ОПЫТ НАУЧНО-ТЕХНОЛОГИЧЕСКОГО РАЗВИТИЯ В КИТАЕ

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Technology, Industry, and Society in the Peoples Republic of China: Past, Present, and the Future — Lessons for the World

In about three decades, China has moved up from a “third world” country to be the world’s second largest industrial nation surpassing Japan. Some projections suggest that China may even surpass the first industrial nation, the United States by the middle of this century. The “Chinese Miracle” has, however, not been achieved without social and environmental costs. This discussion highlights the following main points in continuation of the author’s studies on science and society in China since the 1980s:

(1) Antecedents of the “Chinese Miracle.”

(2) Intended and unintended consequences of technoeconomic growth in China.

(3) Lessons of the “Chinese model” for the developed and the developing countries.

Keywords: Technology, Industry, Society, China

Introduction

This analysis highlights the status of technology and industrial development and their societal impacts in China through the following four historical epochs.

— Chinese science and technology in the ancient period

— “Revolutionary” science — the age of Mao Zedong, 1949 through 1976

— Deng Xiaoping and the Four Modernizations, 1980 to the present

— China’s future and its implications for the world

The Ancient Period

The Chinese built the 4000 mile Great Wall some 200 years before the birth of Jesus Christ. They invented bureaucracy even earlier, thousands of year before Max Weber brought it to the attention of the western world. Some of the greatest inventions we live by even today came from China; most notorious among them being the gun powder. The Chinese also invented paper, printing, the paper money, papier-m ché, the viaducts, suspension bridges, the wheel barrow, dams, dykes, clocks, the compass, kites, astronomical observatories, herbal medicine, acupuncture, moxibustion, and countless other such inventions. Coal carbonization, steel rolling mill, blast furnace, and botanical grafting were commonly used in China in the ancient period. The Chinese and Indians exchanged knowledge and culture for centuries until they were disrupted during the colonial period; and more recently due to border disputes between the two nations and the status of Tibet (Needham, 1981; Temple, 1986; Ahmad, 2010: chapter 7).

Yet until recently, Chinese contributions to the development of science and technology in the ancient and the medieval periods were largely ignored in the West. Joseph Needham, the renowned British scientist, traveler, and chronicler of science and society in China, once noted the American missionary Wells Williams solemnly and formally declaring that "botany in the scientific sense of the word is wholly unknown to the Chinese." Needham's response was equally noteworthy: "Such a statement could only have been made by one of a generation totally ignorant of the history and prehistory of science" (Winchester, 2008: 66).

The ancient wisdom of China began to eclipse by the turn of the 17th century. The Renaissance, Reformation, and Industrial Revolution were taking shape in Europe along with the age of colonialism. Ironically, the colonial powers used some of the earliest Chinese inventions like gun powder and the compass to dominate the world, including China. They also got the Chinese hooked on to opium illegally brought in from Goa and Java via the famous Silk Road. (The China Yearbook, 1996) The British Navy mercilessly destroyed the Chinese armada in the middle of the nineteenth century as part of the so-called opium wars (Fay, 1975).

"Revolutionary" Science in the Age of Mao Zedong, 1949 through 1976

Revolutionary science in China began along with the Proletarian Cultural Revolution (1966–76). The Chinese Academy of Sciences (CAS) was established in 1949 under the State Council of China — the highest political authority. Prime Minister Nehru's Science Policy Resolution in India in 1948 and the establishment of the Indian Council of Scientific and Industrial Research even earlier (1942) are noteworthy parallels.

The Academy now has six sections for the development of mathematics and natural sciences in about 100 institutions spread all across China. Its contributions to the development of science and technology were less than meritorious in the early phase of its existence. This was due largely to governmental patronization, lack of academic freedom, and lack of interaction with similar agencies abroad, (except with those in the (then) Soviet Union). All technoeconomic interactions with the so-called "Free World" were then banned. The Academy followed science policy dictated by the State Council.

During this period China was noted by the outside world for its political excesses, persecutions, regimentation, and above all, the Great Proletarian Cultural Revolution (GPCR). The GPCR sent millions of scientists and intellectuals into farms and factories to do what Mao called "the people's work through manual labor." Brutal as this "revolution" was, it left a legacy of how a nation could mobilize its vast resources for "human centered development" (a la Mahatma Gandhi).

During the Cultural Revolution China created 50,000 Peoples Communes. The greatest organized movement in world history to develop decentralized rural technology systems was launched through these communes, 15 years before the publication of Schumacher's (1973) "Small is Beautiful." The commune-based Great Leap Forward produced the (then) famous barefoot doctors, free rural clinics, thousands of biogas power plants, backyard steel furnaces, mini-hydroelectric dams, systematic use of animal and human refuse as agricultural fertilizers; and many more such small-scale people-centered schemes.

Through these schemes Mao envisioned overtaking the technoeconomic achievements of the West. But the "self-reliant" Leap Forward turned into a colossal fiasco. Collectivization of technology, industry, and society became a collective peril instead of a panacea. By 1985 all rural Communes, and communal life along with them, disappeared from the Chinese landscape. China was about to enter a cataclysmic change.

Notable achievements of "revolutionary science" include universal healthcare, population control through one-child per family, enhanced agricultural productivity, self-reliant labor intensive technical systems in the Communes, massive public housing projects in the cities, free and compulsory education for all, and arguably the detonations of an atomic bomb (1964) followed by an H-bomb (1967) apparently through pirated Soviet know-how. However, even as late as the1980s, China remained a technologically backward and generally a very poor country (Sigurdson, 1977, 1980; Woei Lien Chong, 2002; Ahmad, 2009; Dikotter, 2010).

Most Chinese during the "revolutionary science" and even much after its demise were deprived of modern means of communication and transport, decent housing with adequate water and power supply, sanitation facilities, discretionary foodstuff, personal possessions, and expendable incomes. Bicycles were the most common means to commute by the common people. Crowded trains and rickety buses were used for long distance travel. Personal automobiles were non-existent, even for the top government and party officials who used official cars.

All cars, including government run taxicabs, looked exactly alike — green Soviet era Ladas. Up until the end of the 1980s, computers, fax machines, personal telephones, TVs, and other IT products already commonplace in the advanced industrial societies were generally nonexistent in China. Commercialization of products and services was considered a morally depraved bad bourgeois habit (Ahmad, 1991).

Deng Xiaoping and the Four Modernizations

Matters took a dramatic turn in the early parts of the 1990s in the Chinese social and economic fabrics. China was about to enter the most dramatic scientific and social change, and the world to witness the most dramatic technoeconomic transformation in human history. The Chinese Premier Zhao Enlai had initiated the idea of Four Modernizations — of agriculture, industry, national defense, and science and technology in 1963, but only to languish until much later. They started to take shape in the 1980s under the leadership of Deng Xiaoping who took command of China in 1978 following the death of Chairman Mao in 1976. Given the nature of the Chinese political system, when the top leadership decides to change course or implement a scheme, it just gets done, unlike some other countries we all may know well. Deng lifted the Chinese veil of secrecy and isolation through his open door policy. Foreign technology and capital began to flow into China. Market mechanisms were introduced. Business enterprise and agriculture were gradually deregulated.

Following the example set by the Japanese Ministry of International Trade and Industry (MITI) nearly four decades earlier, China began to vigorously divert its substantial R&D infrastructure towards industrial development and export markets. The Chinese Academy of Sciences was given the mandate to launch new industrial enterprises in addition to its traditional research and education functions. Since then, the CAS has invested in or created over 430 technology-based enterprises in eleven industrial sectors, including eight companies listed on world stock exchanges.

The computer giant Lenovo is the most famous of the enterprises floated by the CAS.

In 2005 Lenovo bought out the IBM-PC division for a paltry sum of less than $2 billion. It is now the fourth largest vendor of personal computers in the world and the largest seller of PCs in China, with a 28.6% market share. Another example of highly successful state owned enterprises is the China National Offshore Oil Corporation (CNOOC) with aggressive oil and gas explorations through joint ventures in Africa and Australia.

Huawei Technologies, established in 1988, is a notable example of privately owned IT companies in China. Its worldwide R&D, manufacturing, and marketing operations are located in cities like Stockholm, Dallas, Silicon Valley, Bangalore, Moscow, Jakarta, and Wijchen. Huawei, along with other Chinese companies, is rapidly moving towards software development as well to compete with the other software development Mecca, India.

Shanghai Electric Company recently signed a $10 billion deal to sell power generating equipment to the Indian conglomerate Reliance AD Group. China's space program is rapidly moving towards landing a Chinese man on the moon. It has also built its first aircraft career and intends to build four more. Its automobile and aircraft industries will soon be competitive on a worldwide basis (Business Week, Nov. 20, 2006: 55).

Recent Chinese infrastructure developments include modern airports, four lane freeways, and fast train grids connecting this vast country through land routes. The 2006 Qinghai-Tibet_Railway connecting Tibet with the mainland runs with 100 miles per hour speed at an altitude of 1000–1500 feet above sea level. Super computer Tianhe-1A, developed at the National University of Defense Technology, is now the fasted computing machine in the world. It surpasses anything that currently exists even in the United States, including the fast one at the Oak Ridge National Laboratory in Tennessee. These developments have serious implications for the modernization of Chinese national defense as well as part of the Four Modernizations program (Baum, 1980; Ted Tschang, 2003; Thomson & Sigurdson, 2008). The world has to be mindful of the fact that China is already a nuclear power with the largest standing army in the world.

As part of infrastructure development, China is investing heavily in science and engineering (S&E) education as well. It is noteworthy that Chinese students earned 800,500 bachelor's S&E degrees in 2006, or 21 % of 4+ million worldwide next to 19 % in Europe and only 11% in the United Sates. This number may be considered small in relation to China's large population. Nonetheless it is a substantial number for a rapidly developing country. It amounts to one-third of all bachelor's degrees in China next to only 20 % in Asia as a whole. China's production of S&E doctoral degrees in 2006–07 was even more impressive: 23,000 next to 20,000 in Russia and negligible in India. Sixteen percent of foreign born scientists and engineers in the United States today are Chinese. Many of them are now returning home. Their knowledge transfer to the home country adds substantially to the development of science, education, and culture in China.

Production of qualified scientists and engineers, particularly those employed in R&D, directly impact a country's technological and industrial capacity. Per capita production of scientists and engineers in the West (particularly the US) is still well ahead of the world average. But the total annual production in China (and India) surpasses the US in about 4 to 1 ratio: US = 84,898; India = 103,000; China = 292,569 (India-China combined total = 395,569). In 2007, China published 51,000 science and engineering papers next to only 10,000 in India. Its R&D expenditure currently runs at 1.5 % of GDP, more than in most EU countries, and next to India's less than one percent after decades of national planning. There are 3000 researchers per million of population involved in technology adoption and adaptation. What is more significant is China's 6 % of GDP expenditure on the development of information/communication technologies (next to India's 4 %).[1] It is no wonder, therefore, that China's high-tech exports increased from 6 % of the world total in 1995 to 20 % in 2008 making it the largest single country global exporter; while the American and Japanese shares declined considerably.

Just about two decades ago, personal telephones were nonexistent in China. You could not easily make an intercity telephone call even through the publicly available network either. In contemporary China Mobile phones have grown from 87 million in 2000 to more than 500 million today. Internet is spreading like wildfire with 220 million users, the world's largest number, surpassing Web surfers in the United States although it still represents only 13 % of the total population (National Geographic, 2008, p. 70).

China has developed secure supply and demand chains with mega superstores like the American Wall-Mart and the British Tesco. About ninety percent of consumer goods including audio and video systems sold at Wall-Mart and other American stores are imported from China. It is the most favored destination for offshore manufacturing today. Consequently, China has now the second largest economy in the world; although it is not certain how long that distinction would hold.

China's future and that of the world: Lessons learned

The questions often discussed these days in international policy circles are:

1. How could China reach the status of a technological superpower and the second largest industrial economy in the world in a short period of about three decades?

2. What are the lessons others can learn from the Chinese experience of the past 50-60 years?

3. How can other nations interact and collaborate with China in the matters of science, technology, industry, and societal development?

4. What lies ahead for the Chinese science, technology, and society for the next quarter of a century and what may be its global implications?

[1] These estimates are based on Science and Engineering Indicators 2006–07, National Science Foundation (NSF), Washington, DC.

Here are a few tentative answers to the above questions: China's time horizons are very long indeed. From Mao to Hu Jintau the Chinese leadership has been conscious of the fact that China is one of the five great civilizations in world history. Its vision of the future is equally long term — that is to recreate its past glory and become one of the greatest nations again. Brutal as the revolutionary period (1949–1976) was, the foundation for rapid growth through massive mobilization of human and natural resources was laid during that period.

From the very beginning the Chinese science and technology policy makers adopted the "technology and industry first, science later" approach early on unlike India's reverse policy of "science first, technology and industry later." After many missteps and hiccups, that policy started to pay off with full-force implementation of the Four Modernization program soon after Mao's death when China opened it doors to foreign capital and technology in the manufacturing sector. Its non-interventionist policy in the affairs of foreign nations played a significant role to let China develop economic relations with many resource rich developing countries for raw materials imports and export of consumer goods. This strategy led to huge accumulation of capital through foreign exchange and allowed China to concentrate and invest on local development instead of being bogged down in foreign wars.

Building modern science and technology (S&T) infrastructure is an expensive undertaking even in the rich world let alone in a developing country where such foundations may need to be built in a hurry from scratch after decades or centuries of isolation and stagnation. Being mindful of such a historical and cultural drawback, China has invested generously to build its applied S&T capability in the industrial and agricultural sectors.

Others factors have also contributed to China's rapid technoeconomic transformation during the past three decades. As noted above, starting in 1980 one of the main planks of Four Modernizations was to open China to massive foreign direct investment (FDI) and technology transfers to become a Mecca for offshore manufacturing in the 1990s. India, on the other hand, continued to shun foreign high-tech and capital inputs until much later. Unlike many other developing countries, the Chinese decided to learn from foreigners and learned to beat them on their own turf instead of being perpetually dependent on them. But as will be discussed shortly, the Chinese model of technoeconomic development is not without its negative consequences.

China is expected to remain a great technoeconomic and political power in the foreseeable future. It will be a leader in renewable sources of energy at the same time that it continues to invest heavily in developing conventional energy sources like nuclear and coal power to feed its voracious energy appetite for rapid industrialization and urbanization. Consequently, China will have to get serious about controlling its rapidly deteriorating environment, perhaps one of the worst in the world today. Poverty, disparity, and corruption will also continue to haunt China for a long time. The general standard of living is likely to remain highly uneven for its vast population. Labor unrest and public disenchantment will pose serious problems for the Chinese leadership in the coming years. Due to its one-child-family policy, China's population is ageing and the number of working age people is rapidly declining. This and the facts of uneven industrialization and rural to urban migration are highly destabilizing forces in the Chinese society.

These negative consequences of China's technoeconomic development policies are occurring precisely because of the same forces that propelled it to become the second largest industrial nation in about three decades. In its hurry towards industrialization, China failed to attend to its environmental, social, and human consequences. The new generations of Chinese leadership, born and bred in the electronic age, will fail to mobilize national resources to address these problems in the same way that the older leadership has done single-mindedly to pursue economic development regardless of its unintended consequences. China today is a highly educated developing country. But education, particularly higher education, is a double-edged weapon. While it informs, inspires, and creates knowledge, goods, and services, it is also a source of rebellious discontent, distaste for regimentation, and demand for individual freedoms.

Furthermore, due to increasing internal labor unrest and wage increases the center of gravity for offshore manufacturing and FDI will be moving away from China to the other developing countries where cost of production and the social and political environment may be more attractive to multinational corporations. At the same time, I see foreign companies returning home from China as the economic advantage of offshore manufacturing is offset by the rising cost of shipping and lower wage rates in Europe and America due to recession and surfeit of unemployed local and migrant workers. These developments would certainly mitigate the historical Chinese advantage that could easily lead to the beginning of its economic decline in the next decade.

There are other scenarios in the horizon as well. China's so far very impressive technoeconomic performance has encouraged and inspired similar developmental strategies in other industrializing countries in Asia, Africa, and Latin America. Some of these countries, particularly Brazil, India, and Russia with their highly educated workforce and advanced research and development (R&D) infrastructures will pose serious threat to China in the global export markets and competition for R&D investments from abroad.

At the same time, technology transfer and capital flows among the newly industrializing countries, including China, will increase considerably. New common markets are likely to emerge in Asia, Africa, and Latin America. Their combined industrial infrastructure, military capability, soft- and hardware development, vast consumer markets, and qualified manpower are likely to turn the twenty-first century upside down by posing serious challenge to the Euro-American military-industrial hegemony.

Finally, there are two other paramount lessons that both the developed and the developing countries can learn from the Chinese experience: One, that single-minded determination to put national plans into practice, rather than getting bogged down in external political conflicts and endless internal debates and dissensions, may be a surer way to ensure peace and prosperity at home and abroad. And two, that technoeconomic development at the cost of human and environmental welfare may not be in the best long term interest of global societies.

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The Establishment of Chinese Military Academies & the Soviet Aids in 1920s–1950's

Through the aids of former Soviet Union, the Republic of China established the Huangpu Military Academy and Nanking Military Institute, and the People's Republic of China created Harbin Institute of Military Engineering, and other technological institutes of the armed services from the 1920s to the 1950s. Russian ideas, organizational systems, and educational methods and objectives had a significant impact on the establishment of Chinese military academies, especially on military technological institutes. This paper discusses the specific roles played by the Russians on the establishment of Chinese military academies.

Keywords: Chinese Military Academy, Soviet Union, Chinese Military Education History

"Following Russia as an example" and establishing Huangpu Military Academy

From the end of nineteenth century to the early twentieth century, China learned from western countries in military affairs. Its navy took Britain as its example, with army in the wake of Germany and then gradually turning to Japan. The 1920s witnessed Sun Yatsen (1866–1925) as the first man to study from Soviet Union in military education.

In 1911, the Hsinhai Revolution led by Sun Yatsen overthrew the late Qing Dynasty, but due to the weakness of revolutionary force, the victory was in vain, especially considering the rebellion led by Chen Jiongming (1878–1933) in 1922, which was the greatest fiasco during Sun Yatsen's life. Through studying the successful experience of the Great October Revolution of Soviet Union, Sun Yatsen realized that the final success of revolutionary career can only be achieved by establishing a revolutionary army. Then he decided to accept the suggestion made earlier in 1921 by J. F. Malen (1883–1942) — a representative of the Communist International, which was, "We shall establish a military academy as the groundwork of our revolution" (Wilbur, 1986: 128; Shang,1998: 458). As a result, he began to follow Russia as an example, to establish a military academy, and to organize the Revolutionary Army.

In order to learn the experience of establishing military forces and managing military academy from Soviet Union, Sun Yatsen dispatched the "Doctor Sun Yatsen Delegation", joined by Chiang Kai-shek (1887–1975) as the chief and two communist party members-Shen Dingyi (1883–1928) and Zhang Tailei (1898–1927), on August 16th, 1923. The delegation paid an official visit to Soviet Union, made a probe into the organization, training and equipment of the Red Army of the Soviet Union, and visited all kinds of military academies of the Soviet Union including musketry, military chemistry, high-level gunnery and navy. After the discussion with military officials of the Soviet Union, "a plan of establishing a military academy had been formed" (Ynan, 2001: 255–256), and Liao Zhongkai (1877–1925) and Soviet Adviser Mikhail Borodin (М. Бородин, 1884–1951) were appointed to be responsible for planning and preparing the establishment of the military academy and selection of teaching and administrative staff (Guangdong, 1982: 23). In January 1924 Sun Yatsen ordered to "follow Russia as an example" to establish an academy of army officers joined by Chinese Communist Party (CCP) members, which is the famous Huangpu Military Academy. On June 16 of the same year the military academy was formally established in Huangpu Island in Guangzhou. Sun Yatsen served as the part-time principal of the academy. In a speech of the opening ceremony, he pointed out that "My sheer hope by establishing this academy is to form the revolutionary army, for saving China from a fatal crisis" (Sun, 1985: 292).

Learning from Russia, Sun Yatsen sincerely engaged dozens of political and military talented people from the Soviet Union to come to China and assist him to establish the academy (Shang, 1998: 466). Many experts from the Soviet Union occupied the positions of military and political counselors of the Huangpu Military Academy, who were versed in educational theories as well as practical experience and "made great contributions" (Ynan, 2001: 265) in political system, military organization, military guidance, theoretical development and curriculum setting, and so on.

Following the political commissar policy of the Soviet Union as a model, the Huangpu Military Academy set representatives of the Party and implemented political work policy. The policy gave important status and rights to the representatives of the Party and the political works, and ensured the Academy, in a real sense, to become a tool cultivating revolutionary cadres with the belief of "Three People's Principles" (i.e. Nationalism, Democracy, and the People's Livelihood). From then on, the policy was promoted and practiced in the armies of the National Revolutionary Army (NRA), and became an important mark for the NRA to be distinctive from any other old armies in the past. In addition, this policy was also fully enhanced in establishment of military academies and armies by the Chinese Communist Party. As it was mentioned in Interview with the British journalist James Bertram by Mao Zedong (1883–1976) on October 25, 1935, the spirits of the Chinese Worker's and