Chapter 8
Educating Chinese Engineers: The Case of Shanghai Jiao Tong University During 1896–1949

Brent K. Jesiek and Yi Shen

Abstract This chapter summarizes the early institutional history of one of China's most important and well-regarded engineering schools, Shanghai Jiao Tong University (SJTU). It shows how the university and its engineering programs evolved in tandem with national development and defense priorities from the school's founding in 1896 through the formation of the People's Republic of China (PRC) in 1949. More specifically, we look at key changes in the school's admission policies, pedagogy, curricula, and organizational structure, as well as typical career pathways for its graduates. To further contextualize this account, this chapter begins with a general history of engineering education in China from the late Qing Dynasty through the Nationalist period. This chapter should be of interest to those wanting to know more about the historical foundations of the engineering profession in China, including the role of leading educational institutions in China's national development.

Keywords China • Engineering education • Engineering profession • History • Nationalist • National development • Republic of China • Shanghai Jiao Tong University

---

Equal coauthors on this chapter. The content of this chapter is based on work supported by the National Science Foundation under Grant No. EEC-0965733, "IREE: Developing Globally Competent Engineering Researchers."

B.K. Jesiek, Ph.D. (✉)
School of Engineering Education and School of Electrical and Computer Engineering, Purdue University, West Lafayette, IN, USA
e-mail: bjesiek@purdue.edu

Y. Shen, Ph.D.
Digital Research and Curation Center, Johns Hopkins University, Baltimore, MD, USA

S.H. Christensen et al. (eds.), *Engineering, Development and Philosophy*, Philosophy of Engineering and Technology 11, DOI 10.1007/978-94-007-5282-5_8,

Introduction

In relation to social and economic development, China is often portrayed as a recent and rather dramatic success story. *The World Factbook*, published by the US CIA, nicely captures the dominant story line: "China's economy since the late 1970s has changed from a closed, centrally planned system to a more market-oriented one that plays a major role in the global economy" (US CIA 2011). One might even argue that China now plays a *primary* role in the global economy. In 2009, it moved into position as the world's leading exporter and in 2010 surpassed Japan to become the world's second largest national economy, trailing only the USA (Hamlin and Yanping 2010).

In light of such trends, many commentators have expounded at length on China's so-called economic miracle. And in line with the preceding *Factbook* quote, much of this literature portrays China's developmental arc as one of recent origin. But with 2011 marking the hundredth anniversary of the fall of the Qing Dynasty and first steps toward a Republic of China, it seems an appropriate time to take a longer view of China's development. To what extent is China's ascendency built on deeper historical foundations, going at least back to the country's Nationalist government?

There is also the question of what roles engineers and engineering have played in China's national development. As Andreas notes, "China today is ruled by red engineers" (Andreas 2009, p. 1), as evidenced by the many engineers who have held powerful positions in the upper ranks of China's ruling Communist Party. Engineering is also one of the most popular majors for Chinese students, and even conservative estimates suggest that China graduates 300–400,000 engineers per year at the bachelor's degree level (Bracey 2006; Gareffi et al. 2008). Such trends are especially notable for commentators from Western countries like the USA and Great Britain, where the number, visibility, and influence of engineers are relatively low by comparison.

As a growing body of scholarship suggests, we might better understand such trends by looking squarely at the intersection of engineering and development. Using a series of national case studies, Downey and Lucena (2004) argue that national variations in engineering knowledge and profession are often deeply intertwined with national history and identity. As a more specific example, various scholars have explored how engineers have historically constituted the French state, promoting its development through rationalized planning from within the central government (e.g., Alder 1997). In this regard, China bears some resemblance to France. Yet on closer examination, the history of engineering and development in China is replete with idiosyncrasies and discontinuities that have only begun to be studied, especially in English language accounts.

Zhu (2010), for example, has explored evolving understandings of the modern engineering profession and engineering ethics in China from the dynastic period to the present, while Kirby (2000, 2010) has examined the roles of engineers and engineering education in modern China, especially during the Nationalist period. Andreas' *Rise of the Red Engineers* (2009), on the other hand, examines the history of China's prestigious Tsinghua University from the formation of the PRC to the present. The author shows how changes in political ideology and development priorities directly impacted

the structure and content of engineering education at Tsinghua, as well as the status and influence of the school's students, staff, and graduates.

By discussing the history of another important educational institution during the country's Nationalist period, our chapter makes further contributions to the English language literature on engineering and development in China. We begin with a general history of engineering education and professionalization in China from the late Qing Dynasty through the Nationalist period. We then turn to a more in-depth institutional history of one of China's most important and well-regarded engineering schools, Shanghai Jiao Tong University (SJTU), with particular emphasis on examining how the university and its engineering programs evolved in tandem with national development priorities from the school's founding in 1896 through the formation of the People's Republic of China (PRC) in 1949. More specifically, we look at key changes in the school's admission policies, pedagogy, curricula, organizational structure, and alumni career pathways. This chapter should be of interest to anyone wanting to know more about the historical foundations of modern engineering education and profession in China, including the roles of leading educational institutions in China's development.[1]

Emergence of Engineering Education

Late Qing Dynasty, Mid-1800s to 1911

While ancient China's important role in the development of science and technology is well documented (Needham and Robinson 2004), its engagement with modern engineering is relatively recent. Through most of the nineteenth century, China's dominant educational model and imperial examination system remained narrowly focused on the study of classical Confucian texts for careers in civil service, and the prevailing social hierarchy gave government officials and farmers higher status than technical professionals, craftsmen, and merchants (Wang et al. 2010). Yet after centuries of traditionalism and isolation, various influences encouraged the initial but uneven development of the engineering profession in China. In particular, a series of military skirmishes and concessions during the latter half of the nineteenth century revealed China's vulnerabilities in relation to the more technologically advanced powers of Japan and the West. In response, a "Self-Strengthening Movement" emerged in the early 1860s to promote China's national development, including through diplomacy, engagement with Western science and technology, and military modernization (Wang 1998, pp. 301–302).

[1] In fact, some of this chapter was first drafted to prepare US engineering students for research internships in China, including at SJTU, for the NSF-funded International Research and Education in Engineering (IREE) 2010 China program (US NSF Award No. 0965733).

Against this historical backdrop, Kirby reports that the first use of a Chinese word equivalent to the modern "engineer" (*gongshi* or *gongchengshi*) appeared in a government report published in 1883, and in 1888 the term was recognized as an official title by Qing officials (Kirby 2010, p. 284). As Zhu notes, such changes in terminology exemplify how the modernization and Westernization movements of the period were challenging China's deeper social and cultural traditions (Zhu 2010, p. 90). Such movements also ran parallel with creation of new indigenous pathways for technical education. In 1862, for example, the Qing government founded the country's first Western-style college, the Tongwen Guan in Beijing. While initially providing language training for China's diplomats, it also soon became the country's first school of science and technology. Foochow Shipbuilding College, on the other hand, was established in 1867 as part of efforts to upgrade the country's outdated navy. British and French influences were evident in the school's teaching staff and curricula, and it offered 3- to 5-year programs in navigation, ship design, and ship maintenance (Wang et al. 2010, pp. 5–9). By 1911, it had graduated 178 naval engineers, although some have questioned the quality of the education provided and noted that job prospects in China were limited at the time for graduates with advanced technical training (Reardon-Anderson 1992, p. 55).

Given a lack of domestic educational opportunities, in the 1870s, the Qing government also started sending Chinese students and military personnel abroad for training. Many traveled to the USA, Europe, and Japan, and some earned degrees in science and engineering (Hayhoe 1996, p. 40). One of China's most famous engineers, Zhan Tianyou, was among the first cohorts of Chinese students educated abroad, and his biography illustrates the uneven state of engineering education during this period. Zhan was fortunate to receive his bachelor's degree in civil engineering from Yale in 1881, just before the Qing government abruptly and temporarily reversed its policy and recalled all Chinese students who were studying in the USA at the time ("Imperial Students" n.d.). After returning to China, he completed a year of naval training at Foochow and soon after launched a career in civil and railroad engineering ("Imperial Students" n.d.). In fact, Zhan was the first Chinese official to hold the official Qing title of engineer, and he led a series of ambitious and successful railroad construction projects (Kirby 2010, p. 284). Given the underdeveloped state of engineering education and profession during the late Qing Dynasty, Zhan's is a story of improbable success.

During the late nineteenth and early twentieth centuries, the Qing government took a number of steps to expand and modernize the country's educational system. For example, Peiyang University was founded in Tianjin in 1895, during the last years of the Self-Strengthening Movement (Wang et al. 2010, pp. 9–10). In addition to being one of the first schools in China to wholly adopt a Western model of university education, Peiyang responded to national needs through its early establishment of rigorous 4-year programs in civil, metallurgical, mining, and railway engineering. Even more generally, legislation passed in 1902 and 1903 explicitly advocated creation of a system of higher education that included engineering universities, or *gongke daxue* (Hayhoe 1996, p. 35), and in 1905 the Emperor famously endorsed a discontinuation of the country's traditional examination system (Elman 2000).

Yet the actual implementation of such measures stalled as the power and stability of the dynasty eroded. By 1909, China had only three universities (*daxue*) with 749 students, 24 higher-level, provincial schools with 4,203 students, and 101 specialist colleges with 6,431 students. These schools were training very few engineers. For example, just three percent of students in the specialist schools were studying science or engineering at the time – as compared to 50% in law and politics (Hayhoe 1996, p. 42). As this evidence suggests, engineering education remained a marginal and immature field through the late Qing Dynasty.

Nationalist Period, 1911–1949

The history of modern engineering can often be explored by looking at the emergence and growth of higher education, professional societies, and sites of employment. During the Qing Dynasty, educational and career pathways underwent modest developments, while professional societies did not yet exist. As dramatic change swept through China during the Nationalist period, the growth and vitality of the engineering field was evident in all three domains, especially as the profession became increasingly intertwined with the government's priorities for national development and defense.

The country's educational system was one early and important target for reform, paving the way for major expansions of higher education generally and engineering education specifically. As examples of some early and important changes, the Confucian classics were ordered out of curricula, and a "university decree" in 1912 identified universities as the highest educational institutions in the country (Yang 2002, p. 32). The decree also linked universities with specific combinations of fields. For example, a given university might elect to strategically focus its mission and curricula on sciences along with agriculture, medicine, or engineering (Hayhoe 1996, p. 43).

Through the 1910s and into the early 1920s, continued social and political unrest impeded the formation of new educational institutions. Yet as the 1920s progressed, increasing political stability and national unity, coupled with supportive legislative moves, ushered in a major expansion of higher education. The number of university-level institutions increased to eight in 1917 and 35 by 1923 (Hayhoe 1996, p. 47; Yang 2002, p. 33). The number of specialized institutions of higher education, including engineering schools, also rose, and the number of students enrolled in both types of schools jumped from 23,334 in 1917 to 34,880 in 1923. Study abroad continued during the 1910s and 1920s, with many hundred Chinese students sent to the USA and Europe and thousands to Japan (Hayhoe 1996, p. 49). Many of the scholars who received graduate degrees abroad quickly moved into leadership roles in Chinese universities.

As the central government gained greater control of the country in the latter half of the 1920s under the leadership of Chiang Kai-shek and the Nationalist Party (KMT), the expansion of higher education accelerated. By 1930, there were 39 universities, and student enrollment in engineering rose to 11.5% of all university

and college students (Hayhoe 1996, p. 52). This growth temporarily stabilized in the early and mid-1930s, with the country home to about 100 universities, 7,000 faculty, and 40,000 students at any given time (Xin 2001, p. 187). Yet concerns about a lack of students in the basic and applied sciences led to further reforms, and by 1937 the proportion of students in engineering was 18% (Hayhoe 1996, p. 54). Kirby similarly notes that the number of students in science and engineering doubled at government institutions between 1931 and 1936, and during the entire decade of the 1930s, the total number of engineering students increased threefold. Engineering programs at prominent schools like Shanghai Jiao Tong University benefitted greatly from major increases in student enrollment and government funding (Kirby 2000, p. 147).

The dominant style of higher education also evolved as China's universities expanded and matured in the 1920s and 1930s. American influences were evident, for example, in the use of course credit systems and formation of academic colleges and departments (Xin 2001, p. 186, Hayhoe 1996, p. 54). European influences were more apparent during the latter part of this period, especially as faculty embraced academic freedom and universities sought greater institutional autonomy. Other Western influences from this period include the widespread use of English language textbooks and an emphasis on "general education" and common curricular requirements (Xin 2001; Cheng 1965, p. 99). Yet especially in the area of graduate education, China continued to rely heavy on training abroad, with American universities alone granting more than 9,000 degrees to Chinese students between 1930 and 1954 (Guo 1998, p. 45). Perhaps not surprisingly, many of the academic programs developed during this period emulated the high academic standards of schools abroad. As one commentator noted, "In the pre-Communist period, admission to a department of science or to an engineering college was granted only after strict selective processing. For graduation, rigorous examinations had to be passed" (Cheng 1965, p. 102).

As China's system of higher education trained ever more engineers, the aforementioned Zhan Tianyou established a new organization to support the profession. Formed in 1912, the Chinese Society of Engineers (*Zhonghua gongchengshi xuehui*) initially had just 148 members (Kirby 2010, p. 284, Hao 2003, p. 41). In 1931, it merged with the Chinese Engineering Society, which was founded at Cornell University in 1918 by Chinese nationals pursuing advanced engineering degrees in the USA. Around this time, the organization had some 2,300 members – itself a testament to the profession's growth. During its early history, the group worked to promote the profession, standardize engineering education, and advance the nationalist agenda. Initially the society also strived for professional autonomy and self-regulation, but this "gradually gave way to greater cooperation with, and reliance on, the state that now educated and certified engineers" (Kirby 2000, p. 149).

As the preceding passage suggests, engineers gained prominence as the Nationalist government embraced a development ethos in the 1920s and 1930s. This opened up important career pathways as many engineers helped build infrastructure and promote urban development, including by expanding the country's communication, power, and transportation networks. Sun Yat-sen's *The International Development of China*, published in the early 1920s, was particularly influential as a technocratic and scientifically oriented blueprint for building the Republic under Nationalist rule

(Kirby 2010, p. 285). Kirby even describes Sun as "the spiritual father of the Chinese engineering state" in light of his proposals for ambitious infrastructure projects and faith in science and technology (Ibid, p. 286).

In the 1930s, the government's National Resources Commission (NRC) emerged to lead development of China's infrastructure and industries, including in anticipation of a possible war with Japan (1937–1945). It quickly became the biggest employer of engineering graduates and for a time was headed by a former president of the Chinese Society of Engineers. It recruited heavily from the leading Chinese technical schools, and especially graduates of Shanghai Jiao Tong University. As Kirby notes, the NRC was an "engineer's salvation" because it provided career opportunities in an environment that was less politicized than other government agencies (Kirby 2010, p. 151). At the same time, NRC engineers performed essential functions and achieved many successes for the Nationalist leaders they served.

The Nationalist government supported intensified industrial and technological development during war with Japan, in part relying on the growing ranks of engineers and other technical experts being trained domestically. In fact, higher education in China grew considerably during this period, and by 1945 there were 141 higher education institutions with 83,498 enrolled students (Hayhoe 1996, p. 56). And by 1944, a quarter of the country's university students were studying engineering (Reardon-Anderson 1992, p. 217). As further evidence of the profession's growth, membership in the Chinese Society of Engineers rose to 14,000 by 1948 (Kirby 2010, p. 284).

China's universities matured during the later years of the Republic, achieving a balanced integration of Chinese intellectual traditions, Western scholarly and curricular influences, and academic ideals like intellectual freedom and social responsibility (Hayhoe 1996, p. 59). This was also a time of greater harmonization across schools via standardized courses and curricula and the implementation of quality control mechanisms for teachers and educational materials. Nonetheless, such reforms did not address a long-standing problem with Chinese engineering education, namely, a lack of practical and applied training. As summarized in one account, "China's engineering curricula had been copied from European and American models and based on advanced technologies that had nothing to do with China" (Reardon-Anderson 1992, p. 217). The ramifications of this trend became more apparent during war with Japan. According to one account, "By War's end, most NRC [National Resources Commission] enterprises were overstaffed with recently trained engineers and understaffed with individuals who had practical experience" (Kirby 1989, p. 31).

To address these deficiencies, more than 1,000 Chinese engineers, scientists, and managers received supplemental training in US firms during the later years of the war (Kirby 1992, p. 201). Attempts were also made to continue many of the Nationalist government's policies during the postwar period, including those related to industrial and human resource development. Yet the legacy of wartime devastation, combined with growing political unrest, posed tremendous barriers. After 1949, many policies – and the educational institutions that grew up under Nationalist rule – were fundamentally transformed as the Nationalists fled to Taiwan, and the Chinese Communist Party formed the People's Republic of China on the mainland.

Looking back on this period, a 1965 report by the US National Science Foundation (NSF) concluded that "Pre-Communist China suffered an extreme scarcity of scientists and engineers," and added that the country graduated only 31,700 engineers from 1928 to 1947 (Cheng 1965, p. 72). Yet as the preceding account makes clear, China produced an impressive quantity of engineers during Nationalist rule – especially when one considers that much of the formation and growth of the profession and its educational system occurred during the 1920s and 1930s. And while the quality of their education can be questioned, many of the engineers trained during this period played important roles in the country's development – both during and after Nationalist rule. To further enrich this history, we now turn to the formation and evolution of one of country's leading engineering schools.

Shanghai Jiao Tong University, 1896–1949[2]

Shanghai Jiao Tong University is one of the China's oldest institutions of higher education. Founded in Shanghai in 1896 as Nanyang Public School by an imperial edict of the Qing government, the school was originally a product of the Westernization and Self-Strengthening movements. In successive historical periods, the school underwent many major transformations in response to the nation's evolving needs. From 1907 to 1920, it became an industrial school and actively expanded its science, engineering, and technical programs following Western educational models, ultimately becoming a modern engineering school. The 1920s saw further transformations at the school resulting from vigorous Sino-American collaboration in science and higher education, the growing influence of foreign educational models, and changes in the boundaries of the major engineering fields. After the Nationalist government took more control of China in 1928, the relevance of higher education to nation building was even more evident, reflected in the university's rapid growth, close cooperation with government agencies, and reputation for training the country's top engineers.

During the anti-Japanese War (1937–1945), the university was devastated after first being forced to move to the French Concession and then to Chongqing to preserve its educational system and train specialists to meet wartime infrastructure needs. Immediately after the war, Jiao Tong University returned to its home campus in Shanghai and started to recover from the ravages of the protracted conflict. However, the postwar struggle from 1945 to 1949 caused the school to be embroiled by constant student protests and frequent changes in leadership, reflecting the unsettled political condition of the country as a whole.

[2] Unless indicated otherwise, this account is translated and adapted from *The History of Jiao Tong University: 1896–1949* (History of Jiao Tong University Writing Group 1986).

From Public School to Industrial School, 1896–1920

An imperial edict issued in 1896 by Emperor Guangxu established Nanyang Public School in Shanghai, which included a middle and high school, normal (or teacher training) school, and school of foreign studies. Sheng Xuanhuai (1844–1916), who proposed the idea to the Emporer, became the first president and is regarded as the university's founder. Sheng was a key member of the Westernization Movement and among the first industrialists in modern China (Zhang 2010). He was influential and controversial as both a government official and advocate for nationalism and capitalism (Liu and Li 2006).

To promote the Westernization Movement, Sheng realized the importance of understanding and mastering foreign languages and technologies and new modes of education. In particular, he wanted to weaken the role of the imperial examination and emphasize the adoption of Western academic models and a more practical style of education (Jin 2005). Under Sheng's aegis, Nanyang Public School symbolized the alliance of capitalist practice and feudal heritage. The school initially emphasized business and political science to support the country's developmental needs and Self-Strengthening Movement.

In 1905, Nanyang Public School was transferred to the government's commercial department and renamed High Industrial School. In 1906, it was renamed Shanghai High Industrial School of the Postal Transmission Department. Around the time of the Xinhai Revolution (1911–1912) the school was renamed Grand Nanyang University. After the Republic of China was founded in 1912, it was managed by the traffic department and renamed Shanghai Special Industrial School. These changes in name and affiliation reflected the exploratory and experimental character of the school's early development. Yet its ties to the country's commercial, postal transmission, and traffic departments foreshadowed its future trajectory into fields such as economics, management, telecommunications, and transportation.

Tang Wenzhi was the school's president from 1907 to 1920. His administration emphasized a curriculum organized along the disciplinary lines common in modern Western practice in engineering higher education. The school actively expanded its scientific and technical programs to become a major engineering school, and the birth of a 4-year traffic management program in 1918 symbolized the emergence of a modern industrial school that combined education in engineering and management.

Comparing the curricula of civil engineering and electrical and mechanical engineering before and after the Xinhai Revolution reveals many changes (History of Jiao Tong University Writing Group 1986, pp. 75–76). First, the scope was expanded, from 18 courses for the old railway program to 28 courses for an expanded civil engineering program; an increase from 14 courses for the electrical engineering program to 23 courses for an expanded electrical and mechanical engineering program; and the addition of a new railway management program with 47 courses, which was equivalent to a full four years of schooling.

The structure of the school's curricula also changed, with general education requirements replaced by specialized coursework. For example, after the railway

program was changed to a civil engineering program, the load of general courses was reduced from 43.9% to 27.3%, while specialized courses increased from 19.7% to 33.4%. There were similar changes of course load in electrical and mechanical engineering. At the same time, greater emphasis was directed to experiments, practice, and working experience. Many courses were specially designed and offered for hands-on practice and experiments, in part displacing the previously dominant approach of combining class instruction with experimental demonstrations.

New industrial economy and factory management programs were also added. During the late Qing Dynasty and early Republic, the country lacked experts with specialized knowledge in engineering, industrial economy, and factory management. The goal of these new programs was to train experts who could apply these types of domain knowledge to real practice. It is also notable that the factory management program was the first of its kind in Chinese higher education. It seeded the later addition of a railway management program and established foundations for a much longer tradition of combined engineering and management education at Jiao Tong University.

Nonetheless, the school was initially short on qualified staff to teach in many areas, so it imported expertise. From 1908 to1920, for example, foreign instructors – mostly American – represented about half of the school's faculty in the disciplinary specialties, and the Departments of Civil Engineering and Electrical Engineering were both headed by American professors. Yet as noted below, the faculty structure quickly changed in the 1920s as large numbers of returned student-educators replaced their foreign counterparts.

In summary, after 1911 the Chinese government's relative weakness opened an unusual window of opportunity for China's revolutionary educators. As it was transformed into an industrial school from 1907 to 1920, the school went through a relatively stable period of development, with curricula gradually reorganized and rationalized to serve emerging national needs. The school also enjoyed a certain degree of educational independence and autonomy. It still emphasized the study of Chinese literature, but followed Western educational models in engineering and technical fields, promoted application of learning to practice, and maintained strict admission requirements.

Shanghai School of Jiao Tong University, 1921–1927

After 1915 China experienced growing antagonism engendered by Japanese expansion and rising currents of Chinese nationalism. Due to persistent political uncertainties and disruptions, from 1921 to 1927 the school underwent a tumultuous phase of development defined by three reorganizations and fourteen turnovers of presidents and major administrative personnel.

This was accompanied by a merger of the Shanghai Special Industrial School, Tangshan Special Industrial School, Beiping Railway Management School, and Beiping Post Telecommunication School, all under the direct supervision of the

traffic department. As a result, the previous Shanghai Special Industrial School was renamed the Shanghai School of Jiao Tong University. Thus, Jiao Tong University had three branch schools in Shanghai, Tangshan, and Beiping. In 1922, the university went through a second reorganization into two branches in Shanghai and Tangshan, each incorporating programs from the original Beiping branch. The original Shanghai School was then renamed Nanyang University of the Traffic Department. In 1927, a third reorganization led to another change in name, this time to become the First Jiao Tong University of the Traffic Department.

Ye Gongchao was president of Jiao Tong University from 1921 to 1922. He advocated an educational model imitating European and American universities and promoted development of science and engineering to protect and develop the country. During 1918 and 1919, Ye traveled to Japan, Europe, and the United States. He explored the cultural, educational, political, and economic situations of these countries and was fascinated by educational systems abroad (History of Jiao Tong University Writing Group 1986, p. 139). His ideas about education were clearly reflected in the school's educational objectives (Xia'an Publishing 1946, p. 172).

A number of other important trends also characterized this period. The general, underlying philosophy was that higher education constituted an indispensable component of the larger task of national reconstruction. The influence of the New Cultural Movement and May Fourth Movement further promoted science and democracy and led to many reforms in higher education, with particular emphasis on integrating teaching and research. Training specialized knowledge experts and conducting advanced research were especially promoted in a proposal to establish a graduate school during the formation of Jiao Tong University, but the plan temporarily stalled.

Foreign, and especially American, influences on Chinese higher education also reached a high point, with the late 1910s and early 1920s a period of vigorous Sino-American collaboration in science and higher education. American educators such as John Dewey visited China to lecture and teach, and their ideas were spread far and wide (Wang 2007). The idea of following an American educational model gained support, as many Chinese students studying in the USA returned to the country with a desire to implement American approaches in China. As a result, the deeply embedded values and social roles of the old Chinese literati gave way to modern educational ideas. For instance, credit hours for the course of Chinese literature were considerably reduced during this period. At the same time, many engineering academic associations, economic associations, and other scholarly societies were established, while academic exchanges prospered. And as research activities gained prominence on the campus, an Industrial Research Institute of Nanyang University was established in 1929.

From Shanghai School of Jiao Tong University (1921–1922) to Nanyang University (1922–1927) and the First Jiao Tong University of the Traffic Department (1927–1928), the curricular structure and instructional plan went through many changes and readjustments that reflected the evolution of modern engineering fields. Until 1927, the First Jiao Tong University of the Traffic Department featured disciplinary programs in electrical engineering (including electric power engineering,

telecom engineering), mechanical engineering (including railway mechanics, industrial mechanics), and traffic management (including financial management, railway transportation management). To train specialized experts, each discipline emphasized its various technical subfields, which tended to mirror the disciplinary organization in many American and European universities.

Other changes during this period included a strengthening of fundamental courses in physics and chemistry, as well as a greater focus on experiments. Also, additional courses were offered to improve students' design ability, and greater emphasis was placed on the breadth and depth of engineering courses. For example, students in electrical engineering were required to take courses in mechanical engineering, and vice versa. A more comprehensive curricula and a heavier course load were required, featuring general education requirements, technical foundations, and specialized technical courses. Finally, English language learning was promoted, including via course requirements and annual English debates and speech contests.

The faculty structure changed during this period as well. After the establishment of the school's first engineering programs in 1906, most department heads and professors were from abroad. Yet this trend reversed in subsequent years as the number of native experts increased and anti-imperialist sentiments intensified. In fact, the percentage of foreign educators in the faculty dropped rapidly, from 42.8% in April 1921 to 26.7% in October 1921, 8.1% in October 1922, and 4.1% in September 1925. By 1927, all 52 of the school's teaching staff were Chinese (History of Jiao Tong University Writing Group 1986, pp. 170–171). Further, most faculty were graduates of Jiao Tong University who had pursued higher degrees abroad. After returning, many wrote and developed their own teaching materials attuned to the Chinese context. This indicated a major change from the school's early years, when most textbooks were simply translations of foreign materials.

Formation of a Comprehensive Jiao Tong University of Science, Engineering, and Management, 1928–1936

As the Nationalist government took wider control of China starting in 1928, the country experienced a rare interlude of peace and unity. With the KMT Party's dictatorship leading from Nanjing, the university's development paralleled a twofold process that was taking place: the improvement of higher education as an aspect of national regeneration and the extension of central authority into the country's interior to promote national unity. This was also a time when the university's reputation as a southern counterpart to other leading engineering schools, such as Peiyang College in Tianjin, was established and cemented.

In 1927, Nanyang University of Traffic Department was renamed the First Jiao Tong University of the Traffic Department. In 1928 the Nationalist government issued "Organizational Outline of Jiao Tong University." As a result, the three schools in Shanghai, Tangshan, and Beiping were merged under the name Jiao Tong University, with headquarters in Shanghai. The first Jiao Tong University in Shanghai

was called the Jiao Tong University – College of Mechanical Engineering, College of Electrical Engineering, and College of Traffic Management; the Jiao Tong University in Tangshan was called the Jiao Tong University – College of Civil Engineering; and the Jiao Tong University in Beiping was called the Jiao Tong University – College of Traffic Management Sub-Division. In the same year, control of Jiao Tong University was transferred to the government's railway department.

The Nationalist government also worked to standardize programs of study across universities. In May 1928, for example, KMT political education in Sun's Three Principles of the People was mandated, requiring a dedicated set of courses and exercises. And beginning in 1933, additional ordinances were issued to govern such matters as required courses, electives, and college entrance examinations (Fairbank and Feuerwerker 1986, p. 391).

The educational goal of Jiao Tong University during this period was focused on conducting advanced research and developing specialized experts, especially for the country's transportation systems. From the spring of 1929, when the railway department initiated the reorganization of Jiao Tong University, to the fall of 1930, the whole educational system was under reconstruction to integrate it with the railway department and railway transportation system. Consequently, the university developed pedagogical methods, teaching plans, curricula, and research activities attuned to the needs of the railway department and the country's rail system. Since the university was to train experts specialized in railway transportation and construction, the graduates of Jiao Tong University were usually assigned to work in that industry.

Cai Yuanpei, a leading liberal Chinese educator of the twentieth century and an outspoken advocate for progressive and democratic reforms in Chinese education, served as president of the school from spring to autumn of 1928. He emphasized the necessity of students gaining a broad knowledge base and pronounced the importance of all three educational domains of science, engineering, and management. When Sun Ke (from the winter of 1928 to the winter of 1930) and Li Zhaohuan (from the winter of 1930 to the autumn of 1944) served their terms as president, they firmly believed that mathematics, physics, and chemistry were fundamental for scientific development. In line with this view, these three departments were at the core of a new and growing College of Science, established in 1930. Jiao Tong University continued to develop rapidly through the 1930s with the establishment of a College of Management in 1931 and further expansion of the College of Engineering. The whole educational system took engineering as a core focus, science as a foundation, and management as a key addition.

To continue developing engineering during this period, the school expanded the original civil engineering, mechanical engineering, and electrical engineering programs into colleges and added many new programs. At that time, the major transportation instruments and telecommunication tools included train, telephone, and telegram. To support railway construction and the production of locomotive, telephone, and telegram devices, the university established railway engineering, road engineering, and construction engineering programs in the College of Civil Engineering; added railway mechanical engineering and mechanical automation engineering programs in the College of Mechanical

Engineering; and placed electric engineering and telecommunication program in the College of Electrical Engineering. Thus, a comprehensive engineering education system was tailored to serve and build the country's transportation and communication infrastructures.

Scientific research activities in Jiao Tong University were also very active, mostly bound to the needs of the transportation and construction industries. At the time, the Jiao Tong University Research Institute had two divisions: industrial and economic. Their main research activities revolved around railway construction, management, and operation, and practical issues related to national economic development. From 1926 to 1936, the industrial research division accomplished 38 research projects, and the economic research division completed 16 (History of Jiao Tong University Writing Group 1986, p. 298).

The number of foreign instructors during this period also remained low. Faculty members were mostly graduates of Jiao Tong University, including scholars who had returned after studying abroad. For example, the number of such returning faculty increased from 36 in 1931 to 67 in 1936 (among which 55 were professors), representing more than one-third of the total number of faculty (History of Jiao Tong University Writing Group 1986, p. 311). The whole curricular system also still followed the American philosophy of "general education." Further, the College of Engineering and College of Science mostly based their curricula on models adapted from MIT and Cornell, and the College of Management curriculum was patterned after the University of Illinois and the University of Pennsylvania.

The growth of the school was evident in the total number of undergraduate students, which increased from 450 in 1928 to 710 in 1936. In addition, the university started to admit female students in the fall of 1927, starting with 11 female students rising to 35 in 1935 (History of Jiao Tong University Writing Group 1986, p. 312). Female students mostly majored in management, less in science, and least in engineering. From 1927 to 1937, the total number of graduates from Jiao Tong University was 1,407, almost doubling the number of graduates during the 30 years prior. There were many scholarships set up to encourage and reward good academic performance among students.

In summary, the period from 1928 to 1936 witnessed the rapid development of Jiao Tong University and was regarded as a golden age for the school before the People's Republic of China was founded. This could be attributed to a number of factors. First, there was the formation of a relatively high-quality faculty, most of whom were graduates of the university or returned student-educators who studied abroad or had work experience in industry. Second, after 1928, both Shanghai and the Nationalist government were relatively stable politically, and there was both public and government support to realize Sun Yat-sen's industrial and commercial plans. Overall, the social and political environment of the country was favorable and conducive to the university's development.

During this period, the major endeavors of Jiao Tong University included the promotion of science, social reform, and research on the Chinese economy. This agenda fit well with the government's plans for infrastructure development and was

clearly aligned with the national policy of promoting science in China to replicate and augment knowledge from abroad and adapt it to the Chinese context.

Jiao Tong University in the French Concession, 1937–1940

The Second Sino-Japanese War erupted on July 7, 1937, and soon developed into a full-scale Japanese invasion of China. Building on the hard-won victory in Shanghai, the Japanese captured the KMT capital city of Nanjing and southern Shanxi province by the end of 1937. On November 12, 1937, the Japanese occupied Shanghai, and the Jiao Tong campus was devastated and taken by the Japanese military. To save the university, all faculty and students moved to the French Concession in Shanghai to continue classes.

After the university moved to the French Concession in 1938 and was turned over to the Ministry of Education by the Nationalist government, its faculty structure, teaching plans, and educational objectives changed little. However, the university experienced serious budget difficulties and student unrest. Inadequate resources, serious inflation, and price increases left many faculty members no choice but to teach at two or more institutions simultaneously or conduct other business on the side to make ends meet.

As the war intensified, many factories and corporations in coastal China moved to the country's interior. Given heavy demand for transportation engineers and management experts in these less-developed regions, many graduates from Jiao Tong University went to work there and made significant contributions opposing the Japanese and developing the interior. To encourage graduates to work in these areas, the university provided a scholarship of 450 yuan (Chinese currency at that time) to each student who was willing to relocate. It is also notable that many of the school's full-time students and graduates chose to join the New Fourth Army or go to the frontier of the anti-Japanese War or the revolutionary base at Yan An.

State-run Jiao Tong University in Chongqing, 1940–1945

By 1941, Japan had occupied much of northern and coastal China, and the KMT central government and military had retreated to the Western interior to continue their resistance. The Nationalist government of Chiang Kai-shek struggled on from a provisional capital at Chongqing City.

Due to continuing and urgent demand for engineering, management, and other technical experts in the Western interior to support rapid development of railway, railroad, and air and telecommunication systems, in 1940, a state-run branch of Jiao Tong University was set up in Chongqing. When the occupying forces took over the Shanghai school in 1942, the Chongqing branch was officially declared the university's headquarters. This period was a low point in the development of the university's

academic instruction and scientific research. However, it survived the toughest period with tremendous help and donations from alumni and considerable effort from faculty and students.

Due to a lack of human and physical resources, the Chongqing branch was not able to restore all three colleges (engineering, science, and management) from the original Shanghai school. However, new programs were developed in areas such as aviation, shipbuilding, industrial management, telecommunications research, navigation, and marine engines, including through a June 1943 merger with the Chongqing Merchant Marine School.

During this period, the Nationalist government also advocated "applied science" to support development of the country's military, bureaucratic, and economic systems. Influenced by American ideas, it was a common belief among the university leaders that engineers should have broad knowledge about economics and management. The school's educational philosophy thus emphasized the integration of engineering and management, leading to the creation of programs in transportation management, commercial management, industrial management, and financial management (Mao 1943). Other pressing development needs were met through the addition of an irrigation program in civil engineering and improved curricula in aeronautical engineering and automotive engineering in the Department of Mechanical Engineering. The faculty of civil engineering also started teaching senior-year students graduate-level courses that were normally offered only in foreign countries.

The Nationalist government made its own mark on the university at this time by mandating political education and strictly controlling student activities. All first-year engineering students were required to study KMT Party principles, and monthly and weekly KMT Party events were organized for all faculty and students. The Nationalist government especially enforced military training and applied military management schemes at the university. Military training courses were required for all first-year students, with two hours per week without credits. In all regards, the university was mobilized for wartime industry and national defense.

Recovering Jiao Tong University After War with Japan, 1945–1949

In August 1945, Japanese troops in China surrendered. Jiao Tong's home campus, Xujiahui in Shanghai, had been occupied by the Japanese military during the war and was sabotaged as it was deserted. Campus buildings, educational facilities and equipment, laboratories, and library collections were all seriously damaged. Soon thereafter, the Chongqing migrant university returned to its home campus in Shanghai to restore the original school. During the return, however, a ship transporting a set of mechanical engineering, electrical engineering, and civil engineering materials and equipment sank in the Changjiang River. In addition, 20 of 60 bookcases shipped from the Chongqing campus were lost on their way back. Such accidents cast further shadows on the university's postwar recovery.

After 2 months of recovery effort, classes were finally resumed in October 1945, although the school's facilities were still in poor physical condition. By mid-April

1946, more than 1,240 students from the Chongqing branch campus had returned to Shanghai after several rounds of difficult transportation. These students, along with more than 800 students from the original Shanghai branch, reconverged at the Xujiahui campus. After the school was fully reunited in May 1946, it signaled the end of Chongqing Jiao Tong University. In 1946, the state-run Jiao Tong University was restored, and the school's staff undertook the arduous task of restoring its educational and research activities.

The educational objective of Jiao Tong University as stated by President Wang Zhizhuo in a 1948 speech to new students was based on an integrated and complementary system of three colleges, of which the College of Science emphasized basic theories, the College of Engineering focused on applications of theories, and the College of Management stressed scientific management (History of Jiao Tong University Writing Group 1986, p. 445).

During this period, Jiao Tong University had 18 academic departments, two special training programs, and one research institute. It also graduated an impressive 1,868 students from 1946 to 1949. After the university was restored in Shanghai, the College of Engineering was immediately rebuilt and expanded from three to six departments, including civil engineering, electrical engineering, mechanical engineering, aeronautical engineering, marine engineering, and industrial management, along with three special training programs in telecommunications, marine engines, and navigation (History of Jiao Tong University Writing Group 1986, p. 454). By 1947, there were altogether 2,063 students enrolled in engineering at the school.

In 1943, Jiao Tong University, in collaboration with Telecommunications Administration under the Ministry of Communications, the Central Broadcasting Management Office, the Central Electrical Appliances Factory, and the Central Radio Factory, founded a Telecommunication Research Institute. An associated graduate program was also quickly established, allowing the institute to admit graduate students into a 2-year master's program of telecommunication engineering starting in the fall of 1944. Until 1948, the Ministry of Education offered no more than 30 engineering master's degrees nationwide, 16 of which were awarded to students in this program at Jiao Tong University. Its curriculum was patterned after similar offerings at Harvard University and MIT.

Yet even with these steps forward, the national situation became ever more chaotic. As political instability and economic depression pushed the government and society to the brink of collapse, the entire population sank into a morass of frustration and fear. In this adverse environment, both the academic community and Nationalist government tried to preserve and restore what had survived the military, political, and economic disruptions and destructions of the previous decade (Fairbank and Feuerwerker 1986, p. 420). Yet these efforts also generated intense conflicts between the university and government as each followed their own goals.

In 1945, for example, less than a month after the anti-Japanese War was won, the Nationalist government announced that workers and students in the formerly enemy-occupied territories were "fake workers" and "fake students." Worrying about the influence of the Chinese Communist Party (CCP) and social unrest, and especially progressive movements led by students, the Nationalist government refused to acknowledge the student status of those who had previously studied in Shanghai

and required them to register for and complete a 1-year "thought training" program. In fact, the government deprived students of their educational rights at six higher educational institutions and colleges of Shanghai, among them Jiao Tong University. As a result, these universities and colleges suspended classes, and many students were inspired and organized by the CCP members who were working underground at the time. Uniting with workers, they staged a series of petitions and demonstrations fighting for their right to study. Under tremendous pressure, the Nationalist government gave in and withdrew its decision and stopped imposing the so-called thought training. However, it still insisted that students take tests on Sun's "Three Principles of the People."

As the country became more embroiled in civil war and domestic unrest, in 1947, Minister of Education Zhu Jiaye ordered Jiao Tong University to stop running the departments of navigation and marine engines. The students and faculty of Jiao Tong University strongly opposed any intervention at the school by the Ministry of Education and responded with large-scale student protests to protect the university's autonomy. The university leaders strongly resisted the prospect of government or KMT Party activities on campus. The students carried out riots and strikes, which generated a series of administrative crises at the university.

To direct resources toward civil war against the Communists, in 1947, the Nationalist government also reduced the country's educational budget to just 2.9% of the national budget. In the same year, the Ministry of Education allocated a monthly fund of just ten million yuan to Jiao Tong University, which had actual, monthly operating expenses of more than fifty million yuan. To solve the financial and budgetary deficits, Jiao Tong University united with other higher educational institutions in Shanghai to issue a budget request and petitions to the Ministry of Education or other arms of the Nationalist government almost every month from late 1948 to May 1949.

Even more generally, the postwar years were pulling China's system of higher education into the chaos of revolution. On May 20, 1947, students nationwide led an "Anti-Hunger, Anti-Civil War, and Anti-Persecution" campaign, later known as the "May 20th Patriotic Students Movement." Students led demonstrations and movements that brought them face-to-face with the KMT authorities, who moved quickly to put an end to any expression of dissidence. The student protests were dispersed by armed troops. Meanwhile, the war strengthened the Communists both in popularity and as a viable fighting force. Within 3 years, Jiao Tong University became an important base for Communist student movements in Shanghai.

During the three years between the war and the founding of the People's Republic of China, the country's economy was sapped by the military demands of a long and costly conflict, internal strife, spiraling inflation, and government corruption. The postwar struggle left the Nationalists severely weakened and their policies unpopular. Jiao Tong University was plagued by student protests, frequent changes of leadership, increasingly destitute faculty, and a general sense of institutional uncertainty, all reflecting the unsettled political condition of the country as a whole. During this period, the president of Jiao Tong University was changed three times in an attempt to suppress political discontent and bring the school in line with the KMT's desire for order

and control. By 1949, what had been a vital and thriving system of higher education exemplified by Jiao Tong University appeared ready to unravel.

Conclusion

Describing China's trajectory from 1928 to 1937 as the "birth of the developmental state," Kirby emphasizes the important roles played by engineers during this decade (Kirby 2000). Primarily under the aegis of the railway department during this period, Jiao Tong University trained many of the technical experts who were developing the country's infrastructure. The school added, expanded, reorganized, and rationalized a series of engineering specialty programs and developed pedagogical methods, teaching plans, curricula, and research activities. Others describe the period of war with Japan as a time when the country's developmental arc peaked, and not only in ideological terms (Bain 2007). By expanding and rationalizing the government bureaucracy, forming state-owned industries, and creating supporting infrastructures in education and other sectors, the Nationalist government's state-building and defense efforts during the war were ambitious – and highly dependent on engineers and engineering. During this period, Jiao Tong University was mobilized and transformed for national unity and defense, especially after its move to Chongqing. It trained large numbers of technical experts to support the wartime industries and government bureaucracy and to develop the country's interior. New specialty programs were also created at Chongqing in key technical areas. Yet the war and its aftermath also proved profoundly disruptive, both for China in general and Jiao Tong University in particular.

After the Chinese Communist Party (CCP) took control of the mainland in 1949, the school was transformed into a narrowly specialized, Soviet-style engineering university. Then, in the mid-1950s, many of the school's faculty were ordered to leave Shanghai to help launch another key engineering school, Xi'an Jiao Tong University (XJTU n.d.). Some influential alumni of Jiao Tong University, on the other hand, led formation of National Chiao Tung University in Taiwan in 1958, and this school also traces its roots back to the founding of Nanyang College in 1896 (Yen-Hwa Yu 2008).

More recently, the story has come full circle. Today SJTU is one of the most prestigious engineering universities in China, supplying large numbers of high-quality scientists and engineers that serve as the backbone of the country's scientific and technological advancement (SJTU n.d.). Its total enrollment was 53,900 students in 2010. Today the school has 26 academic schools and departments, 63 undergraduate programs, 232 master's programs, 147 doctoral programs, and 10 state key laboratories and national engineering research centers. Among the school's more than 1,900 professors and associate professors are an impressive 34 members of China's Academy of Sciences and Academy of Engineering. The university is also very active in academic exchange programs, with over 5,500 international students on its campuses and exchange relationships with more than 100 universities worldwide.

One might be tempted to see SJTU's contemporary achievements and high rankings in engineering education and research as a historical success story for the People's Republic of China. Yet the Communists did not inherit a tabula rasa when they took control of the school in 1949. Emphasizing historical continuity, Bain has argued that there remain many opportunities for "understanding why and how the Chinese Communists kept intact, built on, and expanded existing institutions, structures, and ideologies in certain key areas of political, economic, and administrative life" (Bain 2007). Additionally, many alumni and staff who attended or worked at the school during the Nationalist period assumed important positions across China (and beyond) after the formation of the PRC. By examining the first 50 years of the history of Shanghai Jiao Tong University, including the important role it played in supporting the development of the early republic, our chapter provides part of the prologue of this much longer and larger story.

References

Alder, Ken. 1997. *Engineering the revolution: Arms and enlightenment in France, 1763–1815*. Princeton: Princeton University Press.

Andreas, Joel. 2009. *Rise of the red engineers: The cultural revolution and the origins of China's new class*. Palo Alto: Stanford University Press.

Bain, Morris L. 2007. How crisis shapes change: New perspectives on China's political economy during the Sino-Japanese War, 1937–1945. *History Compass* 5(4): 1091–1110.

Bracey, Gerald. 2006. Heard the one about the 600,000 Chinese engineers? *Washington Post*. Retrieved from http://www.washingtonpost.com/wp-dyn/content/article/2006/05/19/AR2006051901760.html

Chang, Chu-yuan. 1965. *Scientific and engineering manpower in Communist China, 1949–1963*. NSF Report 65-14. Washington, DC: National Science Foundation.

Downey, Gary, and Juan Lucena. 2004. Knowledge and professional identity in engineering: Code-switching and the metrics of progress. *History and Technology* 20(4): 393–420.

Elman, Benjamin A. 2000. *A cultural history of civil examinations in late imperial China*. Berkeley/Los Angeles: University of California Press.

Fairbank, John K., and Albert Feuerwerker (eds.). 1986. *The Cambridge history of China. Volume 13: Republican China, 1912–1949. Part 2*. Cambridge: Cambridge University Press.

Gareffi, Gary, Vivek Wadhwa, Ben Rissing, and Ryan Ong. 2008. Getting the Numbers Right: International Engineering Education in the United States, China, and India. *Journal of Engineering Education* 97(1): 13–26.

Guo, Yugui. 1998. The roles of returned foreign-education students in Chinese higher education. *Journal of Studies in International Education* 2(2): 35–58.

Hamlin, Kevin, and Li Yanping. 2010. China overtakes Japan as world's second-biggest economy. *Bloomberg News*. Retrieved from http://www.bloomberg.com/news/2010-08-16/china-economy-passes-japan-s-in-second-quarter-capping-three-decade-rise.html

Hao, Zhidong. 2003. *Intellectuals at a crossroads: The changing politics of China's knowledge workers*. Albany: State University of New York Press.

Hayoe, Ruth. 1996. *China's universities, 1895–1995: A century of cultural conflict*. New York/London: Garland.

History of Jiao Tong University Writing Group. 1986. *The history of Jiaotong University: 1896–1949*. Shanghai: Shanghai Education Publishing House.

Imperial Students. n.d. *Chinese undergraduate students at Yale (CUSY)*. Retrieved from http://www.yale.edu/cusy/imperialstudents.htm

Jin, Qi-zhen. 2005. Adoption of western academic achievements and application of pragmatic theories: Sheng Xuan-huai's view on education and talents. *Journal of Southern Yangtze University (Humanities & Social Edition)* 2005(5). Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-WXQS200505022.htm

Kirby, William. 1989. Technocratic organization and technological development in China: The nationalist experience and legacy, 1928–1953. In *Science and technology in post Mao China*, ed. Simon DenisFred and Goldman Merle, 23–44. Cambridge: Harvard University Press.

Kirby, William. 1992. The Chinese war economy. In *China's bitter victory: The war with Japan, 1937–1945*, ed. James C. Hsiung and Steven I. Levine, 185–212. Armonk: M. E. Sharpe, Inc.

Kirby, William. 2000. Engineering China: Birth of the developmental state, 1928–1937. In *Becoming Chinese: Passages to modernity and beyond*, ed. Wen-hsin Yeh, 137–160. Berkeley/Los Angeles: University of California Press.

Kirby, William. 2010. Engineers and the state in modern China. In *Prospects for the professions in China*, Routledge studies on civil society in Asia, ed. William P. Alford, William Kirby, and Kenneth Winston, 283–314. London: Routledge.

Liu, Pei-zhi, and Gang Li. 2006. Sheng Xuanhuai's thoughts on westernization Movement and his concerned activities. *Journal of Shangrao Normal College* 2006(4). Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-SRSX200604015.htm

Mao, Yisheng. 1943. Discussing the relationship between engineering and management. *Civil Engineering of Jiaotong University* 1.

Needham, Joseph, and Kenneth G. Robinson (eds.). 2004. *Science and civilisation in China. Volume 7, the social background. Part 2, general conclusions and reflections*. Cambridge: Cambridge University Press.

Reardon-Anderson, James. 1992. Science in wartime China. In *China's bitter victory: The war with Japan, 1937–1945*, ed. James C. Hsiung and Steven I. Levine, 213–234. Armonk: M. E. Sharpe, Inc.

Shanghai Jiao Tong University (SJTU). n.d. *Jiao Tong University – Overview*. Retrieved from http://en.sjtu.edu.cn/about-sjtu/overview/

U.S. Central Intelligence Agency (CIA). 2011. China. In *The world factbook.* Retrieved from https://www.cia.gov/library/publications/the-world-factbook/geos/ch.html

Wang, Ke-wen. 1998. *Modern China: An encyclopedia of history, culture, and nationalism*, Garland reference library of the humanities. New York: Routledge.

Wang, Jessica Ching-Sze. 2007. *John Dewey in China: To teach and to learn*. Albany: State University of New York Press.

Wang, Jinqui, Nathan McNeill, and Sensen Li. 2010. Growing pains: Chinese engineering education during the late Qing Dynasty. In *Proceedings of the 2010 ASEE annual conference and exposition*, Louisville, KY, June 20–23, 2010.

Xia'an Publishing. 1946. *Chronicle of Ye Xia'an*. Xia'an Publishing.

Xi'an Jiao Tong University (XJTU). n.d. *About XJTU – History*. Xi'an Jiao Tong University (XJTU). Retrieved from http://www.xjtu.edu.cn/en/AboutXJTU/History.html

Xin, Chen. 2001. General education in China's universities from 1911 to 1949. *Bulletin of the Graduate School of Education, Hiroshima University*, 50: 185–190. Retrieved from http://ir.lib.hiroshima-u.ac.jp/00018407

Yang, Rui. 2002. *Third delight: The internationalization of higher education in China*. New York/London: Routledge.

Yen-Hwa Yu, Lee. 2008. *The President's forward*. NCTU Museum. Retrieved from http://www2.lib.nctu.edu.tw/museum/eng/cht/about.htm

Zhang, Ke-hui. 2010. On Sheng Xuan-huai and the defense of Shanghai Huasheng Spinning Mill's rights and interests. *Journal of Lanzhou University (Social Sciences)*, 2010(4). Retrieved from http://en.cnki.com.cn/Article_en/CJFDTOTAL-LDSK201004016.htm

Zhu, Qin. 2010. Engineering ethics studies in China: Dialogue between traditionalism and modernism. *Engineering Studies* 2(2): 85–107.