as the main mechanism for talent selection (or "baton"), played a key role in building the civil service system but also directed social elites away from natural science knowledge domains. The late Qing Self-Strengthening Movement[1] established military industries, placing Western ship and cannon technology and related knowledge in the position of "utility" while continuing to take Confucian ethics as the "essence." The destruction of the Beiyang Fleet marked the failure of the Self-Strengthening Movement. In the early 20th century, the Qing government "abolished the imperial examinations and established schools," finally granting natural science and engineering science institutional status equal to other fields of learning. With the establishment of modern universities, scientific societies, and research institutions, as well as scientific enlightenment in the New Culture Movement, science and technology achieved unprecedented cultural status and became institutionalized before the War of Resistance, with professional scientists and engineers stepping onto the historical stage in China.

The spread of modern science gave us further opportunities to understand the characteristics of Chinese culture. In traditional Chinese culture, scholarship on humanities and society was more developed than natural science, and technology was more developed than scientific theory. Confucian thought basically had no

essential conflict with natural science and was quite complementary from the perspective of the relationship between humanities and science. What hindered people from accepting modern science was not Confucian thought itself but the value orientation and institutional arrangement of "exclusively venerating Confucianism."

Journal of the Chinese Academy of Sciences: Does building scientific culture and establishing cultural confidence and innovation confidence constitute a practical response to the "Needham Question"?

Zhang Baichun: While excavating the valuable heritage of innovative spirit and craftsman spirit in traditional Chinese culture, scientists, engineers, and other science and technology practitioners have the responsibility to promote the scientific spirit, disseminate scientific thought, and establish cultural confidence. Science respects creation, advocates rational questioning, and requires rigorous logical argumentation and practical verification of viewpoints and theories. China's scientific and technological community, and society as a whole, should actively create a cultural environment conducive to innovation, using the scientific spirit to guide people to eliminate ignorance and emancipate their minds.

After 1949, China finally won a peaceful and stable environment, and the government and society focused their main energy on developing modern industry, national defense, science, technology, education, and culture. The country laid the foundations for industrialization and modern science and technology in the 1950s-1960s. Since the reform and opening up, China's comprehensive national strength has continuously increased, and its science and technology have achieved remarkable progress that has attracted worldwide attention, gradually transitioning from tracking and imitation to innovation. In recent years, Chinese scientists have made some breakthrough achievements in discovering the essence and laws of science, constructing advanced large-scale scientific facilities such as the "China Sky Eye" (FAST) and LAMOST (the Guo Shoujing Telescope), launching the "Micius" quantum science experimental satellite and the "Wukong" dark matter detection satellite, and diving into the deep ocean with the "Jiaolong" manned submersible and the "Haidou" autonomous remotely operated vehicle, significantly enhancing scientific exploration capabilities. Moreover, China has risen to second place in the world in important indicators such as scientific paper output and R&D investment. It can be said that Chinese scientists have provided another form of response to the "Needham Question" through innovative practice.

In 2012, the Central Committee of the Communist Party of China required that the contribution rate of scientific and technological innovation to economic development should generally reach over 60% by 2020. In 2017, General Secretary Xi Jinping demanded in his report at the 19th Party Congress: to build a strong socialist modernized country by the middle of the 21st century. To achieve the country's grand goals as soon as possible, the scientific and technological community must make more arduous efforts, continuously overcome difficulties, and

focus on solving problems of insufficient original innovation capability and core technologies in key areas being controlled by others. Facing a bright future, Chinese scientists and engineers should actively participate in building scientific culture, establish cultural confidence and innovation confidence, and make greater contributions to building a modernized strong country and a science and technology powerhouse.

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[1] Also known as the Westernization Movement

Note: Figure translations are in progress. See original paper for figures.