The Transfer of Industrial Technology from the West to China 1780-1870: Some Theoretical and Practical Considerations

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> [The pilots] raised the keys and set the mechanism in motion. All that could be seen were copper wheels, some upright, some horizontal, turning furiously. Some were the size of millstones, others of pulley wheels. [The carriages] seemed like pinwheels, and each one rose up spinning. In an instant they were a few feet off the ground. Then they rose straight up to a height of more than a hundred feet and headed due West.[1]

The above passage is not out of an H. G. Wells or Jules Verne story, but from the Chinese novel, *Ching-hua yüan* (Flowers in a Mirror), published circa 1830.[2] Although this novel has been appreciated for a number of its themes, not least its feminist sympathies,[3] the great delight in technology for which many of its characters feel has not, until recently, received attention. One character steers across the ocean with a magnetic compass; warriors carry "linked-pearls" muskets (a kind of primitive machine gun); the King of the 'Country of Women' consults a striking clock to check if there is time for the nuptial banquet. Not only do the protagonists of the novel enjoy their technological superiority, but also they like to give technical assistance to less advanced peoples: "in the Country of Women, T'ang the Roamer teaches the female inhabitants how to make cast-iron tools and delivers a lecture on hydraulics."[4] Whatever the literary interpretation of these

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* The author wishes to thank Mark Elvin, who generously shared his unpublished work with her.

1 Quoted in Elvin (1991) 56.

2 See Elvin (1991), Evans (1970), Hsia (1974) and Yu (1974) for further information about this novel.

3 For this phenomenon, see Brandauer (1977).

4 Cited, and translated by Elvin (1991) 55.

passages, they do indicate quite clearly an appreciation of technological ingenuity. Seagoing ships, chronometers, and firearms were not, in the words of the well-known historian of Chinese technology, Mark Elvin, European monopolies.

While some readers may see *Ching-hua yüan* as simply literary recreation, it is, nevertheless, a certain indication of how Chinese intellectuals could fantasize about technology in the early nineteenth century. If this is indeed the case, then the novel presents a contrasting image of Chinese attitudes toward this subject circa 1830, expressed by many contemporary Western observers. As Michael Adas has documented so well, Westerners at this time were exasperated by the idea that the Chinese refused to recognize the superiority of Western technology over indigenous tools and machines. In 1835, for example, the Reverend Jacob Abbott wrote that 'self-conceit' prevented the Chinese from appreciating the advantages of the weapons and machines, which Lord Macartney had brought to China, over their own.[5] In preparation for his study, *China and the English* (1835), Abbott had utilized John Barrow's *Travels in China*, a work full of disparagement toward Chinese attitudes concerning science and technology. Writing in 1804 about his experiences in China during the Macartney Embassy in 1793, Barrow noted: "The practical application of some of the most obvious effects produced by natural causes could not escape observation of a people who had, at an early period, attained such a high degree of civilization, but satisfied with the practical part; they pushed their enquiries no farther."[6]

While Westerners in the first half of the nineteenth century drew ever more to the conclusion that China was "scientifically and technologically backward", they did not lose confidence in the idea that the Chinese were capable of adopting, if they chose to do so, the technical achievements of the West. Westerners continued to be impressed with earlier Chinese technological accomplishments: its bridges and canals, sailing vessels and water mills were all reminders of what a great civilization China had once been and could be, if only the country could overcome its "stagnation".[7] In a brief essay, published in 1838, "The Intellectual Character of the Chinese", three missionaries noted that "without exception, the 'natural (mental) endowment' of the Chinese was equal to that of any other people on earth."[8] In short, it was *not* 'intellectual deficiency' that kept Chinese from

5 Adas (1989) 231. For a complete list of those apparati (both scientific instruments and technological devices) that Macartney brought to China, see Cranmer-Byng and Levere (1981) 520-523.

6 See Adas (1989) 190. The recent work by the French writer Alain Peyrefitte (1989), which is nothing more than a catalogue of China's faults for allowing itself to 'fall behind', is a good example of how this attitude still pervades Western thinking. See my critique of this work in Zurndorfer (1989).

7 Adas (1989) 285.

8 Cited in Adas (1989) 285.

borrowing Western technology, but xenophobia; Chinese ethnocentrism was the root of this "blindness".

Despite the overwhelming documentation on China's supposed reluctance to utilize Western technology in the nineteenth century, there has been, surprisingly, little published research on the problem of technology transfer from the West to China. And what little that has been produced has generally concentrated on China's special political culture as the source of its technological poverty. The two most common reasons stated for China's inability "to take off", after having been exposed to Western military weaponry during and after the Opium War, focus upon the "despotism" of the Court, and the country's reverence for past precedents, presumably by the scholar-official ruling class.[9] Had China acted more perspicuously, so these critics write, the country would have realized the real meaning of the Western intrusion, and taken realistic measures to counter the enemy.

Interestingly, Mark Elvin, whose publications have pioneered new and different ways of examining the history of the Chinese economy, has introduced the concept of "techno-cultural style" as one of the most important factors in differentiating the progress of Europe and China after the late sixteenth century. What China missed, the Europeans had. Moreover, Europeans appreciated a number of elements that, in the long term, may have determined their course of development. In contrast to the Chinese, Europeans placed (1) value on the use of non-human forms of energy and materials; (2) value on accuracy; (3) value on 'disciplined imagination' (according to Elvin, Chinese pragmatism worked against the actual manufacture of a 'flying-carriage'); (4) value on 'geometry in motion'.[10] Elvin considers these crucial differences "in style" as possible explanatory devices for China's technological formation, or lack thereof, from the seventeenth century.

It is not the purpose of this paper to sort out how Chinese xenophobia, or Chinese deficiencies with regard to 'technico-cultural style', may, or may not have been, an explanation for the slow dissemination of Western technology in nineteenth century China. Moreover, we will not attempt here to become involved in the debate between the so-called domestic-limitation school and foreign-intervention school which have formed the two major approaches to China's "failure to modernize." While the latter school clearly places imperialist intervention since the first Opium War (1838-42) as the main obstacle to China's

9 This reasoning forms the basis of Peyrefitte's (1989) argument.

10 Elvin (1988) 108-112. Elvin's ideas have had a tremendous impact on other historians making comparisons between China and the West. See Jones (1990) and Mokyr (1990) 209-238.

development,[11] the former sees China's own institutions and values as the inhibiting factors to nineteenth century progress. In this view, foreign intervention, however painful or humiliating, is understood either as a benign, or a necessary challenge to traditional values and systems, and, not least, a way to modernization.[12]

It would be a great mistake to cast all problems concerning technology transfer within the parameters of this debate, for as a number of recent publications have demonstrated, the process of change is complex, and the persons involved had a variety of motives. One thinks of the "transcultural milieu" formed from a set of "intellectual and cultural frontiers, outposts of intercultural collision where parochial (traditional) commitments were subjected to constant challenge".[13] It was in this environment where both Westerner and Chinese, such persons as John Fryer, Prosper Giguel, Wang Tao, and Yung Wing learned about each other.[14] 'Transcultural men', were neither entirely Western nor wholly Chinese; studies of their activities have negated stereotype images and, rather, emphasized the individual aspirations of these men, who played such important roles in nineteenth century Sino-Western interaction.

Taking this view as a starting point, this paper shall examine a number of specific incidents of technology transfer from the West to China, and attempt to evaluate the persons and places involved. In our investigation specific locational conditions are rather important, since the sheer size of China dictated differences in how technology was transferred and diffused. We are especially interested in the cases of the technology transfer to the silk and tea industries, since both these commodities were very much linked to China's involvement in international trade already in the eighteenth century.[15]

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11 The groups adhering to this view include not only Marxists and Maoists, but also proponents of Chinese Nationalism, including Sun Yat-sen and Chiang K'ai-shek. For more information about this school, see Cohen (1984).

12 The classic example of the 'traditional values limitation' school publication is that by Perkins (1967). Dernberger (1975) presents an especially sophisticated analysis of economic modernization in China. It may be argued that Marx's own Euro-centric developmental approach also belongs to the 'traditional values limitation' school (as well as the 'foreign intervention' school). For further discussion and elaboration about this debate, see Cohen (1984). The comparison between China and Japan also forms part of the disputation.

13 Cohen (1974) 257.

14 For information about these men, see Bennett (1967), Cohen (1974), Leibo (1985), Schwartz (1964), and Spence (1964).

15 Lin (1990) has much to say about this.

1. Some Preliminary Remarks on the Concept 'Technology Transfer'

Before we proceed further with our inquiry, a number of definitions are in order. Technology may be defined as knowledge about the ways in which processes and products are designed, made or organized.[16] In writing about the "transfer of technology", one should make a distinction between *invention, innovation,* and *dissemination.*[17] *Invention* refers to the development of new techniques within a region; *transmission* or *diffusion,* the transfer of knowledge of technological form from one region to another; and *dissemination,* the widespread adoption of a technique. In simplest terms, the transfer of technology is the transfer of knowledge, usually embodied in men or machines, and most successful transfers involve both.[18]

According to the leading expert in the history of Chinese agricultural technology, Francesca Bray, the direct transfer of technology can only take place between technological systems at a similar level of development. Transfer between technological systems at different levels requires important modification.[19] To prove her point, Bray recalls the example of Wang Chen's *Nung-shu* (Agricultural Treatise) (1313) which became a classic handbook for local magistrates to improve agriculture in regions under their jurisdiction.[20] In the preface Wang Chen stated that one of the reasons for writing his book was to make the agricultural technology of North China known to South China, the former being based on dryland cultivation *(ti),* and the latter on wet fields *(t'ien).* It was Wang's desire that more efficacious tools and techniques might be disseminated, so that the relatively labor-saving tools and machines utilized in the wheat-growing regions of North China could be adopted in the wheat-growing regions of the South. The idea never came to fruition, and according to Bray, this was due probably because of such factors as the differences in scale of enterprise and patterns of labor-use typical of those technological systems, particular to North and South China.[21]

16 Jeremy (1991) 1.
17 Bray (1991) 211.
18 Brown (1979b) 181.
19 Bray (1991) 212.
20 Bray (1991) 213.
21 An interesting example of technology transfer, "between regions at comparative levels of development" was that between China and the United States, occurring in the mid-nineteenth century, which is related by Tsien (1964-65). In 1868, the chargé d'affaires of the American Legation in China, Samuel Wells Williams, proposed to the Tsungli Yamen, or Chinese Foreign Office an exchange of information about their respective countries. The U.S. Department of Agriculture was "especially desirous of obtaining information about Chinese agriculture, which had supported so large a population for so many centuries." (p. 22). Thus, about one

Bray's point, that we must be cautious in our estimation of how technology is 'successfully' transferred between systems at a similar level of development is underlined by published studies of technology diffusion occurring in Western countries during the nineteenth century.[22] The slow rate by which application of the steam engine spread in England is a case in point. H. H. Habbakuk has argued that, although steam power was important in powering the British economy in the 1830's and 1840's, it was not massively applied until the 1870's and 1880's.[23] Nathan Rosenberg, in his study of factors affecting the diffusion of technology, notes it is likely that 'old' technology will continue to be improved even after the introduction of the 'new', and that it is the fault of historians to concentrate their attention on the technological feasibility of the 'new', and end all interest in the 'old'.[24] Rosenberg demonstrates that the slowness by which the stationary steam engine was established as a new source of power in the first half of the nineteenth century, was due in part to important improvements which continued to be made in design and construction of (old-fashioned) water wheels.[25] He pleads that the diffusion of technology should be "viewed as occurring along a gradual downward slope of real costs rather than as a Schumpeterian gale of creative destruction."[26]

In a similar vein, other historians of the Industrial Revolution in the West have cautioned that the analysis of the technology diffusion process during the 1780-1870 era should take into view those artisan skills whose transmission was highly dependent upon personal knowledge and contacts.[27] There were other

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year later, a certain Colonel Charles D. Poston, appointed Commissioner to China to deal with agricultural matters, arrived in Peking and brought with him, besides a collection of American seeds of grain, vegetables, and pulse, several books relating to agriculture, mechanics, and mining, and maps and reports connected with the survey of the Pacific Railroad, hoping to exchange these for similar materials from the Chinese Government. After some tussling to and fro, the Tsungli Yamen decided "to award" the Americans with books and seeds (but not details of the Chinese population). The books, including the Chinese Classics and scientific works on medicine, agriculture, language, accupunture, mathematics, and metaphysics, running to 934 *ts'e* or volumes, wrapped in 130 *t'ao*, formed the U.S. Library of Congress's earliest acquisition in an Asian language. It marked the beginning of Orientalia collections in America, and certainly one of the finest in the entire world.

22 Bray (1991, 212) acknowledges the importance of Sigaut's (1989) critique of her earlier work on technology transfer. European winnowing-fans constructed in the eighteenth century were not directly inspired by Chinese models.

One may appreciate how relatively underdeveloped the study of technology transfer is with Rosenberg's (1972-73) point, that Marc Bloch was probably the first historian to study the effects of the invention of the watermill and its widespread adoption.

23 Discussed by Rosenberg (1972-73) 5.

24 Rosenberg (1972-73) 24.

25 Rosenberg (1972-73) 25.

26 Rosenberg (1972-73) 33.

27 Cameron (1975) 220.

factors important in the technology transfer process that were purely economic, i.e. cost-price ratios. Market orientation and accessibility to Britain in terms of transport time and cost were most relevant to the rate by which continental Europe and North America adopted Great Britain's new technology during that era. The transfer of technology from the West to China may be analyzed in a similar strategy. Specifically, we argue that much of Western technology could only be "transferred" when it met special local conditions.

The Case of Silk Manufacture

The most penetrating and interesting recent research on the Chinese silk industry has concentrated on two regions where raw silk and silk goods have been produced in great quantities. Although silk was processed all over Northern China in ancient times (and would remain important in Hopei and Shantung), after the eighth century sericulture was associated with the southeast regions of the country.[28] The Lower Yangtze and Lake T'ai region, conventionally known as Chiangnan, some 75 to 100 miles from modern Shanghai, and the Pearl River Delta near Canton (specifically, the counties of Shun-te, Nan-hai, and Hsiang-shan) have been considered important sites of the silk industry in the nineteenth century.[29] The production of silk has always been a labor-intensive industry. The stages of silk production all required large amounts of time and labour: the silkworms needed constant care and feeding (the keepers had to be alert to the danger of various silkworm diseases), the reeling of silk fibers had to be completed in great haste, so as to prevent the cocoons from being destroyed by emerging moths, and finally, the weaving of silk fabrics involved great skill and patience.

It was in the second stage of this process, the reeling, that Westerners thought machinery could be applicable. Thus, in 1861 the British import-export firm of Jardine, Matheson and Company decided to establish a steam-powered reeling filature in Shanghai, then the only place in the Chiangnan silk district where foreigners were allowed to set up business. In a well-documented study, based in part on Jardine-Matheson private records, the American scholar Shannon Brown has investigated this filature, known as the Ewo Filature.[30] As Brown argues, the problem technology transfer for the silk industry there was not constructing the filature, nor recruiting and training a local labor force, nor reeling the silk, but securing high quality cocoons in the Shanghai hinterland, and

28 For a general introduction to China' silk industry during the Ch'ing, see Shih (1976).
29 Recent historical studies of the silk industry are Eng (1986), Li (1981), and So (1986).
30 Brown (1979a).

transporting them to the treaty-port of Shanghai. Despite a number of initial difficulties, the Ewo Filature was founded, and it did produce superior quality silk, which sold at higher prices on the British market than European silk. But the opposition from the guild of Chinese silk merchants, who forced up the price of cocoons throughout the decade of the 1860's, was so great that the operation eventually had to shut down. Even if it had been possible to obtain all other inputs—labor, coal, capital, etc.—free of charge, the cost of cocoons would still have exceeded the value of the finished product. Moreover, the efforts of the Filature's manager, John Major, to promote the use of steam power in silk-reeling, by demonstrating its advantages were unsuccessful. After Major's death in 1869, Jardine-Matheson decided to close the filature, which lost HK$276,000 during the dozen years of its existence. Brown concludes that foreigners made little economic impact on China in the 1860's.

It is worth pointing out here that neither cultural nor political barriers seem to have been very important as far as the construction of a plant or the provision of a work-force were concerned. Most of the equipment for the factory was made in Hong Kong and together, with the skilled labor required to assemble it, brought to Shanghai. For the recruitment of a Chinese labor force and their instruction in the skill of unwinding cocoons on steam-powered reels, Major had four French women reelers sent to Shanghai to teach a core of 25 Chinese women the Western techniques of mechanized silk-reeling. This was a great success, and by early 1863, the filature was operating with Chinese reelers alone. The failure of the Ewo enterprise lay in the strength of the Chinese middlemen who were able to prevent Major from obtaining what he wanted. Given the large number of cocoon producers in the Chiangnan region, it is a tribute to the strength of the silk guild that it so frustrated Major's efforts.

In the Canton region, it was the local gentry who controlled the production and financial sectors of the silk industry. In the mid-1850's, as British and French forces attacked and captured Canton, and the Ch'ing government troops were busy suppressing the Taiping rebels in Central China, the gentry in this locale organized the Kwangtung Province Central Militia Bureau.[31] To finance the

31 Wakeman (1966) 165-67; 169-173. In Southeast China, the local power structure, i.e. the relationship between gentry and local government was particularly complex. The local gentry supported numerous institutions to help maintain the community. These included numerous societies and covenants to conduct public affairs or to raise money for and manage specific institutional projects like schools, bridges, dikes, welfare, and, not least, defense. According to Rankin (1990) 33, the detailed township (*hsiang*) and county gazetteers from Nan-hai give information about the eighteenth and nineteenth century development of locally financed and managed *hsiang* education institutions. Thus, it is reasonable to conclude that long before the mid-nineteenth century crises hit Kwangtung, the local gentry had organized themselves effectively into the community and could penetrate existing social networks without much

resistance, the gentry had to find their own tax base and looked to the silk industry as a ready source for funds. Although sericulture had existed in this region in the seventeenth century, it did not really become economically important until the expansion of the Canton trade during the eighteenth century.[32] In comparison with the Chiangnan region, the Kwangtung silk industry was a relative newcomer, and it would prove to be more receptive to technological modernization than the older silk areas.[33]

In the 1860's, as the South China gentry found themselves needing more and more funds, they openly stimulated the development of the silk industry by encouraging the peasantry to abandon other crops, and switch to the production of mulberry leaves, cocoons, and silk-worm eggs. They provided free credit, employed silk-worm rearing teachers and advisors, opened mulberry leaf markets, and petitioned for tax exemption on raw silk transactions. Moreover, the industry soon mechanized itself. The first steam filiature in South China was built in 1866 by Ch'en Ch'i-yuan (Chan Kai-wen), a Nan-hai *hsien* native who had traveled widely overseas.[34] According to his autobiography, and biographies written by his son and grandsons, Ch'en was originally a school teacher; after failing to pass in the examination system, he went to Annam where he learned the advanced technique of steam reeling. Making a fortune as a trader, he returned to China, and with the support of the local gentry set up the first filiature in his own native village. It was said that Ch'en paid such a high price for the raw cocoons that local peasants no longer found profitable the execution of the reeling process. Ch'en himself could afford this economic strategy because of the rising prices of silk in the world market, a result of the silk-worm disease in France and Italy, and the destruction of mulberry trees in Central China during the last struggles of the Taipings. After Ch'en's initial efforts, the steam filiature gradually spread to other villages in the region.

While the fate of the Kwangtung silk industry by the post-1870 imperialist intrusion is beyond the time limitations of this paper, suffice it to say that technology transfer in this case developed out of the historical conjuncture of the foreign encroachments in the 1840's and 50's, rising silk prices in the world

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difficulty. In fact, it is this background of *hsiang* local societies in both county cities and smaller towns that lay behind the organization of militia bureaus during the Taiping Rebellion.

32 Li (1981) 113.

33 Li (1981) 115, makes the point that Kwangtung was unique among all the silk-producing regions of China in that it was able to support six or seven crops of worms and leaves per year, and many peasant households who raised silk-worms did so on a full-time basis rather than working part-time.

34 The account here of Ch'en Ch'i-yuan is based on information in So (1986) 107-109.

market, the gentry's support of the local economy, and not least, the initiative of one resourceful Chinese entrepreneur. The two case studies here support our thesis that the transfer of technology must be analysed as a complex interaction of internal and external factors, and should not be oversimplified. Both John Major and Ch'en Ch'i-yuan had to confront specific local conditions—Major the silk guild, and Ch'en the local gentry—to undertake these enterprises. The different outcomes of their ventures are also a good indication of how significant regional diversities may be in the evaluation of technology transfer from the West.

Further Examples of Technology Transfer

One important source book on industrial technology in China, *Chung-kuo chin-tai kung-yeh shih tzu-liao ti-i-chi, 1840-1895 nien* (Source materials on the history of modern industry in China, first collection, 1840-1895) lists some fifteen enterprises founded between 1843 and 1860 that brought Western technology to China.[35] These include eight ship repair facilities, four printing establishments, one chemical firm, one bakery, and one freight-packing company. Another recent documentary collection, *Shanghai min-tzu jih-chih kung-yen* (The Chinese-Owned Machinery Building Industry in Shanghai] provides information on the migration of skilled artisans to Shanghai in the nineteenth century.

In an unpublished study of this second set of documents, Mark Elvin has stressed that these craftsmen, such as scissor-makers from Chechiang, or the builders' tools specialists from Soochow, were attracted to the growing economic opportunities Shanghai offered in the period 1850-1880.[36] The result, Elvin argues, was extensive personal contacts between skilled Chinese labour, Chinese entrepreneurs, and foreigners, and eventually, the self-sufficiency of the Chinese machine-building industry. The fourteen shipyards set up in Shanghai by British and American firms in that period were not just industrial enterprises, but also "schools for the first generation of China's modern engineers."[37] There, ships were built by Chinese master-craftsmen and Chinese labourers, many of whom were initially imported from Kwangtung Province. Elvin's main argument is that the foreign presence in Shanghai facilitated the transfer of modern Western machine technology, and that the key factors in this process were "extensive personal contacts" and the "continuity of the gamut of opportunities".

Elvin's contentions for Shanghai may be relevant for that region and the machine building industry there, in particular, but the fact remains that the

35 Sun (1957) I, 234-5.
36 Elvin (unpublished paper) 3.
37 *Ibid..*, 4.

principal motive of those foreigners who founded these shipyards was to do business and make profits. The fact that China may have, in the process, acquired technological knowledge was secondary to the revenue foreigners expected for their investment. Thus, the industries which they pursued were those whose products they could sell to the Chinese, or buy from them, to ship to foreign markets. Shipping, export-import, and Western-style consumer goods were the mainstay of Western investment in China until the end of the nineteenth century. Nearly 48% of all foreign capital investment in Chinese industry until 1895 was in the processing of exports, and to a minor extent, imports, and nearly all of this percentage was either for reeling silk for the European market, or producing brick tea for Russian consumers.[38]

Western interest in the mechanization of tea processing began once the Canton monopoly system was terminated. After 1842 many Western tea importing firms re-located to Foochow to be near tea-growing centres. In Taiwan, first opened to Western trade and residence from 1860, foreigners began to introduce mechanical means for firming and packing teas. However, because foreigners were barred from land ownership there (and elsewhere), as well as leasing land outside the treaty ports, a plantation system could not develop, and ultimately, they were denied a productive role in the interior tea-growing regions areas of China.[39]

The only real impact technology transfer had on the tea industry was in the manufacture of brick tea. It was made by the compression of tea dust and low quality tea leaves into bricks. A simple steam-powered machine first grounded black or green tea leaves into a powder, and then compressed the mixture into bricks of a given weight. These bricks were more durable, and less likely to crumble than bricks compressed by manpower. Brick tea proved profitable, and it was manufactured in great quantities in the two treaty ports of Hankow and Foochow. There tea dust and low-quality leaves, otherwise waste-products, were easily obtainable from Chinese firms, and coal was cheap.[40]

38 Sun (1957) 242-47, provides the following statistical information:

Foreign Industrial Investment by Type, 1895

Shipyards and Docks	25.0%
Brick Tea	20.3%
Silk Filatures	20.1%
Other Export-Import Processing Industries	7.6%
Printing, Publishing, and Paper	9.5%
Food and Provisions (food, beer, drugs, cigarettes, soap)	7.1%
Construction Materials (wood, bricks, concrete, machinery)	2.7%
Public Utilities	7.7%

(Adapted from Brown [1979b] 184)

39 Brown (1979b) 186. Compare Gardella (1976) 141-158.

40 Brown (1979b) 186.

Brick tea factories were dominated by Russians, although some small Chinese firms entered the business.[41] The reason for this is simple: brick tea was destined for the Russian foreign community. The Chinese had little interest in the consumption of brick tea, and therefore gave no opposition to growing Russian involvement in the industry in the second half of the nineteenth century. A few wealthy Russian firms controlled its manufacture and distribution.[42] The opening of the Suez Canal in 1869 stimulated brick tea production, for the home market could now be supplied more quickly by sea than by the old overland route through Siberia.[43] Thus, brick tea, like silk, was an example of a product Westerners bought from the Chinese to ship to foreign markets. Whatever technology was transferred to these industries in China itself, was limited, and conformed to the specific conditions of each geographical location.

Another Chinese industry which steam-powered technology may have seemed applicable was the soybean industry. Processing soybeans to produce cakes and oil had always been a labour-intensive industry. With the exception of the grinding of the beans, usually by an an animal-powered stone wheel, all aspects of the process were done by humans. Soybeans were a product of northern China. It was there that they were crushed to make cake and oil, but the most important markets for these items were in south China. Especially important was Swatow, where the cakes were used as fertilizer in the production of sugar. Foreign participation in the manufacture and trade of this item was prohibited until 1863 when the Peking Government, in need of financial support for its survival against the Taiping rebels, began to allow foreigners to trade in beancake. Their success in dominating the trade in beancake (although not the oil) was swift, and led foreigners once again to think about establishing processing factories in northern port cities.[44]

Under the initiative of an English merchant, Thomas Platt, Jardine, Matheson and Company, offered to finance a steam-powered soybean mill in Newchwang in northern China. The plant started production in the spring of 1869. Here again, Shannon Brown has made an original study of the relevant Jardine, Matheson documents, and written:

> Boilers and steam engines were used to crush the beans, steam them, and press them. To be sure, the oil-yield rate was lower than in the native mills since the greater, but briefer, pressure possible from steam power did not extract as much of the slow-flowing oil as did the longer application of

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41 Sun (1957) 43-64.

42 Rowe (1989) 163, provides an interesting example of how expanding Russian firms encountered resistance from Chinese entrepreneurs who denied them fire insurance.

43 Gardella (1976) 48.

44 This information here follows Brown (1979b) 190-191.

> lower pressure from the traditional technology. Still, it was expected that the lower yield would be fully offset by the higher productivity—both labor and capital—resulting from the new technology. Furthermore, the Western technology produced a firmer cake and a better oil than the native technology, both of which sold at higher prices than their native counterparts. But to realize fully the higher productivity possible with the new technology, it was necessary to introduce a totally different system of labor discipline and material incentives than that existing in the native mills. The effort, which after two years still had not succeeded, was plagued by strikes and other forms of resistance, some of it apparently inspired by the owners of native mills. The result was that the profitability of the mill was reduced to marginal levels... In its third season, despite the improved efficiency attributable to 'learning-by-doing,' the plant was closed.[45]

The experience here echoes that of John Major in Shanghai, and once again reiterates the relevance of specific local conditions. In Swatow, where Jardine's compradore (Chinese factotum) established a steam-powered bean-mill in 1880, the factory prospered and underwent several expansions over the years. Brown attributes the Swatow success story to the low customs taxes there, and the lack of previous vested local interests in using the old technology.[46]

Conclusion: The Transfer of Technology from the West to China 1780-1870 in Context

This paper has discussed, at some length, several experiences of technology tranfer between the West and China. Needless to say, the treatment has been suggestive rather than exhaustive. The examples discussed here were confined to those cited in documentary collections, and secondary studies thereof. Readers may have noted that we have entirely neglected the problem of the 'Self-strengthening Movement' in which the import of Western military technology from 1860 for use against both internal and external enemies of the dynasty, became a priority. The reason for this is not because Self-strengthening was unimportant. Rather, the overwhelming attention this Movement has received may have diverted scholarly regard from other relevant matters, and at worse, led to misunderstanding. For example, in a study of a poll of seventeen regional leaders regarding further expansion of foreign technology importation to China, effected in 1867-68, it was demonstrated that only three individuals, Li Hung-chang, Tseng Kuo-fan, and Shen Pao-chen revealed significant interest in telegraphs, railroads, and steamships.[47] Thus, it might be concluded that at a

45 Brown (1979b) 191.
46 *Ibid.*, 192.
47 Biggerstaff (1950) 136.

crucial time in its history, Chinese leadership in the main did not promote technical modernization.[48]

However, in the instances we have examined here, the lack of political support was not as pertinent to the success or failure of a particular industry to utilize Western technology, as the strengths of China's (traditional) political economy. While successfully restricting foreigners to operate in treaty ports, the Chinese were able to protect their own industries from foreign encroachments. To sum up, three factors seem to account for the progress (or lack thereof) of technology transfer from the West to China in the era 1780-1870. These are: (1) the small profit gained in the application of machine-applied technology; in a country where labour was cheap, the use of technology did not necessarily make certain manufacturing processes less costly. (2) The influence of Chinese local elites in the production process; as demonstrated here in the cases of Kwangtung silk reeling, or Swatow bean processing, local elites could and did exert authority over the acceptance of foreign technology in their communities. It would seem that the role of local elites may have been pivotal in the transformation of late imperial policies toward the welfare of local communities. This is a subject that needs much more research, based on local archival resources.[49] (3) The choice of foreign investments; in this period, foreigners invested only in what they could sell at home for a profit. Thus, the enterprises in which they involved themselves required less capital than did the mining, metallurgical, and military arsenal-type enterprises Chinese officials endeavoured to create during the Self-strengthening Movement. None of these conditions, it should be clear, has anything to do with the mental ability of the Chinese people to adopt Western technology. Let us hope that this paper has expelled this myth forever.

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48 Smith (1976) makes the important point that one of the goals of the Self-strengthening Movement was to eliminate dependence on foreigners while strengthening China's internal and external defenses.

49 Although this is not the place to argue whether mid-nineteenth century China was experiencing what historians term "an emerging sphere of public activity between state authority and private society," we may acknowledge the possible relevance of this subject here. For further information about the 'public sphere' in late imperial China, see Rankin (1990) and Rowe (1990).

References

Adas, Michael *Machines as the Measure of Men—Science, Technology, and Ideologies of Western Dominance* (Ithaca 1989).

Bennett, Adrian *John Fryer: The Introduction of Western Science and Technology into Nineteenth Century China* (Cambridge, Mass. 1967).

Biggerstaff, Knight 'The Secret Correspondence of 1867-68: The Views of the Leading Chinese Statesmen regarding Further Opening of China to Western Influence', *Journal of Modern History* 22:1 (1950) 27-149.

Brandauer, Frederick 'Women in the *Ch'ing-hua yüan*', *Journal of Asian Studies* 36.4 (1977) 647-660.

Bray, Francesca 'Some Problems concerning the Transfer of Scientific and Technical Knowledge', in Thomas Lee, ed. *China and Europe—Images and Influences in Sixteenth to Eighteenth Centuries* (Hong Kong 1991) 203-220.

Brown, Shannon 'The Partially Opened Door: Limitations on Economic Change in China in the 1860s', *Modern Asian Studies* 12.2 (1978) 177-192.

——— (a) 'The Ewo Filature: A Study in the Transfer of Technology to China in the Nineteenth Century', *Technology and Culture* 20: (1979) 550-568.

——— (b) 'The Transfer of Technology to China in the Nineteenth Century: The Role of Direct Foreign Investment', *Journal of Economic History* 39.1 (1979) 181-197.

Cameron, Rondo 'The Diffusion of Technology as a Problem in Economic History', *Economic Geography* 51 (1975) 218-230.

Cohen, Paul *Between Tradition and Modernity: Wang Tao and Reform in Late Ch'ing China* (Cambridge, Mass. 1974).

——— *Discovering History in China* (New York 1984).

Cranmer-Byng, J. L. & Trevor H. Levere 'A Case Study in Cultural Collision: Scientific Apparatus in the Macartney Embassy to China, 1793', *Annals of Science* 38 (1981) 503-525.

Dernberger, Robert F. 'The Role of the Foreigner in China's Economic Development, 1840-1949', in Dwight Perkins, ed. *China's Modern Economy in Historical Perspective* (Stanford 1975) 19-47.

Elvin, Mark 'China as a Counterfactual", in J.Baecheer, John A. Hall, & Michael Mann, eds. *Europe and the Rise of Capitalism* (Oxford 1988) 101-112.

——— 'The Inner World of 1830', *Daedalus* 120 (1991) 33-61.

——— [Unpublished paper] 'Facts and Problems: Aspects of the Transfer of Western Technology to China between the 1860's and the 1930's'.

Eng, Robert Y. *Economic Imperialism in China—Silk Production and Exports, 1861-1932* (Berkeley 1986).

Evans, Nancy 'Social Criticism in the Ch'ing, the Novel *Ching-hua yüan*', *Harvard University East Asian Research Center Papers on China* 23 (1970) 52-66.

Faure, David *The Structure of Chinese Rural Society: Lineage and Village in the Eastern New Territories, Hong Kong* (Oxford 1986).

Gardella, Robert 'Fukien's Tea Industry and Trade in Ch'ing and Republican China: The Developmental Consequences of a Traditional Commodity Export'. Unpublished Ph.D. Dissertation, University of Washington, Seattle (1976).

Hsia, C.T. 'The Scholar-Novelist and Chinese Culture: A Study of *Ching-hua Yüan*', *Tamkang Review* 5.2 (1974) 1-32.

Jeremy, David J. *International Technology Transfer—Europe, Japan, and the USA 1700-1914* (Manchester 1991).

Jones, Eric L. 'The Real Question about China: Why was the Song Economic Achievement not Repeated', *Australian Economic History Review* 30.2 (1990) 5-22.

Leibo, Steven A. *Transferring Technology to China: Prosper Giquel and the Self-strengthening Movement* (Berkeley 1985).

Li, Lillian *China's Silk Trade: Traditional Industry in the Modern World 1842-1937* (Cambridge, Mass. 1981).

Lin Man-houng 'From Sweet Potato to Silver: The New World and Eighteenth Century China as Reflected in Wang Hui-tsu's Passage about the Grain Prices', in Hans Pohl, ed. *The European Discovery of the World and its Economic Effects on Pre-industrial Society, 1500-1800* (Stuttgart 1990) 304-327.

Mokyr, Joel *The Lever of Riches—Technological Creativity and Economic Progress* (New York & Oxford 1990).

Perkins, Dwight 'Government as an Obstacle to Industrialization: The Case of Nineteenth Century China', *Journal of Economic History* 27 (1967) 478-492.

Peyrefitte, Alain *L'empire immobile ou le choc des mondes* (Paris 1989).

Rankin, Mary 'The Origins of a Chinese Public Sphere: Local Elites and Community Affairs in the Late Imperial Period', *Études chinoises* 9.2 (1990) 13-60.

Rosenberg, Nathan 'Factors Affecting the Diffusion of Technology', *Explorations in Economic History* 10 (1972-3) 3-33.

Rowe, William *Hankow: Conflict and Community in a Chinese City, 1796-1895* (Stanford 1989).

——— 'The Public Sphere in Modern China', *Modern China* 16.3 (1990) 309-329.

Schwartz, Benjamin *In Search of Wealth and Power: Yen Fu and the West* (Cambridge, Mass. 1964).

Shanghai min-tzu jih-chih kung-yeh [The Chinese-Owned Machine Building Industry in Shanghai] Chung-kuo shu-chü (Shanghai 1979).

Shih Min-hsiung *The Silk Industry in Ch'ing China* trans. by E-tu Zen Sun (Ann Arbor 1976).

Sigaut, François 'La Chine, L'Europe et les Techniques Agricoles', *Annales ESC* (1989) 207-216.

Smith, Richard 'Foreign Training and China's Self-Strengthening: The Case of the Feng-huang-shan 1864-1873', *Modern Asian Studies* 1 (1976) 195-223.

So, Alvin *The South China Silk District—Local Historical Transformation and World-System Theory* (Albany 1986).

Spence, Jonathan *To Change China: Western Advisers in China, 1620-1960* (New York 1964.).

Sun Yu-t'ang *Chung-kuo chin-tai kung-yeh shih tzu-liao, ti-i-chi, 1840-1895* [Materials on the history of modern industry in China, first collection, 1840-1895] (Peking 1957).

Tsien Tsuen-hsuin 'First Chinese-American Exchange of Publications', *Harvard Journal of Asiatic Studies* 25 (1964-5) 19-30.

Wakeman, Frederic *Strangers at the Gate: Social Disorder in South China 1839-1861* (Berkeley 1966).

Yu Wang-luen 'Knowledge of Mathematics and Science in *Ching-hua yüan*', *Oriens Extremus* 21.2 (1974) 217-236.

Zurndorfer, Harriet 'La Sinologie Immobile', *Études chinoises* 7.2 (1989) 99-120.