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The Origin of Chinese Modern Engineering Education: Fuzhou Shipping School's Engineering Education at Late Qing Dynasty

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Engineering education is an important issue in engineering practice, and engineering practice and characteristics can be seen through examining the history of early Chinese engineering education. During the period ranging from the 1860s to the middle of the 1890s, the westernization group set up a series of modern industrial and mining enterprises for military and civil use, making the implementation of modern engineering education become possible and necessary. Thanks to their efforts, many schools and old-style private schools for teaching knowledge about western science and technology and training senior engineering managements and talents were gradually founded in China. These modern education organizations are the source and beginning of Chinese engineering education, which is also the origin of modernization of Chinese engineering education. This article takes Fuzhou Shipping School for case studies, using a cultural anthropology approach to examine the overall status, basic characteristics, and impact evaluation of engineering education during the Westernization Movement in China. It reiterates the idea of that "engineering education should be returned to engineering practice," and tries to explain the framework of the development of engineering education in China. Through conducting research, we find that the development of engineering education in modern China generally has the basic resources for realization of internationalization through "westernization" and localization through traditional culture and education and the general characteristics of diversification of social influence. During the development process, it has accumulated valuable experience for timely reform and gradual improvement of modernization: attaching importance to culture and cultivating qualified technical personnel; strictly requiring and building high-level schools and specialties; learning the advanced knowledge and bravely utilizing foreign educational resources; setting pragmatic and highly pertinent disciplines and specialties. It also left the society with thought-provoking lessons, namely, the lagging industrial production and social instability made the development severely restricted and obstructed; the unreasonable development layout resulted in the intensified imbalanced development in different regions; the bureaucracy nature imposed serious impact on efficiency and effectiveness of education; the negligence of innovation made the great-leap-forward development failed, etc.

Keywords: Engineering Education, China, Fuzhou Shipping School, Late Qing

1. Introduction

The emergence of modern engineering education in China starts from the transplant of education mode in

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Western industrialized society. It is determined by the nature of China's modernization. As an exogenous modernization country which develops later, China's modernization is expanded by the external forces in the background of the capitalist powers' global expansion. As Tao Xingzhi said, since 1820 to 1860, we always fail in the contact with foreigners, and our weaknesses are gradually exposed, while foreigners' advantages are gradually found. After these, we think over the reason why we are so weak and why they are so strong. They are strong because of their diplomacy, therefore we set up Tong Wen School; they are strong because of their navy, therefore we set up Navy and Vessel College; they are strong because of their manufacturing industry, therefore we set up the machine school; they are strong because of their army, therefore we set up Military Academy; they are strong because of their science and technology, so we set up science college (Tao Xingzhi 1991).

2. A Brief Introduction of Fuzhou Shipping School

The Fuzhou Shipping School (renamed from "Seeking Truth Bureau") was established in January, 1867 which was attached to the Fuzhou Dockyard. Though the Fuzhou Dockyard was still in the embryonic stage at the time, the school was already opened and recruited students. The Fuzhou Shipping School is the first modern Chinese navy manufacturing school, and it is also the first one to introduce western science and technology teaching materials and some education system. After Westernization Group establishes Capital Tong Wen Foreign Language School and some other foreign language schools, it is the earliest new school to train technological talents about sailing, ships, and manufacturing technology. The school sets up front school and back school. In front school, students study French linguistics and literature, especially three parts—manufacturing, painting, and horticulture, and it is also called French school or manufacturing school。 Back school studies the English linguistics and literature, especially drive, ships, and engineering, and it is also called English school. This school trains shipbuilding and marine talents which is equal to the level in the modern university. In this sense, Fuzhou Shipping School is the precedent of modern engineering education in China.

Xinhai revolution broke out in 1911, and Chinese history was into the period of the republic of China. In October 1912, the navy department separated Fuzhou Shipping School from the Fuzhou Dockyard. The school was under the direct jurisdiction of central admiralty department, and it was divided into three separate schools—manufacturing schools, naval schools, and art schools. At this point, Fuzhou Shipping School withdrew from the historical stage.

From 1867 to 1912, Fuzhou Shipping School has existed for more than 40 years, which has trained large numbers of talented persons for China, including high-ranking officers of the Navy, engineers, writers, and scholars. Its existence is the longest, and impact is the largest, and it surpasses any modern foreign language schools founded by Westernization Group. Especially as the earliest new school which implements western modern science culture and cultivate talents of science and technology in Chinese modern education, it has the irreplaceable historical significance and far-reaching influence.

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3. Engineering Education in Fuzhou Shipping School

3.1. History and Social Background

After the Opium War, China began the process of modernization. Chinese coast defense engineering quickly started under the influence of these two concepts—"Learning western skills to fight against western countries" and "Western science and technology is used in Chinese feudal system." During this period, the main goal of the coast defense engineering is to defense invasion from the sea, which means defense against the foreign invaders' invasion from the sea. It has gradually become central topic of discussion in some courtiers of the Qing government. As for how to defense invasion from the sea, Zuo Zongtang said: "To prevent the danger from sea and receive the benefits, we must arrange navy division; to arrange navy division, we must set up bureau to supervise and build ships" (The Society of Chinese History, 1961). This means that "once you master the manufacture of steam warships technology, foreigners will not the only ones who are good at this technology." At that time, Zuo Zongtang and some others considered the westernization schools and cultivated new talents as the basis of development of modern Chinese military industry. When Fuzhou Shipping School was founded, Zuo Zongtang cleared that the educational goal of the school was to train China's shipbuilding and driving talents, seek independent of technology, and get rid of foreign control. China wants to be self-improvement, so it is better to learn foreign weapons. Wanting to learn foreign weapons, it is better to seek how to make weapons, so we need to learn their method to make weapons, but we don't need to use the foreigners (Li Shuyuan 2009). Through here, owner's learning Kanren driving actually is to cultivate self-made ships, marine engineering and technical personnel of the machinery and equipment, and offshore and ocean-going sailing ship drivers. In addition, from this passage, it can also be seen that Zuo's "focuses on school-made" thinking.

3.2. Educational System

Shipping School was divided into a "Qian" (front) school and a "Hou" (back) school: Front school studied French and set steamship manufacturing school (major); "Hou" school studied English and set driving and engineering schools (major). Later "Qian" school set painting school (major) to cultivate the turbine design talents; also set up a "skill field" for workers' amateur training in shipyard. These were in line with the characteristics of modern higher education sub-faculties and professional training of specialized personnel.

Each major in shipping school has a relatively complete curriculum system (teaching plan). Foreign language (English or French), arithmetic, and planimetry are common required courses in every major. In addition, every major has its own professional foundation courses and professional courses; some of them are same, while others are completely different. Such as manufacturing major emphatically studies calculus, physics, mechanical principle, internships, graphics, turbine design, and plant practice; driving professional focuses on study of spherical triangle, nautical astronomy, navigation theory, geography, etc. After three years' theoretical study, students must also take part in more than two years' practical training which is called "practice ship." Engineering major focuses on learning mechanical drawing, the offshore mechanical operation rules, machine installation and instrumentation use, etc (Pan Maoyuan 2004).

From the curriculum in Fuzhou Shipping School, it is not difficult to see that its course changes the status quo of the traditional Confucian classic "*Four Books*" or "*Five Classics*" as the main emphasis on practicality and relevance of the curriculum; classroom learning to change the past, only emphasizes imparting knowledge

of the status quo, and pays more attention to the combination of learning and practice and the unity of knowledge; changing the status of the response to the imperial examination distracted pays more attention to the integrity and continuity of the course and the formation of a complete curriculum system (public course, professional foundation courses, specialized courses, and practical classes). This curriculum system breaking the feudal traditional education mode, has a significant impact on the end of Qing founder.

It is set due to a variety of practical courses, training ability batch after batch of senior engineering and technical personnel. This curriculum system beckons the transformation of the traditional educational values, "Despising art," or "your righteousness cheap Lee," underestimating the old concepts of scientific scorn technical impact; old ideas in education have begun to waver (Liu Hong 2006).

3.3. The Unity of School and Factory

The Fuzhou shipping administration government sets up the shipyard and the school at the same time, but it isn't that shipyard runs schools or schools run shipyard, also isn't the factory and schools' union or cooperation, but the factory and schools change to one school system, and teaching and practice are closely integrated. The painting homes of professional design, during the three years of learning, have eight factories internship to the scene to deal with the workers, familiar with the actual details of the various turbine and tools in order to prepare for the various parts of construction drawings and instructions.

Due to the integration of factory and school, each specialty could arrange a lot of internship according to their own characteristics. For example, the machine manufacturing specialty of the manufacturing school had steam engine manufacturing practicum, and shipbuilding specialty had hull construction practicum. A few hours of manual labor were required in each lesson. For instance, there was an eight-month internship in factory during the three-year study of the design specialty. For tube wheel specialty, students were required to exercise engine assembly on shore and then learned machine installation in the newly built ship; students of piloting specialty firstly studied the basic lessons and sailing knowledge in school for five years and then learned the theoretical and practical knowledge of sailing techniques, naval warfare, marksmanship, and command necessary to a captain in the practice school for two or more years.

Integration of the school system in this factory school, there are obvious advantages: First, to better reflect the education and productive labor close. The teacher, "Double Type," is a teacher and engineer; both on the class and factory class. Students are both trainees and apprentices; not only to learn, but also to participate in labor to undertake the production tasks. Carpenter's first School of Arts and Christian's work-study, are both trainees and apprentices, with the obvious characteristics of the "dual system." The second is to better reflect the close integration of the theory and practice. Ocean supervision is both tube school teaching and tube factory production, to facilitate an integrated and coordinated management. So, in this mode of education, school students before graduation, are all with independent producers, management workshops, and directing construction ability; students after school graduate are competent in tube riding tube round, the first mate and the rank (Shen Feimin 2007).

3.4. First Overseas Education Sponsored by Government

Fuzhou Shipping School attaches great importance to the roles of foreign experts. Hiring foreign teachers to teach students is also an important factor in the success about education; it is the best way to change from the state of the closed-door policy in the feudal society in China to learn the advanced technology of western

countries. Teaching and studying are complementary, so it has remarkable results. In the start-up period of Fuzhou Shipping School, all the teachers and assistants are foreigners. According to statistics, the Fuzhou Shipping School employed a total of 42 foreign teachers (25 French, 9 British, and 2 Singaporean).

In 1877, the Shipping School sent 30 students of the first session to learn manufacturing in France and piloting in Britain respectively. In 1881, 10 students of the second session were sent, and the third session was sent in 1886. Before the First Sino Japanese War, the Shipping School has sent 64 students of three sessions to learn in France and Britain. Previously, the Qing Dynasty had the practice of sending children to study in the United States, but it only aimed to "reserve talents for the country," without specific purpose, which can be described as "lack of the consciousness of absorbing the essence of Western culture." However, the Shipping School selected outstanding students to study abroad to cultivate senior engineering and technical talents.

Under the guidance of this thought, Fuzhou Shipping School established the system of study abroad. Regulations of study abroad and teaching plans were formulated by Giquel, and the school hired him as foreign administrator, and hired Li Fengbao as Chinese administrator. Compared with children who were sent to America, students of Fuzhou Shipping School mostly were adults, who had professional and systematic learning in Shipping School, and also had practical study purpose and study plans: Length of schooling is three years, including one year of probationary period and four months to visit and investigate in various regions, then integrate theory with practice. Front and back school both sent students abroad, and students were supervised by both of the Chinese administrator and the foreign administrator. Students were examined for three months, and the final exam was in the last three months before the three years' terms were finished for the various professional students according to the counterpart professional learning to study in colleges or universities except individuals.

4. The Influence of Fuzhou Shipping School of Engineering Education

4.1. Influences on other Contemporary Colleges Engineering Education

At the same time, the school principals, deans, and teachers were mostly the graduates of the Shipping School. For example, Yan Fu once served as the dean, vice principal, and principal of Tianjin Naval Academy; Wei Han once served as the principal of Huangpu Naval Academy; Jiang Chaoying served as the dean, dispatcher, and principal of Jiangnan Naval Academy; Sa Zhenbing established Yantai Naval School and served as the principal of Wusong Merchant Marine School, etc.. Li Hongzhang held that, in the history of modern navy education, "the Shipping Schools in Fujian were the founder, and the Shipping School was the originator of modern Chinese navy school," showing the role and influence of the Shipping School at that time.

These features of curriculum setting and major requirements in Fuzhou Shipping College were emulated by many higher educational institutions. For instance, Shi Xueguan (western studies) in Guangdong, stated clearly in its school constitution that it was set up based on Fuzhou Shipping College's constitution, taking into consideration of the situation in Guangdong Province. Its reasoning is as following: Foreign languages teaching is not specialized in Tongwen College in the provincial capital and Guangfang College in Shanghai before. This time the new college was built up to cultivate experts in navy. Therefore, they should be taught with special knowledge in driving manufacture and be flexible according to the settings in Fuzhou Shipping College. Now two colleges would be opened, with specializing English, in the subjects of Driving and manufacturing respectively. Besides shipping, they could also learn mining, manufacturing, guns and arms, and submarine

mine. This new college's constitution, no matter from the consideration of major, recruitment, rules, curriculum, and examinations, all stated explicitly that the contents came from Fuzhou Shipping College, with some minor modifications. Apart from this case, Fuzhou Shipping College also set a good example for Fuzhou Telegraph College, Tianjin Telegraph College, Shanghai Telegraph College, Tianjin Medical School, Tianjin Shipping College, Guangdong Shipping and Army College, Jiangnan Shipping College, and Tianjin Arms Equipment College. New colleges in different area not only increased their teaching of fundamental science and applied sciences, but also broke the old tradition of teaching pattern, bringing in the combination of theory and practice. The results were that students not only possessed higher level of theory, but also were qualified with practice ability.

4.2. To Cultivate Engineering and Management Talents for the Modern China

The shipping college provides talent resources for the early modernization of China industry. According to the record, Fuzhou shipping which started in 1867 and closed in 1907 has 629 graduates. This group of students has become the earliest engineering and technical personals and technical management personals in modern China. In the Chinese modern history, Yan Fu, Deng Shichang, Zhan Tianyou, and Sa Zhenbing and so on are all early graduates of shipping college.

The first batch of marine engineers in modern Chinese was from the Shipping School. Since the establishment in 1866, the Shipping School cultivated 178 students of manufacturing specialty of 8 sessions, 36 of whom studied in France, and they were China's first batch of marine engineering experts. The outstanding students of the first session included Wang Qiaonian, Wei Han, Chen Zhaoao, Zheng Qinglian, etc.. The hull plan of "Yixin" was: The first ship designed and manufactured by China was measured and calculated by Wu Dezhang and others, while the turbine and tank plans were made by Wang Qiaonian alone. In 1879, presided by Wei Han, the Shipping School Manufacturing Engineering Office including Chen Zhaoming and Zheng Qinglian, replaced the office of foreign experts and became the technical guidance center of the Ship-building Bureau. In 1883, "Kaiji" ship designed and manufactured by Fuzhou Ship-building Bureau was China's first independently designed and manufactured cruiser. According to statistics, naval ships and merchant ships in different sizes imitated, independently designed, and manufactured by graduates of the Shipping School graduates from 1869 to 1905 were up to 44.

Zhan Tianyou, a graduate of the 8th session of the Shipping School, was an outstanding railway engineer. From 1905 to 1909, he presided over the design and building of Beijing-Zhangjiakou Railway, the first railway designed and built by China. It was an arduous project, even difficult to foreign experts at that time, which won great honor for the motherland. Wei Han participated in the building of Guangzhou-Kowloon Railway, and later served as the command of Henan Xuchang railway construction project. Gao Lu prepared "Changchun Almanac," built China's first astronomical observatory, which formally determined the latitude and longitude of Beijing, and cultivated a number of meteorological measurement talents and he was regarded as the founder of China's modern astronomy. The graduates of the Shipping School participated in the establishment of China's first aircraft manufacturing factory, and succeeded in manufacturing the first 150 horsepower airplane. Later, they independently designed and manufactured 15 aircrafts, making significant contribution to China's early development of aviation industry.

The Shipping School also provided a number of outstanding talents for China's modern education and cultural undertaking, who made remarkable contribution to the east-west cultural exchanges. Yan Fu, a graduate

of the first session, was the first person to systematically introduce and disseminate the capitalist culture and scientific knowledge. He translated eight western classics, of which the "Evolution and Ethics" has the greatest influence. The materialist theory of evolution of "natural selection, survival of the fittest" advocated by "Evolution and Ethics" sounded the horn of modern ideology of the enlightenment, and inspired a generation of patriots to save the nation from subjugation and ensure its survival. As a renowned enlightenment thinker in modern China, Yan Fu was highly respected by celebrities such as Kang Youwei, Cai Yuanpei, and Mao Zedong. Wang Shouchang, a graduate of the third session of the Shipping School, co-translated "Camille" with Lin Shu, arousing a sensation in the country. Chen Jitong, another outstanding graduate, was the first Chinese who translated classics such as "A Dream of Red Mansions" and "Strange Ties from a Scholar's Studio" into French.

The graduates of The Shipping School were also in the hot seat of military and civilian industrial sectors including machinery, metallurgy, aviation, telegraph, weapons, mines, etc., making an important contribution to the construction of China's modern economy. The Shipping School set up in late Qing Dynasty raised a large number of elites to modern China. Its status and influence went farther than Guangdong Huangpu Military Academy founded in the Republic of China.

5. The Evaluation of Engineering Education at Late Qing Dynasty

About the origin of Chinese engineering education, there usually are some common perspectives, as following. Wang Lieying regards shipping school as the beginning of Chinese modern higher education of engineering. Hong Zhao and Yong Jin think Peiyang University is the start of Chinese engineering education (Wang Lieying 2004). Qian Wei thinks that the modern Chinese engineering education starts from various western schools that the westernization group of late Qing Dynasty set up, but in a very real sense, the higher education of engineering starts from the Peiyang University after the Sino-Japanese War (Qian Wei 2002). We can put this two kinds of engineering education as two typical representative which are "academism" engineering education and "non academism" engineering education. Among them, "Academism" engineering education views engineering knowledge as explicit knowledge, pays attention to the scientific nature of the engineering activities, and focuses on the students' scientific theory, technical knowledge training, knowledge accumulation, knowledge dissemination, and the construction of knowledge systems; while, "Non academism" engineering education views engineering knowledge as tacit knowledge, pays attention to the engineering practical activity, and focuses on the students' practical ability and skills training. For a long time, influenced by the western engineering education thoughts, Chinese engineering education attaches great importance to the theory and light practice, causing the lack of practice ability of Chinese engineering. In ancient times, Chinese engineering education has strong practical guide, and it gets a good inheritance from Fuzhou Shipping School.

From the engineering history, ancient and modern early engineering talents are craftsmen who have the skills and experiences. After the 18th century industrial revolution, with the theories of natural science knowledge in the application of engineering and production increasing widely and deeply, the industrial production technology structure gradually becomes multilayered, according to that the discrepancy engineering talent team structure also is in produce change. Not only the craftsmen in the original level need to master certain knowledge of science and culture, but also gradually form some of the higher professional class above the craftsmen, i.e., engineers and technicians. So, the engineering talent team of western industrialized countries has formed a basic technology, workers, technicians, and engineer's hierarchical structure with

pagoda shape. In the 1960s and 1970s, Chinese industrialization was in the initial stage. Those people who strongly advocated the development of modern machine industry and industrial education still lacked of clear understanding about the multiple level of the modern engineering talent team structure. They often focued on skill training and ignored the training of engineers who were "very familiar with the scientific principle." The situation was changed by the end of 1990s, so understanding of the nature and the characteristics of higher engineering education with the purpose of training engineers also began to clear up (Shi guiquan 2003).

The modern engineering education development has been one of the important aspects of China's education and social modernization. Based on the historical logic of "strengthen the army and revitalize our country, develop industry, cultivate intellectuals, enhance education," the appearance of modern engineering education in China starts from the education mode which transplants the western industrialized society. It makes the national goals and national planning, and constitutes the direct power and important influence factors of Chinese engineering education development. With the purpose of promoting "science services for the need of daily life," it may be viewed as clearly different from the western engineering education (Lawrence Grayson 1998).

But like that the endogenous development of western modernization is from bottom up, the engineering education development of western industrialized countries is the comprehensive realistic requirement proposed by the industrial society and engineering education, and society realizes the organic connection and unity. In second resource countries of modernity, engineering education is founded in the national planning and transplantation of western mode, and the process of its development inevitably is faced with all kinds of maladjustments in the Chinese society. This maladjustment and even isolation are expressed in: On the one hand, it is isolated from traditional Chinese society and traditional culture which brings the conflict between culture and concept; on the other hand, it is isolated from business enterprise (market) for the performance of the engineering education development and Chinese economic development, and the process of industrialization is often in the inharmonious state. Therefore, engineering education in China has shown a unique developing process since it first comes into being (Wang SunYu 2009).

6. The Revelation of Engineering Education at Late Qing Dynasty

In America, engineering education is the education and teaching activity which is for those learners with the purpose of engaging in engineering profession or popularizing scientific and technical knowledge through the science, mathematics, and practice to enhance learners' interest in technology vocational education among the middle school, the academy, and the university.

The scholar of our country, Xie Zuzhao thinks: "Higher engineering education is a kind of professional and technical education, and one of the important tasks of it is to train students to master the basic knowledge of natural science which makes the students have the knowledge applied to practical ability" (Xie Zuzhao 1992). Zhang Guangdou points out: "Higher engineering education has two basic characteristics which are as a kind of technology education: On the one hand, it takes technology and science as its main subject foundation, and the application of technology as its main professional content which distinguishes the scientific education; on the other hand, it takes engineering application as its main service object" (Zhang GuangDou 1995).

6.1. "Engineering Practice" Turn in Engineering Education

The nature of engineering lies in application, practice, and innovation. The nature of engineering

rationality manifests as practical rationality. Engineering represents the non-representational practice tradition of life, which is related to contingency, purpose, trial, and error. Goldman held that the differences between engineering and science represented two different cultural traditions in the west, and were shown as two groups with different concepts (Sheng Xiaoming 2005). However, the two concept groups could be respectively integrated into the principle of sufficient reason and principle of insufficient reason 1. Therefore, engineering rationality and scientific rationality characterize two rational traditions, which are mutually antagonistic while mutually uniform. Throughout the development of western culture, scientific analytic rationality has been dominating the social reality of life and people's ideas, and engineering rationality is a part of the so-called irrational tradition. Relative to science education, engineering education has more distinctive culture, ethnicity, and sociality.

As a very practical activity, engineering is not only a process of knowledge application, but more of a process of knowledge integration and innovation. Therefore, from operational view, engineering knowledge has strong "individual property" and "social" characteristics.

Engineering knowledge is the process of design, building, and operation of artifacts for the purpose of human environment. Its main contents include the investigation of engineering agreed terms, determination of engineering goals, design of engineering proposal, wise decision-making, and forecast of engineering consequences, etc.. Engineering knowledge is task-targeted and focuses on the production of artifacts to fit the needs of the intended purpose (Li Shixin 2005). As a result, unlike pure scientific knowledge which can be obtained in the laboratory and verified by reasoning, engineering knowledge is largely associated with action and tested in the outdoors. It has strong simulation and situationality, and its comprehensiveness is more significant than the analyticity. In terms of curriculum provision, these features of engineering knowledge require basic and comprehensive scientific knowledge, humanities and social sciences adaptive to engineering activities, and adequate practical active knowledge and experience. On the other hand, in terms of the intrinsic property, it is characterized by explicit and tacit features. Explicit engineering knowledge can be acquired through concrete learning process, whereas tacit engineering knowledge can only be comprehended in the experience of engineering activities (Duan Xinming 2007).

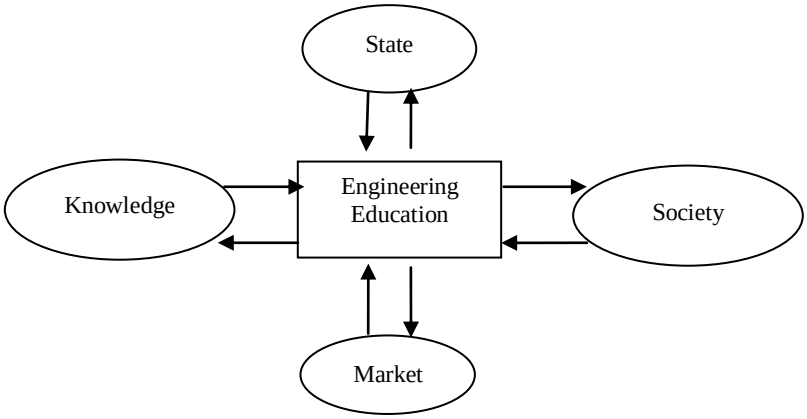
6.2. Explanation Framework on the Engineering Education at Late Qing Dynasty

On the whole, the engineering education in the westernization period represented by shipping school failed to play an important role in China's engineering education, and almost interrupted the heritage of modern engineering education in China. In the exploration of early failure factors of engineering education in China, we should not simply attribute to the failure of the ideology of "Chinese learning for the essence, western learning for practical use." In the aspects of the arrangement of curriculum and teaching system, the early engineering education system was fully transplanted from the western education; to some extent, it can be deemed as "Western learning for both essence and practical use." Such singular "system-practice" relationship analysis framework cannot explain the changes of engineering education process, but more factors and explanation frameworks should be introduced to illustrate the evaluation of engineering education.

In 1983, Burton Clark proposed the "triangular coordination mode." He believed that there were three systems and three powers in higher education, namely, state, academic power, and market, and constructed a three dimensional coordination framework of state power, academic oligarch, and market to positioning the development of higher education. Clark's "triangular coordination mode" eliminated the defects of

one-dimensional analysis of higher education development and became a classic paradigm to explain the development of modern higher education system operation. However, the analytical framework established by Clark still cannot show the impact of social, economic, and cultural factors of different countries on authoritative direction (Gareth Williams 1995).

To this end, we propose a quaternary interpretive framework combining state, society, knowledge, and market.



Early Chinese engineering education was established by following the mode of Germany and Japan. In face of the special political environment, its state-serving political function was particularly significant, and the state was always in the dominant status of engineering education. As described by Shu Xincheng, the reason for implementing new school system at that time was not the need of national conditions or at people's request, nor the education responsible personnel or scholars had special study in this regard and were aware of its advantages, because of the weakening country potential. The rulers thought the prosperity of other countries was based on the specific education system with a strong sense of form, thus striving hard to imitate to seek survival. Shu's remark was made on the school education system. For engineering education, it encountered the dilemma of being sniffed by most gentries while unknown to the majority of people. The planning and implementation of the country's modernization (industrialization) has always been the direct driving force and the crucial influencing factor of the development of Chinese engineering education over the century. The play of these roles would inevitably face the challenges of gradually maturing academic elites. In policy making, how to realize the appeals of different interest groups such as the society and market, and how to balance and resolve the scale of education development, structural contradictions, and regional differences, would form challenges to the traditional national hegemony.

The short of stable social environment and reliable economic guarantee for normal development is also a special problem in engineering education in modern China. Since the breakout of the Opium War, China has suffered great toughness of unceasing wars broken out on its territory, which also left the engineering educational organizations in the ravages of war. The influence on Fuzhou Shipping School by Sino-French War, the influence on Peiyang University and School of Combined Learning by the war launched by the Eight-Nation Alliance, and the disturbance and damage on schools at all levels by domestic political turbulences and warlord dogfights were rarely seen in other countries. The military expenditure which occurred in the wars frequently flamed inside and outside China, and especially the huge amount of war indemnity after being defeated, made the central and local governments in the late Qing Dynasty and the earlier stage of the

Republic of China severely suffered from deficient financial resources, which also imposed direct and indirect negative effects on the development of engineering education. The direct influence is that due to the short of financial support, all large-scale modern educations could not be launched including the engineering education, which required heavy funds. The indirect influence is that the development of modern industry and the basis for engineering education, could not be greatly boosted.

In terms of society, as a product completely transplanted from the west, Chinese engineering education has been under the restraints of traditional concepts, cultural, and traditional values on long-term basis. Since the establishment of engineering education in China, like the local technical knowledge, the technical knowledge taught by the schools was not concerned by people. The imperial examination system, a traditional talents selection system in old China, took the Confucian's cultural and literary books and records as contents and basis of examinations, thus intensifying the dominant position of Confucian's academic science mainly which adopted the philosophical and intellectual speculation and textual research method in exploration of abstract philosophy, moral principles, and political topics; instead, it regarded the studies and writings about science and technology which were closely related with actual production and live as inferior thoughts. Therefore, most of Chinese scholar-bureaucrats (in feudal China) and civilians neglected and even despised the scientific invention and creation. For a long time, the relatively powerful and prosperous culture and comprehensive national strength of traditional China have made Chinese intellectuals always feel arrogant. Beginning from the middle of the Qing Dynasty, the government started executing the seclusion policy, making Chinese people utterly ignorant about the tremendous changes and progress of the western and becomes extremely and blindly conceited. For this reason, for a long period, the Chinese people were not open-minded to the new modern education which drew experience from the western and focused on teaching science and technology. In the era of official standard dominated by the value of excelling in study following an official career, science and technology were deemed as clever tricks and wicked craft, so it is not difficult to understand the reason for the slow development of engineering education.

In the aspect of market (enterprise), unlike the case in western society, the emergency of Chinese engineering education is not to meet the market (enterprise) need, but serve the country-specific goals. The principal part of Chinese traditional culture is the Confucian's politicized moral principles and culture, and the teaching about Confucian's cultural and literary books and records is the focal point in traditional educational. As a result, in the beginning when the schools of engineering education were founded in China, it was hard for them to recruit the students with qualified knowledge background. Additionally, the small-scale traditional scientific researches and educations in China were mainly focused on the stage of practical technology, instead of the scientific theory and technology needed in modern industry; therefore, in the initial stage when the modern industrial education was introduced to China, the Chinese teachers who were competent for teaching scientific knowledge were in great shortage, making such education greatly depend on the foreign teachers with different levels of academic background and instable working time and sourcing. In a long time of engineering education development, enterprises played a minor role in engineering education.

From the academic point of view, the traditional Chinese academic research was mainly oriented at the study of Confucian classics, a comprehensive knowledge which had not been differentiated and was particularly about the politicized social ethics and morals and mixed with other fields of knowledge. Before the modern knowledge was introduced from the western, Chinese academic research had always been conducted according to domestic logics and ideals. After the modern higher industrial education was unveiled, a series of

completely different western discipline and knowledge systems were introduced to China and emerged in Chinese scholars' vision. Modern Chinese academic systems and modern academic institutions both had the transportation from modern western academic research institutions and the creative transformation of traditional Chinese academic institutions.

In modern times, with engineering education as the leading part in western academic knowledge introduction, the country had introduced the western discipline of natural science and technology and the knowledge and methods about the discipline, which exerted two aspects of influence on Chinese modern academy, namely, the formation of concept and scientific method of multi-channel development of academy.

On the one hand, the concept of multi-channel development of academy in modern times of China originates from the introduction of western's well-defined disciplines. Through classified setting of majors and courses, the higher industrial education shows people the possibility and necessity that the study and research of modern science and technology must be divided into different sorts.

On the other hand, the introduction of strict scientific methods means the thorough transformation and innovation of Chinese academic research by western science and technology. Generally, the methods of Chinese traditional academic research feature in the apparent subjective perception and fuzziness and less spirit of suspicion and breakthrough, which is due to Chinese traditional culture. With the great booming of education of science and technology in the western, especially the expansion of higher education of science and technology and the improvement of educational level and quality which is closely related with the academic world, the concept of adopting scientific method for academic research and "re-examining all values" has basically and unanimously agreed before and after the May 4th Movement.

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