On the Compilation Modes of Local History of Science and Technology

— A Case Study of the History of Ba-Shu Science and Technology

Zha Youliang*

Sichuan Academy of Social Sciences

Abstract: The contents of "Ba-Shu History of Science and Technology" take up a single volume of *A General History of Ba-Shu Culture*. This paper attempts to explore compilation modes of the history of local science and technology by analyzing the compilation of "Shu History of Science and Technology". There are three approaches available, i.e. a general history-based approach, a discipline-based approach and an integrated approach, also known as a discipline-specific approach based on general history. This paper considers the integrated approach to be the most feasible as it elaborates Ba-Shu culture as a sub-culture of Chinese culture, the connotations of Ba-Shu achievements in science and technology, the special significance of the history of Ba-Shu science and technology, as well as the latest progress in studying the history of Ba-Shu science and technology. This paper also puts forward a possible choice to better approach the compilation of the history of local science and technology, reveals areas worth improving, and indicates a proper direction to move towards.

Keywords: history of local science and technology, history of Ba-Shu science and technology, compilation mode

The study of the history of science and technology (also known as S&T history) comprises the study of the history of science and the history of technology. Science concerns understanding the world, with its achievements being knowledge systems. Technology concerns the transformation of the

* Zha Youliang, Sichuan Academy of Social Sciences.

Correspondence concerning this article should be addressed to Zha Youliang, Sichuan Academy of Social Sciences, Chengdu. E-mail: Zhayl@vip163.com

world, with its achievements being operating systems and physical products. Only by transforming the world can we gradually understand the world. Only by inheriting and developing the knowledge systems needed for understanding can we better transform the world. Thus, science and technology although different are closely related. "The connection between science and technology does not bring the two into an integrated whole; likewise, the difference between them does not place them into absolute opposition. Science and technology can sometimes be interactive in a variety of ways through a complicated process, rather than in one single way through a linear process" (Li, 2007).

A General History of Ba–Shu Culture consists of over 20 volumes, among which is the volume regarding the history of Ba-Shu science and technology. The introduction of the science and technology volume explains the significance of studying the history of Ba-Shu science and technology and its historical stages from a macro perspective (Zha, 2012). It first presents an overall framework of the history of Chinese science and technology and then a detailed account of the history of Ba-Shu science and technology including discipline or field-specific achievements.

The science and technology volume covers ancient achievements in technology, astronomy, mathematics, geography, agriculture, traditional Chinese medicine, the Dujiangyan Irrigation System, well salt mining, natural gas exploitation and metallurgy, local Taoist and Buddhist contributions to scientific and technological progress, Ba-Shu folk arts, crafts and techniques, as well as modern achievements in science and technology. More specifically, the chapters on Ba-Shu achievements in astronomy and mathematics mainly concern the area of science while other chapters touch upon both science and technology, although each of those chapters may only focus on one of the two aspects.

The history of science and technology is a brand-new discipline, and the systematic studies of the history of Ba-Shu science and technology have only recently started. Given that science and technology is a huge system of related knowledge, the material selection for this volume aims to highlight the merits of Ba-Shu science and technology and then to interpret its history in chronological order. Readers may notice that there are still many aspects left untouched in the discussion in this regard. The very existence of these blank aspects precisely indicates that more joint efforts are needed to improve the compilation of the history of Ba-Shu science and technology and to enrich people's knowledge and understanding of the general history of Ba-Shu culture.

The study of the history of science and technology around the world mainly follows two approaches. The first approach is from inside to outside, from discipline to society and from a single perspective to a comprehensive perspective. The second approach is from outside to inside, from society to discipline and from a comprehensive perspective to a single perspective. The history of science and technology generally refers to the scientific and technological history of the world. Over the past century, significant research findings have been made in this regard. There were many works specializing in the history of science and some works specializing in the history of technology. Also, there are an increasing number of works specializing in the study of the history of science and technology in an integrated way.

Scholars engaged in the writing and compilation of the history of science and technology

mostly feature an academic background related to science, technology, engineering and art and possess corresponding knowledge of philosophy, historiography, geography and sociology. Any type of scientific and technological history, be it the intellectual history (internal history), the social history (external history) or the combination of the two, has its own historical and regional scope, chronological clues, as well as theoretical framework. True classics on the history of science and technology, although being intellectually challenging, can have a profound and lasting influence on the development of science, technology and society.

There are two main approaches to the study of the history of local science and technology. The first approach is from big to small and from whole to part. The second approach is from small to big and from part to whole. Over the past century, tremendous research findings have been made. However, almost all are about the history of Western science and technology. Many countries have applied such a research framework to the study of their own history of science and technology and, accordingly, the history of Chinese science and technology has become a key research target which is different from the history of Western science and technology.

Inspired by the study of the history of Chinese science and technology, the academic circles of China began to study the history of local science and technology. For example, the study of the history of Ba-Shu science and technology has already made significant progress over the past three decades. Such a big-to-small and whole-to-part research approach has determined historical research clues. What is needed now is a small-to-big and part-to-whole research approach to deepen the study of the history of science and technology, shape a more comprehensive research model, better combine history with logic and promote the creative transformation and innovative development of science and technology. This is where the significance of studying the history of Ba-Shu science and technology lies.

Ba-Shu Culture: A Sub-Culture of Chinese Culture

What is culture? The core of culture is "way of thinking"; the medium of culture is "way of communication"; the shell of culture is "way of life". Culture features relativity, diversity and variability and highlights man's uniqueness and individuality.

What is civilization? The core of civilization should be respect of rationality, the medium of civilization is moral communication and the shell of civilization is a healthy life. Civilization features absoluteness, consistency and universality and highlights general acceptance and common grounds.

Different ways of thinking, ways of communication and ways of life give rise to different cultures. Throughout world history, geographically there have been Western cultures and Eastern cultures; religiously, there have been a diversity of cultures; ethnically there have been an even greater variety of cultures.

Since the Spring and Autumn Period (770-476 BC) and the Warring States Period (475-221 BC) China witnessed the "Contention of a Hundred Schools of Thought" and cultural exchanges among regions. Chinese culture was gradually shaped, becoming a mainstream of Oriental culture. By

region, Chinese culture can be divided into multiple sub-cultures, such as the Qi-Lu (now Shandong) culture, Zhongyuan (Central Plains) culture, Ba-Shu (Sichuan) culture, Jing-Chu (Hubei) culture, Wu-Yue (Eastern China) culture, Min-Tai (Fujian-Taiwan) culture, Qing-Zang (Qinghai-Tibet) culture and Xinjiang culture, all of which have contributed significantly to their superior culture, i.e. Chinese culture.

The Ba-Shu culture, being a sub-culture of Chinese culture, cannot be truly understood unless it is studied within the framework of Chinese culture. Chinese culture cannot be truly understood unless it includes the Ba-Shu culture. From the perspective of systems science, Ba-Shu science and technology is an organic part of Chinese science and technology. As modern science and technology develops, the significance of Ba-Shu science and technology is increasingly reduced to an historical and relative sense. Still, the study of Ba-Shu science and technology helps deepen the study of the history of Chinese science and technology.

The general history of a culture is supposed to be a work of high cultural values, rather than a mere piece of accumulated historical facts. As a sub-culture of Chinese culture, Ba-Shu culture must be demonstrated within the greater context of Chinese culture. Disciplines at the core of ancient Chinese science and technology, such as astronomy, mathematics, agronomy and medicine were mostly achievements made with the support of the then "state system". For this reason, it is not possible to study and expound the history of Ba-Shu science and technology in an isolated way.

Chinese culture is the "trunk", while Ba-Shu culture is its "branch". Before Qin Shi Huang (First emperor of Qin, 259-210 BC) unified China, the sub-cultures of Chinese culture had mainly developed separately. After the unification of China during the Qin Dynasty (221-206 BC), these sub-cultures had close interactions and gradually merged into a whole, with their relative independence on the wane.

In the history of China, the unification of China by Qin Shi Huang in 221 BC was a milestone. The part of Chinese history prior to the unification is known as the pre-Qin period. Early in 316 BC, the Qin Kingdom conquered the Ba-Shu Kingdom (current Sichuan), bringing about an epoch-making change to Ba-Shu history.

Prior to 221 BC when Qin Shi Huang unified China, Ba-Shu culture had had relatively independent development. After 221 BC, however, Ba-Shu culture's relative independence in development was steadily on the wane and its status as a sub-culture of Chinese culture was increasingly highlighted. Even during the Three Kingdoms period (220-280 AD), which was marked by the tripartite division of China among the states of Wei, Shu and Wu. Liu Bei, who proclaimed himself emperor of Shu in Chengdu, continued to stress his identity as a descendant of the royal family of the Han Dynasty (202 BC-220 AD) and his ambition to rebuild the Han regime.

The history of Ba-Shu science and technology should cover the Ba-Shu people's way of thinking, way of communication and way of life concerning science and technology. By doing so, the general history of the Ba-Shu culture can have its cultural excellence highlighted. Any culture has its unique characteristics and Ba-Shu culture is no exception. An open perspective is a must for an objective

introduction of the history of Ba-Shu science and technology. More specifically, the introduction should be made in the context of the history of Chinese science and technology and should highlight the individuality and uniqueness of Ba-Shu science and technology.

The Connotations of Achievements in Ba-Shu Science and Technology

Achievements in Ba-Shu science and technology mainly refer to scientific and technological achievements "made by Ba-Shu natives" or "made in the Ba-Shu region". The following two achievement categories also count, i.e. achievements made by Ba-Shu natives outside Ba-Shu region and achievements made in the Ba-Shu region by those who were not born in the Ba-Shu region. For example, astronomer Lohsia Hung was born in Langzhong, Ba county (current Langzhong, Sichuan), Ba-Shu region, although he made his achievements in Chang'an (current Xi'an, Shaanxi), the capital of the Western Han Dynasty (202 BC-8 AD). Another example is Li Bing and his son Li Erlang, who made significant contributions to the Ba-Shu region by building the world-renowned Dujiangyan Irrigation System. However, neither Li Senior nor Junior was born in the Ba-Shu region. Li Bing was born in a place currently known as Yanhu district, Yuncheng city, Shanxi province.

Ancient achievements in Ba-Shu science and technology were mainly made in the areas of astronomy, mathematics, agronomy, medicine, geography, water conservancy, well salt mining, natural gas exploitation and metallurgy. Moreover, the Ba-Shu region also enjoyed a unique status in the world history of science and technology with its advantages in silk production, tea planting, liquor brewing, sugar refinery, paper making and woodblock printing. The Sanxingdui Site and Jinsha Site, along with other archaeological discoveries contain abundant scientific and technological items which are worth further exploration. In addition, it is also imperative to further explore and study the scientific and technological contributions made by ethnic minority groups in Ba-Shu.

Scientific and technological innovations made during the 20th century should be covered in detail. And achievements in the popularization of science and technology should also be mentioned. There are still many untouched areas that need to be covered. The selected Ba-Shu achievements in science and technology should be able to demonstrate corresponding "scientific thinking and technological development" and their influence on contemporary society.

The compilation of *A History of Ba–Shu Science and Technology* follows four categories: characters, works, projects and inventions.

The study of Ba-Shu scientific and technological culture requires properly addressing the relationships between the mainstream culture and the sub-culture. Throughout Chinese history, humanistic culture has remained in the mainstream, with scientific and technological culture being its sub-culture. The study of humanistic culture, which has generated substantial research findings, has had a greater influence than the study of scientific and technological culture, which has generated fewer research findings. Humanistic culture and scientific and technological culture influence each other. More specifically, traditional Chinese cultures, such as Confucian culture, Taoist culture and

Buddhist culture for a long time were in the mainstream of China. During that period, scientific and technological culture as a sub-culture had its own law of development and characteristics, which should be thoroughly studied in a systematic way. Consequently, the achievements in Ba-Shu science and technology must also include the contributions of the Buddhist and Taoist cultures to science and technology.

The study of Ba-Shu scientific and technological culture requires properly addressing the relationships between the Eastern and Western cultures. From a perspective of global culture, both Eastern and Western cultures have made their unique contributions to the world's scientific and technological culture. From the 1st century to the 16th century, China was in a global leading position in science and technology. Such a performance should be partially attributed to the efforts of Ba-Shu people. When it comes to the development of science and technology in modern times, however, China did not make many innovative contributions. Why did Chinese science and technology fall behind in modern times? Can China develop its science and technology faster and better in contemporary times? To answer these questions, this paper will further explore the basic law and characteristics of scientific and technological development.

The science and technology volume is primarily characterized by a combination of history and reality. It "sees the present from the mirror of the past" and also "sees the past from the mirror of the present". It is written in a chronological order yet is free from any time constraints. It strives to reveal the realistic significance of the history of science and technology by combining ancient times with present days. The pursuit of cultural excellence in the compilation of a general history of culture does not mean the simple accumulation of historical facts. Rather, cultural excellence is pursued through truthful depictions of the Ba-Shu people's ways of thinking, ways of communication and ways of life. Ways of thinking belong to intellectual culture; ways of communication belong to institutional culture; ways of life belong to material culture. The three types of culture should be integrated into an organic whole.

The Unique Significance of Ba-Shu Science and Technology to the World

From a global perspective, the 15th century witnessed the emergence of the "spread of Eastern learning to the West" and the "spread of Western learning to the East". In such a context, the Eastern culture was introduced to the West and the Western culture to the East, enabling cultural communications across the globe and shaping an inter-infiltrated cultural landscape. Thus, the Eastern culture absorbed many Western cultural elements and at the same time the Western culture also absorbed many Eastern cultural elements. Such a global cultural communication and integration means native culture (native science and technology in particular) in an absolute sense no longer exists.

Judging from the history of scientific and technological development, it becomes increasingly apparent that today's science and technology is neither purely Western nor purely Eastern. Instead, it belongs to all people across the world. Chinese science and technology has contributed significantly to the world science and technology and is an organic part of it. It is fair to say that without Chinese

science and technology, the world science and technology would not have achieved so much today. Likewise, without Western science and technology, the world science and technology would not have achieved so much today, either.

Science and Civilization in China (Needham, 1954-1979), a series of books initiated and edited by British biochemist, historian and sinologist Joseph Needham, was published by Cambridge University Press and has been translated into many languages. The title of its Chinese version was renamed *The History of Chinese Science and Technology*. In a contrastive approach, Needham expounded the contributions of Chinese science and technology to world science, technology and civilization. Based on the common grounds of all civilizations, Chinese science and technology has generated universally acknowledged achievements and become an inseparable part of the world civilizations.

The study of the history of Ba-Shu science and technology is to study the contributions of Bu-Shu science and technology to Chinese science and technology so as to better understand the contribution of Ba-Shu science and technology to the world science and technology. The unique significance of the history of Ba-Shu science and technology to the world lies in specific areas. Ancient Ba-Shu science and technology used to be world-leading, uniquely innovative and hugely influential in areas such as astronomy, mathematics, systematic water conservancy, well drilling, well salt mining, natural gas exploitation, silk production, tea planting, liquor brewing and woodblock printing (Zha, 2015).

The main purpose of studying the history of Ba-Shu science and technology is to sort out and integrate Ba-Shu scientific and technological culture to promote the scientific development of a harmonious society. The adopted approach to the compilation of this Ba-Shu science and technology volume features several innovations. First, the approach has an arguably comprehensive coverage and highlights merits. Every possible effort has been made to make every chapter of the volume "targeted, focused and to the point". Second, the approach brings every chapter of the volume "cross-cultural, interdisciplinary and trans-regional" features. Third, the approach combines featured pictures and photos with concise yet vivid texts, making the content more attractive to readers.

As science and technology transcends provincial and national boundaries, it is difficult to clearly define Ba-Shu science and technology. There are still some aspects which have been left untouched by previous studies and need to be included. Those untouched aspects include, but are not limited to, the status of Ba-Shu science and technology in the entire history of science and technology, the historical stages of Ba-Shu science and technology and Ba-Shu ethnic minority groups' science and technology. Only when based on a comprehensive review of basic historical works (*A History of World Science and Technology*, *Science and Civilization in China*, *General History of China*, *General History of Sichuan*) can the volume expect to unveil the unique significance of the history of Ba-Shu science and technology to the world.

Status Quo of Researches on Ba-Shu Science and Technology

Chinese people have been traditionally known for valuing history. It has been a time-honored tradition for the Chinese to value the accumulation of records on the history of science and technology.

In the Western Han Dynasty, Sima Qian already included the chapters on horoscopes, calendars and music temperament in his masterpiece *Shiji (The Records of the Grand Historian)*, marking the start of including science and technology-related knowledge such as astronomy and tonality in official historical records in biographical style. That was a special case in world history. Even today, China has retained numerous ancient works, which are of great literary value to the study of the history of Chinese science and technology and have become classics for researches in the history of science and technology. Of those works, some are about the history of Ba-Shu science and technology (The editorial department of Zhonghua Book Company, 1976).

Over the past century, outstanding contributions have been made by Chinese scientists in archaeology and archaeological studies. Those contributions have furthered the continuous re-examination of ancient Chinese science and technology. In 1929, Chinese archaeologist Pei Wenzhong discovered the first skull fossil of the Peking Man during excavations at Zhoukoudian (southwest of Beijing), causing a worldwide sensation. The group of fossil specimens unearthed at the Peking Man site in Zhoukoudian indicate that Peking Man (Homo erectus pekinensis) used to live around the area of Zhoukoudian some 700,000-200,000 years ago. They mostly scavenged for food and sometimes also went hunting. They were at the Paleolithic period in the history of science and technology.

In 1995 on the vast Ba-Shu land, a number of archaeological groups (including the municipal archaeological team of Chengdu, Sichuan province and the archaeological team from the Archaeological Teaching and Research Section, Sichuan University) launched a journey of archaeological investigations and excavations at the Baodun site (in Xinjin), the ancient Yufu city site (in Wenjiang), the ancient Pixian city site (in Pidu), the ancient Mang city site (in Dujiangyan), the ancient Xiamang city site (in Shuanghe, Chongzhou) and other sites. This archaeological journey for the first time ever discovered a cluster of ancient city sites dating back to the Longshan period of the Central Plains Civilizations, a historical period some 4,550-4,300 years ago. Those sites were active during the Neolithic period in the history of science and technology.

From the initial archaeological discovery in 1929, the archaeological excavations in the Ba-Shu region have continued off and on for decades. For example, the Sanxingdui site was discovered on the Chengdu Plain, followed by the discovery of the Jinsha site in downtown Chengdu. It can be inferred from the numerous cultural relics unearthed at the two sites that the Ba-Shu region was already in the well-developed Bronze Age from 1700 BC to 476 BC. The new archaeological discoveries on Ba-Shu land have enriched people's understanding of the history of Ba-Shu science and technology.

The first scholar to conduct in-depth research into the history of Ba-Shu science and technology is arguably Lv Zifang, who was a professor at the Department of Physics of Sichuan University. Lv Zifang was born in Ba county, Sichuan province and later went to Japan, where he was admitted to Tokyo Vocational School (current Tokyo Institute of Technology) in 1914. He went to the UK for advanced studies of mathematics, physics and astronomy at the University of Leeds in 1918 and returned to China in 1923. He then successively taught at several universities, including Xiamen University, devoting himself to the education of science and technology. After the founding of the People's Republic of China

in 1949, he first taught at the Beijing Institute of Technology for two years before he was transferred to the Department of Physics of Sichuan University and promoted to professor. During his 12 years of teaching at Sichuan University, Prof. Lv Zifang specialized in the study of the history of Chinese science and technology, completing research works with over 500,000 words (Chinese characters), most of which were about the history of Ba-Shu science and technology. Prof. Lv Zifang played a key role in shaping the academic tradition of Sichuan University. Some of his research findings were immediately recognized and quoted by Prof. Meng Wentong at the Department of History of Sichuan University.

In November 1978 advocated by Yang Chao, then Secretary of the CPC Sichuan Provincial Committee, and supported by Li Chang, then Vice President of the Chinese Academy of Sciences (CAS), the Center for the Studies in Dialectics of Nature of the Chengdu Branch of the Chinese Academy of Sciences was established. The first research task assigned to the center was to sort out the manuscripts left by the late Prof. Lv Zifang and to compile a collection of essays. The completed two volumes of *Collection of Essays on the History of Chinese Science and Technology* were published in 1983 and 1984 by Sichuan People's Publishing House (Lv, 1983, 1984). In 1981 a nationwide symposium was held to discuss the late Prof. Lv's academic works on the ancient history of Chinese science and technology.

According to Prof. He Lu (1983), a well-known mathematician, "Lv Zifang understood the intentions of ancient Chinese people so well that he was able to reinvigorate their achievements made some 2,000 years ago. In this sense, Lv's contribution was significant." The British scientist Joesph Needham considered Lv Zifang to be a scholar with a profound insight into the study of the history of Chinese science and technology. The Hong Kong-based newspaper *Mingpao* published an article entitled "Beyond Joesph Needham" to introduce the newly published *Collection of Essays on the History of Chinese Science and Technology* by Lv Zifang. Joseph C. Y. Chen, an tenured professor of physics at University of California, San Diego, wrote to Zha Youliang, who was a visiting scholar at that university, asking Zha to bring him a copy of *Collection of Essays on the History of Chinese Science and Technology* (Vol. I & II) by Lv Zifang from China.

Based on Lv Zifang's *Collection of Essays on the History of Chinese Science and Technology* (Vol. I & II), the study of the history of Ba-Shu science and technology was enabled, and related monographs were compiled and published. Among the published monographs were *Study of the History of Ba–Shu Science and Technology* (compiled by Feng Hanyong and other staff at the Sichuan Center for Literary and Historical Studies, and published by the Sichuan University Press in 1995), *Lohsia Hung–An Outstanding Astronomer* (written by Zha Youliang and published by the Sichuan Cishu Publishing House in 2001, 2009 and 2018), and *Outstanding Mathematician Qin Jiushao* (written by Zha Youliang, et al. and published by the Science Press in 2003). Lv Zifang was the first one to study the history of Ba-Shu science and technology in the context of Chinese and global S&T history.

With five years of joint efforts between the Sichuan Center for the Research of Ba-Shu Culture, Center for Ba-Shu Cultural Studies under Sichuan Normal University and Sichuan People's Publishing House starting in 1996, *The Series of Ba–Shu Culture* (consisting of 10

volumes) were compiled and published in August 2001. The Series cover the basic aspects and major areas of Ba-Shu culture ranging from the ancient Shu Kingdom, the history of Ba-Shu culture, the history of Ba-Shu philosophy, the history of Ba-Shu science and technology, major Ba-Shu figures from ancient times until now, Ba-Shu places of historical interest and tourist attractions, Ba-Shu food culture, the art of Sichuan opera and the history of Ba-Shu literature, to the culture of Ba-Shu ethnic minority groups.

Duan Yu, a senior researcher and also then director of the Institute of History of Sichuan Academy of Social Sciences, commented "The *Series of Ba–Shu Culture* was the first book series to fill the gap by including monographs on the ancient Shu Kingdom, the history of Ba-Shu science and technology, the history of Ba-Shu philosophy, the history of Ba-Shu literature and the culture of Ba-Shu ethnic minority groups. There were academic and theoretical innovations in its multiple volumes. The *Series* summarized the achievements in Ba-Shu astronomy and mathematics, assessed the important status of Ba-Shu science and technology in the history of world science and technology, explored the ancient Shu Kingdom's system of chieftainship, studied Sanxindui theocratic civilization and discussed the ancient Shu Kingdom's foreign cultural exchange. Representing the latest achievements in contemporary study of Ba-Shu culture, the *Series* has drawn extensive attention in academic circles and laid a solid basis for further theoretical discussions" (Duan, 2002).

Hu Zhaoxi, a professor at the School of History and Culture of Sichuan University held, "The *Series* has unprecedentedly covered a brief history of Ba-Shu science and technology. Although not comprehensive enough to form a general history, it is already a breakthrough" (Hu, 2002). Hu Zhaoxi considered one volume of the series, i.e. *A Brief History of Ba–Shu Science and Technology* to be a breakthrough and pointed out a direction for future development, namely, connecting the highlights of each Ba-Shu scientific and technological achievement by means of general history narration to put things into context.

A Brief History of Ba–Shu Science and Technology was published in 2001 and reprinted in 2010 as a volume of *All About Sichuan Series* by Sichuan People's Publishing House. In the foreword of *A Brief History of Ba–Shu Technology and Science* by Zha Youliang and Zhou Suizhi, Ba-Shu science and technology is defined as follows: "First, it must cover contributions made by those born in the Ba-Shu region to world science and technology; second, it must cover scientific and technological inventions made within the Ba-Shu region in history."

In general, the study of the history of Ba-Shu science and technology is still at an early stage.

Approaches to the Compilation of the History of Local Science and Technology

The history of Ba-Shu science and technology belongs to the category of local science and technology. And there are three approaches to the compilation of a scientific and technological history.

General History-based Approach

Based on general historical clues, the compilation of a history of Ba-Shu science and technology

should cover all historical stages of scientific and technological development; from the stage of infancy (Paleolithic and Neolithic periods), the Pre-Qin period, the Qin and Han dynasties, the Wei and Jin dynasties, the Southern and Northern dynasties, the Sui and Tang dynasties, the Northern and Southern Song dynasties, the Yuan Dynasty, the Ming Dynasty and the Qing Dynasty, to modern times.

Is it possible to compile a history of Ba-Shu science and technology by extracting the parts on science and technology from the historical stage-based seven volumes of *General History of Sichuan*? No, it is not possible. *General History of Sichuan* does not contain much about the history of science and technology or introduce it in a systematic way. In fact, the history of science and technology is just mentioned in passing. Nevertheless, *General History of Sichuan* does offer abundant historical materials and inspirational research findings for the compilation of a history of Ba-Shu science and technology.

Discipline-based Approach

Based on the disciplinary structure of modern science and technology, the compilation of a history of Ba-Shu science and technology should cover introduction, mathematics, astronomy, agronomy, medicine, geography, hydraulics, architecture, engineering, physics, chemistry and biology.

Is it possible to compile a history of Ba-Shu science and technology by extracting the parts on Ba-Shu science and technology from the already published works on the history of Chinese science and technology such as *A History of Science and Technology in China* (Vol. I & II) edited by Du Shiran, et al., *Science and Civilization in China* (Vol. I & II) originally written by Joesph Needham and adapted by Colin Ronan, and *The History of Chinese Science and Technology* (30 volumes) edited by Lu Jiaxi? No, it is not possible. That is because none of these works has shaped the concept of "Ba-Shu science and technology". Still, the research findings on the history of science and technology in China set concrete models for the study of the history of Ba-Shu science and technology.

Integrated Approach: A Discipline-specific Approach Based on General History

This approach combines the disciplinary structure with general historical clues in the context of the history of Chinese science and technology and highlights the merits of Ba-Shu science and technology to compile a history of Ba-Shu science and technology. Much importance is also attached to the expounding of such merits in the general historical context of the development of science and technology in China. This approach is by no means a compromised combination of the first and second approach. Instead, the third approach is a discipline-specific approach based on general history, which is also known as the integrated approach, for short.

What is new about this approach is that the expounding of the historical development of basic disciplines such as astronomy and mathematics is not in the chronological order of Chinese dynasties but is based on major scientists (such as astronomers and mathematicians) and their representative works in history. In the process, their contributions to Ba-Shu science and technology are highlighted. It is my belief that the progress of imperial dynastic alterations is not totally synchronized with the progress of scientific and technological development, for which the stage division of the history of

science and technology should not strictly follow imperial dynastic alterations. This is not a simple application of a particular approach, but a new approach to the compilation of a history of local science and technology.

The history of local science and technology should not be written in an isolated way. Rather, it should be set in a whole picture to allow a part-to-whole comparative study. In this way, a comprehensive view of the history of Ba-Shu science and technology (including its achievements, disparities and deficiencies) is presented to readers. It is true that the primary purpose of studying the history of Ba-Shu science and technology is to carry forward remarkable achievements in Ba-Shu science and technology. Yet at the same time, comparative studies and reflections are needed to identify and reveal those disparities and deficiencies. Only by doing so can Ba-Shu science and technology expect sustainable development, more outstanding talents and more innovations in the years to come.

When studying the history of Ba-Shu science and technology, relevant scholars should attach great importance to the major contributions made by outstanding scientific and technological talents in the Ba-Shu region throughout history, and also to those achievements promoting the comprehensive and sustainable development of the world economy, society and mankind.

The Chinese culture is a sustainable culture and the world's only culture that has continued up to now without interruption. Chinese culture apparently features inseparable "wholeness", which includes the "wholeness of time" and the "wholeness of space". Chinese culture is the "trunk", while other local cultures in China are its "branches". The "trunk" stands for universality while the "branches" represent individuality. Understanding the relationships between universality and individuality is at the core of dialectics.

Chinese culture is characterized by "diversity in harmony" and also "harmony in diversity". Harmonious wholeness is important to Chinese culture, so is diversity. The history of Ba-Shu science and technology is an organic part of the history of Chinese science and technology. An understanding of "diversity" not in the context of "harmonious wholeness" will lead nowhere. Likewise, an understanding of "harmonious wholeness" not in the context of "diversity" will go astray.

Science and technology is an important part of culture. One volume of *A General History of Ba–Shu Culture* is on local science and technology. Since ancient times, scientific and technological developments in the Ba-Shu region have been inseparable to the scientific and technological development of China, which in turn has been inseparable to the scientific and technological development of the world. It was not until the last 50 years that the systematic study of the history of Ba-Shu science and technology began to attract more attention and generate some discipline- and subject-specific research findings. Admittedly, the already completed volume on the history of Ba-Shu science and technology remains shallow and far from profound.

The systematic study of the history of Ba-Shu science and technology has become a new academic fashion which now enjoys favorable conditions. First, this study can borrow substantial research findings which are arguably complete and systematic from *Science and Civilization in China*

and General History of Sichuan for reference. Second, preliminary research findings on the history of Ba-Shu science and technology have already been made. There are related publications such as *Study of the History of Ba–Shu Science and Technology* and *A Brief History of Ba–Shu Science and Technology*. Still there are aspects left untouched and waiting to be covered. The science and technology volume of *A General History of Ba–Shu Culture* marks a new chapter in this research area, which requires further studies.

In the preface of *A General History of Ba–Shu Culture*, the contributor Zhang Yujun clearly explains, "The research object of this book is Ba-Shu culture; the nature of this book is a general history of culture that combines specialized histories; the compilation principle concerns 'three whole', i.e. vertical, horizontal and staggered whole".

"The first is vertical whole, which refers to diachronic whole-process of history." "The second is horizontal whole, which refers to synchronic all-round communication." "The third is staggered whole, which refers to cross-cultural, interdisciplinary panorama" (Zhang, 2019). The "three whole" principle is an innovative top-level design. It requires close attention to the dialectical unity of time and space, cross-culture and inter-discipline, whole and part, the nation and regions, as well as universality and individuality. The "three whole" principle helps scholars understand that the study of the history of Ba-Shu science and technology should give equal consideration to the three aspects of general history, discipline and specialized theme. Every possible effort has been made to study and compile the science and technology volume. Yet, there is still a long way to go.

Regarding the science and technology volume, vertical whole refers to historical clues and development; horizontal communication refers to logical structure and interdisciplinary integration; staggered communication refers to Sino-foreign comparison and ancient-present fusion. To fulfill the three-communication principle, substantial academic efforts should be made in the compilation of the science and technology volume. The development of science and technology follows its own laws. Accordingly, what is adopted for the compilation is the integrated approach (i.e. a discipline-specific approach based on general history), rather than the general history based-approach, which strictly follows the progress of imperial dynastic alterations. Still, this approach is only a preliminary attempt and is far from comprehensive and mature.

The integrated approach (i.e. the discipline-specific approach based on general history), combines the general history based-approach with the discipline-based approach, and theme discussions with general history-based clues. The integrated approach to the compilation of the history of Ba-Shu science and technology highlights the merits of Ba-Shu science and technology, concludes those merits' significance, and reveals the limitations of Ba-Shu technology and science in the context of the general history of Chinese science and technology. The following words are added in the conclusion part of the volume to highlight these merits: By discipline, this volume lists all major achievements of all time in Ba-Shu science and technology; in chronological order, this volume lists outstanding Ba-Shu talents (particularly those with significant historical contributions) from ancient to modern times.

Scholars specializing in the study of science and technology are familiar with science and

technology itself but are likely to lack an awareness of general history regarding the historical development of society, for which they may find "vertical communication" difficult. By contrast, scholars specializing in the study of history have a solid historical framework in mind, but probably lack a profound understanding of science and technology, for which they may find "horizontal communication" difficult. There is still a long way to go before the three-communication principle can truly be fulfilled in the compilation of the local history of science and technology. There are ten scholars participating in the compilation of the science and technology volume. They have tried their best to achieve this preliminary level. It is my hope that the experience and lessons summed up in this paper can help lay a more solid foundation for future innovation and development in this regard.

REFERENCES

Duan Yu. (2002, January 16). Speech at the forum on the publication of the *Series of Ba-Shu Culture*. In Zhang Bin&Zou Yiqing (Eds). Retrieved December 19, 2002, from http://www.sass.cn/124000/352.aspx.

He Lu. (1983). The historical significance and Santong calender and its algorithm: A foreword. In the Center for the Studies in Dialectics of Nature under Chengdu Branch, Chinese Academy of Sciences (Eds). *Collection of essays on the history of Chinese science and technology (Vol. I)* (pp. 20-22). Chengdu: Sichuan People's Publishing House.

Hu Zhaoxi. (2002). Speech at the forum on the publication of the *Series of Ba-Shu Culture*. In Zhang Bin&Zou Yiqing (Eds). Inheriting, innovating, developing and prospering academic culture–Minutes of forum on the publication of the *Series of Ba-Shu Culture*. *Forum on Chinese Culture*, 2, 8-11.

Li Xingmin. (2007). On similarities and differences of science and technology. *Journal of Dialectics of Nature, 29* (1), 1-9. DOI: 10.3969/j.issn.1000-0763.2007.01.001.

Lv Zifang. (1983, 1984). *Collection of essays on the history of Chinese science and technology* (Vol. I, II). In the Center for the Studies in Dialectics of Nature under Chengdu Branch, Chinese Academy of Sciences (Eds). Chengdu: Sichuan People's Publishing House.

Needham, Joseph. (1954-1979). *Science and civilization in China* (Vol. I-III). Cambridge: Cambridge University Press.

The editorial department of Zhonghua Book Company. (1976). *Collection of astronomical calendars and other chronicles of all dynasties in China* (Vol. I-X). Beijing: Zhonghua Book Company.

Zha Youliang. (2012). A tentative discussion on the historical stages of Ba-Shu science and technology from a macro-perspective. *Forum on Chinese Culture*, 2, 68-73.

Zha Youliang. (2015). Ten major achievements in Ba-Shu science and technology. *Forum on Chinese Culture*, 9, 75-79.

Zhang Yujun. (2019). Foreword. *A General history of Ba-Shu culture*. Chengdu: Sichuan People's Publishing House.

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