Study of Development Course System of Chinese Science and Technology History from International View

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Abstract

China boasts a 5,000-year history of civilization, and its history of science and technology also has a long history. In ancient times, China had been taking a leading role in the level of science and technology of the world for a long time, and produced a large number of outstanding inventions, playing an important role in promoting the development of world’s science and technology as well as the development of human civilization. However, as the industrial revolution in western countries started, China's science and technology development greatly lagged behind the world’s level, for which Needham Puzzle was proposed, which is a very special problem in history and has inspired many scholars to in-depth studies on the development course of Chinese science and technology history. However, most of these studies are fragmented and lack of systematic arrangement. Therefore, this paper aims to study the history of Chinese science and technology by arranging the development course of Chinese science and technology history.

Key words: International view, Science and technology history, Needham Puzzle.

1. SUMMARY OF STUDIES

1.1 Study background

1.1.1 Background of Needham Puzzle

Needham Puzzle is an issue with a high degree of academic value proposed by a British scholar Joseph Needham after a comparative study of the history of science and technology in China and Western countries. As Joseph Needham make deeper and deeper studies on the history of China, Needham Puzzle has been improved and regulated. The core content of Needham Puzzle is “China's ancient scientific and technological level was ahead of the world and played an important role in promoting the development of human science and technology. But why did the industrial revolution happen in the West and not in China?” The question is of great significance to the study of ancient Chinese science and technology history and even to China's history. At present, there are still some controversies about the Needham Puzzle in the academic circles, and the in-depth study of the Needham Puzzle may provide important lessons and references for the study of the history of Chinese science and technology.

1.1.2 International studies of the history of Chinese science and technology

With a long history, China plays an important role in the field of history. At the same time, affected by the Needham Puzzle, the international academic circles have a strong interest in the history of Chinese science and technology, and a large number of scholars from the United States, Japan and Germany have conducted in-depth researches on the history of Chinese science and technology with important achievements. In fact, although in-depth researches conducted by foreign scholars on the the history of Chinese science and technology, the fragmentation is more serious and lack of systematic arrangement. Therefore, the paper systematically studies the development course of the history of Chinese science and technology from an international perspective, with the significance to arrange the development course of the history of Chinese science and technology.

1.2 Literature review
American studies on the history of Chinese science and technology have the following characteristics: First of all, the research direction is more comprehensive, not only in the history of science and technology, but also in political history, economic history, cultural history, social history and other aspects. Secondly, more and more historical materials have been used, which broken the traditional situation of understanding Chinese history only through newspapers, documents and so on, and a large number of historical data in the mainland and Taiwan have been open to the outside world. Finally, in the conclusion analysis, the traditional binary comment method has been abandoned gradually, and more attention is paid to the analysis and arrangement of the history of Chinese science and technology (Zhang, 2011). At present, the researches on Needham Puzzle are mainly from two directions in academic circles, one is in-depth discussions on Needham Puzzle, and the other one is studies on the rationality of Needham Puzzle. After studying the Needham Puzzle, we can draw the corresponding conclusions in essence, which may play an important role in promoting the contemporary development of China. First of all, we should actively open up to the outside world, and the closed pattern is an important reason that leads to the backwardness of Chinese science and technology. Secondly, we should pay higher attention to the role of theoretical science. In ancient China, practical science was popular, with less theoretical science, which is not conducive to the long-term development of science. Finally, we should promote education reform since education is the most important way to train talents by a country and a nation (He et al, 2011). We should analyze the development course of the history of Chinese science and technology from the aspect such as the general history of science and technology, scientific thinking, scientific and technological exchanges between China and foreign countries, scientific figures, history of astronomy, history of mathematics, history of agriculture, history of medicine, history of geography, mining and metal processing, porcelain technologies, food processing technologies, textile technologies, papermaking technologies, construction technologies, water conservancy technologies, transportation technologies, and military and weapons technologies (Fu, 2011).

2. CALCULATION OF THE LEVEL OF SCIENCE AND TECHNOLOGY AND THE DEVELOPMENT LEVEL OF SCIENCE AND TECHNOLOGY

The level of science and technology and the development level of science and technology are essentially different. The level of science and technology mainly refers to the technological level that the objects currently achieve while the development level of science and technology is the promotion of the level of science and technology of the objects in a period of time. Therefore, the level of science and technology is the prerequisite for measuring the scientific and technological level at that time, while the development level of science and technology reflects the environment for and contributions of the development of science and technology at that time (Wang, 2012).

2.1 Calculation of the level of science and technology

The level of science and technology may be indicated with the below formula:

\[ A = \frac{Y}{f(K,L)} \]  \hspace{1cm} (1)

Factors that affect the development level of science and technology mainly include financial support and labor support.

If you only consider financial support and assume \( f(K,L) = K \), you may obtain \( A = \frac{Y}{K} \), then financial support determines the level of science and technology. If you only consider labor support and assume \( f(K,L) = L \), you may obtain \( A = \frac{Y}{L} \), then the level of science and technology determines financial support. The level of science and technology may be calculated with the following methods (Zhang, 2012).

2.1.1 Calculation model of exponential growth

An in-depth study of history shows that, in the vast majority of cases, the technological level \( A_0 \) as a whole will grow over time, though the level of science and technology will change after events such as natural disasters or wars. The level of science and technology will continue to develop rapidly and revert to the level before the disaster for a period of time. Thus, the conditions are met for \( A_t = A_0 e^{rt} \), where \( r \) stands for progress factor while \( A_0 \) stands for the original level of science and technology (Guo, 2012). Therefore, the development level of science and technology can be expressed by the following formula:
\[ Y = A_0 e^{rt} f(K, L) \]  

Take the above formula into cobb-douglas production function, a new formula will come into being:

\[ \ln Y = \ln A + rt + \alpha \ln K + \beta \ln L \]  

One drawback of the above formula is that it is difficult to draw accurate conclusions if the development of science and technology is too fast. The main reason is that there is an important problem in the formula, that’s, in \( r + \ln(1 + \alpha) \), only the gap between \( r \) and 1 is smaller, the conditions for \( r \approx \alpha \) are met; if the gap between \( r \) and 1 is greater, there will be a greater error in the results calculated (Han, 2012).

2.1.2 Calculation model of specific production function

The formula for calculating the development level of science and technology as mentioned above, \( A = \frac{Y}{f(K, L)} \), is taken into the cobb-douglas production function, a new formula will come into being:

\[ A = \frac{Y}{(K^\alpha L^\beta)} \]  

Where, the estimation of \( \alpha \) and \( \beta \) is simple, so it’s easy to calculate the level of science and technology.

2.1.3 Calculation model of the growth equation

With growth equation, the development level of science and technology can also be calculated with the below formula: \( a = y - \alpha k - \beta l \)

So long as the value range of \( \alpha \) and \( \beta \) can be estimated, It is possible to calculate the scientific and technological level index for a given year according to the formula (Qiu et al, 2016).

\[ A_t \begin{cases} 1, & t = 0 \\ (1 + a)^t, & t = 0 \end{cases} \]  

3. DEVELOPMENT COURSE OF THE HISTORY OF CHINESE SCIENCE AND TECHNOLOGY FROM THE INTERNATIONAL PERSPECTIVE

3.1 Xia and Shang Dynasties

The history of science and technology recorded in China mainly originated from Xia and Shang Dynasties, during which China's science and technology officially entered the bronze age, the bronze became one of the most important tools in people's daily life, and china also came into being this period of time. While in the Spring and Autumn Period and the Warring States Period, the iron had also been widely disseminated, and steelmaking technologies had been improved. In terms of water conservancy, Dujiangyan and Zheng Guokuan were built from Xia and Shang Dynasties. In addition, the decimal system was used from this period, together with the advent of the earliest star table, which accurately determined the length of a year. In medicine, TCM theory had been preliminarily formed (Li, 2016).

3.2 Qin and Han Dynasties

In the Qin Dynasty, the first great unification dynasty was established in China and the main achievements of science and technology are as shown in Table 1 during this period:

<table>
<thead>
<tr>
<th>category</th>
<th>content</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>crop rotation system</td>
<td>Land to integrate</td>
</tr>
<tr>
<td>Medical Science</td>
<td>Shen Nong's herbal classic</td>
<td>Chinese medicine works</td>
</tr>
</tbody>
</table>

490
In the Qin and Han Dynasties, China's ancient science and technology had formed a certain system. First of all, in agriculture, China had established the crop rotation system, and combined land use with land development, which effectively promoted the sustainable development of agriculture. In medicine, the *Shen Nong's Herbal Classic* systematically introduced a large number of Chinese herbal medicines, and the *Treatise on Miscellaneous Diseases* not only introduced the most important disease typhoid fever and its treatment, but also described many other diseases such as infectious diseases, which effectively promoted the development of medicine. In mathematics, the *Nine Chapters of Arithmetic* is the earliest recorded mathematical literature as well as the originator of applied mathematics in China. In terms of invention and creation, papermaking, one of the Four Great Inventions, shipbuilding technology and the seismograph were important inventions. Besides, the Great Wall built to resist the Huns also reflects the development level of Chinese architecture in the Qin and Han Dynasties (Ding, 2016).

### 3.3 Northern and Southern Dynasties

The main achievements of the development of science and technology in the Northern and Southern Dynasties are shown in Table 2:

<table>
<thead>
<tr>
<th>category</th>
<th>content</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Agriculture</td>
<td>QiminYaoshu</td>
<td>The earliest Monographs in agriculture</td>
</tr>
<tr>
<td>Medical Science</td>
<td>Maijing, zhenjiujiayijian, Shenlong bencaojing note</td>
<td>Meridian basis, acupuncture, Chinese medicine works</td>
</tr>
<tr>
<td>Chemistry</td>
<td>Ge Hong's alchemy</td>
<td>Chemical originator</td>
</tr>
<tr>
<td>Mechanics</td>
<td>Ma Jun</td>
<td>Machine building</td>
</tr>
<tr>
<td>Astronomy</td>
<td>Liu Hui, Michael Jordan, Zhang Zixin</td>
<td>Astronomical shaping</td>
</tr>
<tr>
<td>Geography</td>
<td>Pei Xiu - drawing six bodies</td>
<td>Theoretical Geography</td>
</tr>
</tbody>
</table>

During the Northern and Southern Dynasties, the scientific and technological level of China was developed rapidly. In astronomy, Liu Hui, Zu Chongzhi, Zhang Zixin and others formed the theoretical basis of astronomy. In geography, Pei Xiu put forward the Six Graphic-Approach in Theoretical Geography, which laid the foundation of theoretical geography. In terms of agriculture, Jia Sixie’s *Qi Min Yao Shu (Important Arts for the People's Welfare)* is one of the world's earliest monographs on agronomy. In medicine, Wang Shuhe, in his *The Pulse Classic*, formally put forward the thought of meridians, which played a leading role in the establishment of Chinese medicine system. Huangfu Miput forward an important idea of acupuncture treatment in his *A-B Classic of Acupuncture and Moxibustion*. Tao Hongjing systematically described and sorted *Shen Nong's Herbal Classic* in his *Variorum of Shen Nong's Herbal Classic*, which has played an important role in promoting the development of medicine in China. In chemistry, Ge Hong’s alchemy research formed the basis of chemistry. In machinery manufacturing, the machines made by Ma Jun represented the highest level of machine building at that time (Wang and Zhang, 2015).

### 3.4 Two Song Dynasties

During the Two Song Dynasties, the famous Four Great Inventions appeared successively in ancient China, and the level of science and technology reached its peak. During this time, the most famous figure was Shen Kuo, who wrote *Dream Brook Sketchbook*, an important academic work integrating various subjects at that time, which still plays an important role in the contemporary era. And Shen Kuo devoted himself into a wide range of literature, art, astronomy, mathematics and so on with greater attainments, which make him as famous as Da Vinci. Shen Kuo was good at philosophy, and compared to other great people of the same age, Shen Kuo was unique in being willing to do field researches, and his many theoretical results had been practically tested, which even can be said to be the earliest science (Zhang anf Hu, 2013).

### 3.5 Yuan Dynasty
Compared to other dynasties, China had some unique features in Yuan Dynasty. China set up close relationships with Arabia, Persia and other countries. Although the level of science and technology in Yuan Dynasty had far exceeded the world’s level, the exchanges with other countries made the level of science and technology reach a higher level. In terms of astronomy, Almagest, Hakim Star Table and others are important works. The Shoushi Calendar formulated by Guo Shoujing and others clearly defines the length of a year, with a very small error, using a variety of mathematical formulas and solutions to spherical right angles as well as the Arabic numerals. In mathematics, the abacus had become the main method of calculation, but the traditional count gradually declined (Yang et al., 2013). In medicine, the Huihui Formularies is an important book in the history of Chinese medicine, and the author is unknown. The book widely contains rich Arabic and Persian contents, which show the characteristics of Western medicine and Chinese traditional medicine. With about 7,000 pieces of prescriptions, the book is the most comprehensive pharmacy classic at that time. In the field of architecture, the most buildings are now built against the Great Capital of the Yuan Dynasty, which were built by a large number of famous and skilled craftsmen and attracted worldwide attention. In the water conservancy, Guo Shoujing not only built the canal to the Great Capital of the Yuan Dynasty, but also set seven locks, named Tonghui River, which was an important breakthrough in China's water history. In agriculture, Yuan Shizu attached great importance to the development of agriculture. The Agricultural Book was one of the most comprehensive agricultural classics, and contains three parts: Nongsang Pass Tactic, which systematically described agriculture, forestry, animal husbandry, sideline fishing and other contents and breeding system, put forward the agricultural idea of following the timeliness; Hundred Grain Spectrum, a detailed description of a large number of crop species; Agricultural Tools Map, which introduces a variety of agricultural tools and plays an important role in promoting the development of agriculture.

### 3.6 Ming Dynasty

First of all, in science, Compendium of Materia Medica, A Survey of the River Defense Working, Heavenly Creations, Complete Treatise on Agriculture, Xu Xiake's Travel Notes and others are important scientific monographs. In this period, the scientific development advanced by leaps and bounds, partly because the Ming Dynasty isn’t far from modern times, and thus there are more contents passed down the Ming Dynasty and partly because in the Ming dynasty, a large number of western books were transferred to China, with great composition on thoughts, which makes the scientific level of the Ming dynasty reach a very high level and take a lead in the world. In calendar, Xu Guangqi’s plan was adopted to revise the calendar and established Chongzhen Almanac, which contains a large amount of astronomy writings, such as On Armillary Sphere and Heaven and Earth Dating Theory. In addition, the Chongzhen Almanac also covers the latest findings in western countries and even theories of astronomy that have not been widely accepted, such as works by Kepler, Copernicus and Galileo. In translation of Western writings, many Western writings had been translated into Chinese in exchanges with Western countries in Ming Dynasty, and spread widely. Many works in the Ming Dynasty had also been shipped abroad, forming a cultural exchange pattern.

### 3.7 Qing Dynasty

The scientific and technological development in the Qing Dynasty as shown in Table 3:

<table>
<thead>
<tr>
<th>category</th>
<th>content</th>
<th>Significance</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medical Science</td>
<td>A doctor of Medicine</td>
<td>A review of medical classics</td>
</tr>
<tr>
<td>Astronomy</td>
<td>&quot;Xiaoanxinfa&quot;, &quot;Wolstenholmen solution&quot;</td>
<td>Mistakes in Western astronomy</td>
</tr>
<tr>
<td>Mathematics</td>
<td>Chinese and Western mathematics</td>
<td>It covers almost all the mathematical knowledge of the world</td>
</tr>
</tbody>
</table>

In the field of medicine, imperial physicians were invited in Qing Emperor Qianlong Period to revise Golden Mirror of Medicine, which includes many important medical works at that time, such as Treatise on Febrile Diseases and Synopsis of the Golden Chamber. In the field of astronomy, Wang Xichan described in detail the outstanding achievements of Western astronomy in his writings, and pointed out and revised the shortcomings and errors. In mathematics, Mei Wending was one of the most famous mathematicians of the time, and recorded almost all of the mathematical knowledge of the world in his book Chinese and Western Mathematical Communication, which was the highest level of mathematics. He also created the earliest equation, and this
algorithm was ahead of the world at the time. In addition, Mei Wending also made high achievements in studies of Western mathematics (Wan and Wei, 2010).

REFERENCES

Ding G.T. (2016). From Kao Gong Ji to fatan, the history of science and technology and ancient literature a case crossover study. Journal of Anhwei Normal University (NATURAL SCIENCE EDITION),39 (05), 493-497.


Zhang B.C.(2012). And to expand the research on the history of Science in China, Based on the study of the history of natural science, the change for example. of Dialectics of nature,34 (02), 103-109+128.
