Global History, the Role of Scientific Discovery and the 'Needham Question': Europe and China in the Sixteenth to Nineteenth Centuries

Colin Mackerras

1 Introduction

One of the most important and intriguing facts in global history is the dominance that the West established over the rest of the world in terms of scientific discovery and innovation from the sixteenth century onwards. It is not too much to say that this scientific spirit was one of the key factors behind the Industrial Revolution and the growth of the technology that enabled Europe to colonize so much of the world and to assume a position of some degree of domination more or less everywhere. This scientific spirit remains a key feature of the contemporary world, with access to advanced technology among the most important of all levers of power.

C. Mackerras (✉)
Renmin University of China, Beijing, China

C. Mackerras
Griffith University, Brisbane and Gold Coast, Australia

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Yet the fact is that civilizations other than the West have developed significant bodies of scientific discovery and thought. In particular, China had developed a body of scientific knowledge before the time of the Mongol invasion of the thirteenth century that placed it well ahead of Europe. The most famous, and probably the most important, scholar to research and disclose the pre-eminence of Chinese science before that time was the British biochemist and Sinologist Joseph Needham (1900–1995), who masterminded and contributed extensively to a multi-volume and multi-authored work entitled *Science and Civilisation in China*.

This chapter aims to explore global scientific history through the prism of what has become known as 'the Needham question'. This can be formulated as follows: why, having been so far ahead of Europe in the Middle Ages, did China fail to produce the scientific revolution that occurred in Europe and in effect was crucial in creating the modern world. Why did 'universally verifiable' science 'commanding universal rational assent' develop 'round the shores of the Mediterranean and the Atlantic, and not in China or any other part of Asia'? (Needham and Wang 1954: 19).

There can be no definitive answer to such a big question, as Needham himself acknowledged in the foreword he wrote for a book that came out five years after he died (Zilsel 2000). Yet it remains an important question and the present chapter argues in favour of regarding scientific development as a major site of global history. It argues in support of Needham's appeal to social and cultural history for an explanation to this major driver of human history. This author stands in awe of a scholar willing and able to probe Chinese science in such detail as a counterpart to that of the West.

It should be added that the centrality of this 'Needham question' is by no means the only way of approaching the development of Chinese science from the sixteenth to the nineteenth centuries. One major study is specifically 'agnostic' about any claims that try 'to explain why China or the Islamic world failed to develop the rigorous mental mind-set of modern science' (Elman 2005: xxv–xxvi). Elman gives a great deal of credit to the European missionaries and others for scientific development in China over those centuries, but also emphasises the maintenance of a specifically Chinese science. In another balanced view, he attacks the pretensions of those who see modern science in China only as the result of Western influence and intervention, but also presents Chinese science as no more than a 'qualified success story' and eschews any 'nationalistic claim' about 'the march of science in contemporary China' (Elman 2005: xxxviii).

2 Joseph Needham and His *Science and Civilisation in China*

There is already an extensive literature on Joseph Needham and his many works (Sivin 2015). A major biochemist and Sinologist, his *Science and Civilisation in China* can claim to be the largest-scale English-language Sinological work since the Second World War that was basically the product of a single guiding mind. He has been honoured as a scientist both by China and his own country, Britain.

As a person, Needham was unconventional. He was a Christian socialist, a nudist and a folk dancer, as well as a scientist. He had a long-term wife, Dorothy Moyle (1896–1987), and a long-term lover, Lu Gwei-djen 鲁桂珍 (1904–1991), as well as other relationships. Both women and Needham lived to advanced ages, and he did not marry Lu Gwei-djen until 1989, that is, after his wife Dorothy had died. All three were distinguished scientists in their own right and his first wife did not oppose his affair with Lu Gwei-djen.

Needham was not only very pro-China, he was also very sympathetic to the Chinese Communist Party. He got involved in the International Science Commission set up by China and North Korea to investigate the charge that the USA was using germ warfare in the Korean War. He believed the evidence produced in favour of this accusation, which later turned out to be false. His reputation suffered seriously as a result. He was blacklisted by the US Department of State and even after this was revoked in the 1970s, he found it difficult to obtain a US visa.[1]

Despite his anti-Americanism, Needham obviously had a very firm foot not only in China but also in the West. Another major point about him is that he straddled both the disciplines of the natural sciences and the humanistic sciences. He was a major historian and Sinologist, as well as an extremely important scientist. This needs to be said because there are scientists who tend to look down on 'those whose careers are not primarily in the sciences', but still want to research the history of science. One scholar who strongly advocates the value of the humanities says that: 'While training in science is a marvellous benefit for the historian of science, it is not a substitute for historical precision' (Elman 2005: xxx). It is not possible to direct any such criticism against Needham.

Needham's great work was first proposed to Cambridge University Press in 1948, and the first volume came out in 1954. The original plan was for seven volumes, but although this schema survived, all except the

first three were expanded into multiple parts. As of 2016, twenty-five volumes have been published, the most recent being in 2015,[2] with two volumes still in progress. These two incomplete items will belong among the thirteen planned parts of Volume 5:

> Most of the earlier volumes were written in their entirety by Needham himself, but as time went by he gathered an international team of collaborators, to whom the completion of the project is now entrusted. As the project has broadened, so has the range of questions under investigation. It is now clear that no simple answer to Needham's original question will be possible. The question has opened out into an investigation of the ways in which scientific and technical activity have been linked with the development of Chinese society over the last four millennia.[3]

This gigantic project aimed to reveal the scope and originality of Chinese scientific thinking. 'There can be no doubt', Needham writes, 'that China was, among the ancient civilisations of the Old World, the one which was most isolated from the others. The originality of its characteristic cultural patterns was therefore greater' (Needham and Wang 1954: 156).

3 The Development of Science and 'the Needham Question'

Although it has received some criticism for being too positive about China, Needham's *Science and Civilisation in China* has been widely admired and praised for opening up new thinking about Chinese science. The well-known Dutch science historian Hendrik Floris Cohen comments that 'for all his idiosyncrasies,' Needham 'was an intellectual giant' (Cohen 2010: 30). Even a scholar prepared to criticize Needham quite severely for putting too great a stress on the 'benevolent, pacific aspects of Chinese culture' (Keightley 1972: 370) concedes that *Science and Civilisation in China* was 'one of the major scholarly enterprises of the [twentieth] century' (Keightley 1972: 367).

Possibly Needham's most important contribution was to suggest that China has a rich history of science. As Cohen has put it (2001: 23): 'Needham had very little time for explaining the absence of a Chinese Scientific Revolution out of some alleged inability of the Chinese to think scientifically.' The whole point of his magnum opus was to prove precisely the reverse.

Yet, the Chinese ability to think scientifically was a point that needed demonstration. The eminent Chinese philosophy historian Fung Yu-lan (Feng Youlan 馮友蘭, 1895–1990) had argued in essence that China did not develop science because China's values standards rendered it redundant. From the time of the Han dynasty (206 BCE–220 CE) onwards, Chinese were more concerned with looking after and influencing humankind than exploring the natural world. Chinese thinkers 'had no need of scientific certainty, because it was themselves that they wished to know; so in the same way they had no need of the power of science, because it was themselves that they wished to conquer' (Fung 1922: 261). Philosophies like Daoism and Buddhism were more concerned with admiring and following nature than controlling or even influencing it. For Fung Yu-lan to say that there was no science in pre-modern China is not to condemn that civilization, but to praise it; it was not that Chinese were incapable of thinking scientifically, it was simply that they did not do so because China had no need for science.

The fact that Needham knew he had found no final answers did not prevent him from speculating and making some pretty definitive statements. In particular, he rejected any suggestion that historical accident was involved. Moreover, he appealed more to economic, environmental, social and cultural factors than to scientific factors (Mackerras 1989: 130).

So, in this chapter we can divide Needham's reasons as to why China failed to produce the scientific revolution, including the factors that may have inhibited the development of Chinese science, into several categories. These include the material factors, such as the physical environment and economic matters, as well as the non-material or spiritual, such as the philosophical and the politico-cultural. Because it is global history we are dealing with and because Needham himself had plenty to say not only about China but also about the West, we shall be exploring some factors that compare and contrast China and Europe.

3.1 Material Factors: Physical Environment and Economics

We might begin with an interesting passage comparing Europe and China in one of Needham's main works outside *Science and Civilisation in China*. In it he places heavy emphasis on territory and economy, as well as raising some other issues. He explains Europe's 'built-in quality of instability' by referring to:

> the perennial tradition of independent city-states based on maritime commerce and jostling military aristocrats ruling small areas of land, the exceptional poverty of Europe in the precious metals, the continual desire of Western peoples for commodities which they themselves could not produce (one thinks especially of silk, cotton, spices, tea, porcelain, and lacquer), and the inherently divisive tendencies of alphabetic script, which permitted the growth of numerous warring nations with centrifugal dialects or barbarian languages. By contrast China was a coherent agrarian land-mass, a unified empire since the third century B.C. with an administrative tradition unmatched elsewhere till modern times, endowed with vast riches both mineral, vegetable, and animal, and cemented into one by an infrangible system of ideographic script admirably adapted to her fundamentally monosyllabic language. (Needham 1969: 119)

So, the competition among the European states may actually have *contributed to* innovation and creativity based on curiosity. China's territorial unity, which is often touted as one of the country's major achievements, may have been a factor inhibiting the development of innovation and of science.

Some scholars, notably Karl August Wittfogel (1896–1988), have attached very great importance to the physical environment as a driver of Chinese civilisation. Wittfogel wrote widely on this subject, especially in his 1957 book *Oriental Despotism*, basing much of his argument on Karl Marx's Asiatic mode of production theory.[4] He proposed that China was despotic because of the need for water control, in particular the need to build dykes, prevent flooding and in general control the Yellow River on the great northern plain. The link is that water control on a vast scale requires great organization, which can only be provided by a highly professionalized bureaucracy supervising enormous and subservient supplies of manpower. Wittfogel called this society 'hydraulic' and despised it as changeless and cruel. He summed up the response of people living under this despotism as follows: 'To the demands of total authority common sense recommends one answer: obedience' (Wittfogel 1957: 149).

Needham and Wang (1959) reviewed *Oriental Despotism*. In his review, he attacked Wittfogel for the 'naïve assumption' that Marxism could not develop and that all Marxisms were the same. He denied that China was despotic and criticized Wittfogel for ignoring good features of its civilization, such as the development of science and technology that put it generally ahead of Europe until the fifteenth century. He attacked Wittfogel for reductionism and for regarding the need for water control as the only source of China's bureaucracy.

On the other hand, Needham acknowledged Confucian bureaucracy as an obstacle to scientific development. He also praised China for its ability to control water and regarded this as a potential source of power; for instance, he is on record as saying that the Qin dynasty of the third century BCE built its power very largely 'on extensive irrigation works' (Needham et al. 1971: 227).

Clearly, Needham saw a role for the physical environment in explaining the lack of a scientific breakthrough such as the one that occurred in Europe. He shared some points with Wittfogel, but his overall interpretation had none of the latter's harsh condemnation. Instead, he was appreciative and admiring of Chinese tradition and achievements.

In considering the other main material factor inhibiting Chinese scientific development—the economic—we might also suggest a major comparison with how things happened in Europe. An early but still interesting theory concerning the development of modern science is that of the Austrian pioneer of the sociology of science Edgar Zilsel (1891–1944).

A Jewish Marxist, Zilsel fled Austria after the Anschluss, first to England and then to the USA. The 'Zilsel thesis' argues in essence that science of the kind that led to the modern world could only take firm root when capitalism emerged in Western society: 'The whole process was imbedded in the advance of early capitalistic society, which weakened collective, magical thinking, and belief in authority and which furthered causal rational and quantitative thinking' (Zilsel 2000: 7). He posited cooperation between university scholars and superior artisans, which was possible only from about the beginning of the seventeenth century.

Sharing a Marxist approach with Zilsel, Needham was attracted to his theory, in particular the notion that the breakdown of the gap between the merchant class and intellectuals may have contributed to the rise of modern science. The hierarchy dictated by Confucianism actually put merchants quite low in the social hierarchy and thus prevented the kind of cooperation between the merchant and intellectual classes that occurred in Europe. This would certainly be a factor inhibiting the rise of modern science in China (Cohen 2001: 23–24).

3.2 Non-Material Factors: Philosophy and Culture

One of the great divides in Chinese tradition is that between Confucianism and Daoism. The former came to be dominant and was the philosophy that lay beneath the bureaucracy and controlled the state.

It was an ideology that talked not about abstract thinking so much as society, not about nature but about human affairs and governance. It was heavily rationalist, text-oriented and rigidly conservative. It persisted throughout Chinese history and probably inhibited the spirit of enquiry necessary for a scientific revolution.

One can hardly claim that it saw no innovations, because the Song dynasty (960–1279) spawned a new approach to Confucianism, including new ideas, that is known to history as Neo-Confucianism. However, socially Neo-Confucianism also moved Chinese society towards more rigidity in the form of greater oppression of women and stereotypical family relationships. Moreover, the Mongol conquest of the thirteenth century destroyed much of what the Song dynasty created that was new, such as the growth of cities and commercial development.

Needham was harshly critical of Confucianism's role in the development of Chinese science and technology. His views are succinctly expressed in a shortened version of his great work:

> Confucianism has little connection with the history of science. A religion without theologians, it had no one to object to the intrusion of a scientific view on its preserves, but in accordance with the ideas of its founding fathers, it turned its face away from Nature and the investigation of Nature, to concentrate on a millennial interest in human society, and human society alone. (Ronan 1978: 84)

On the other hand, philosophical Daoism was notable for its love of nature and respect for the natural world. It was much more receptive to science and technology than Confucianism, much more open to new ideas and less hidebound and conservative. Daoism remained an influential force throughout Chinese history, but it was always subordinate to Confucianism. Men who had entered the bureaucracy and failed to achieve their career goals or stirred up trouble by disagreeing with powerful people often retreated into Daoist creativity. This is the impulse that led to some of China's most enduring artistic creations, such as the landscape paintings of the Song dynasty.

Needham was very attracted to Daoism and its positive attitude towards nature. In particular, he admired Daoism's most famous doctrine of *wuwei* (inaction). He believed that *wuwei* 'implied learning from Nature by observation' (Ronan 1978: 98).

Daoism raises other questions. A crucial one is whether humankind *ought to* try and conquer nature or cooperate with it, and *wuwei* might imply the latter. Modern science puts the emphasis on using the natural world by recognizing the law of nature; it relies on practical experiment, evidence and the natural law. On the other hand, science also wants to conquer nature in the interests of humankind. Traditional Daoist thinking in China would imply opposition to the extent of interference with nature that the modern world has produced.

Some scholars have contested Needham's excessive emphasis on Daoism as a motor for scientific development in China. They point out that Buddhism and even Neo-Confucianism have elements that absorb observation of the natural world, with ideas on nature that approached contributing to science. Ho Peng Yoke (1926–2014), the distinguished historian of Chinese science who was for a decade the honorary director of the Needham Research Institute, refers to the main Neo-Confucianists as 'philosophers of science' but 'not scientists' (Ho 2005: 180). He describes a conference held in Cambridge shortly before Needham's death and attended by many distinguished scholars, at which the theme was whether Daoism was the only philosophical stream contributing to Chinese science, with most contributors adopting a negative position (Ho 2005: 196–197). To be fair, Needham himself was clearly impressed with Chinese cosmology, which draws not only on Daoism but also on other philosophical strains. He is on record as characterizing the Chinese worldview as seeing a 'harmonious co-operation of all beings … because they were all parts in a hierarchy that formed a cosmic pattern' (Ronan 1978: 306).

Earlier we noted the importance of Confucian bureaucracy in Chinese history, as well as the connection with the physical environment and Confucian philosophy. The state was extremely powerful in dynastic China, with the emperor and his mandarins holding considerably more power than was the case in Europe. Perhaps the Confucian bureaucratic state was just a bit *too* powerful, to the exclusion of other sources of influence that might have made for a wider variety of creative initiatives. Perhaps Alexis de Tocqueville (1805–1859) was right when he famously remarked that despotism makes people look 'coldly on one another: it freezes their souls' (de Tocqueville 2010: ix).

A social connection can also be found in the main way in which men were chosen for entry into the bureaucracy that ran this authoritarian

state. This was a complex system of examinations, which was based on the Chinese classics and involved much more emphasis on rote-learning than on analysis. The examinations bestowed enormous social status on those who were able to pass them and are relevant to China's failure to produce a scientific revolution in several ways.

Two of these deserve emphasis. One is that the examinations exercised a stultifying impact on the educated elite. This meant that the most intelligent and educated people within society failed to be innovative because the spirit of creation contributed nothing to their chances of doing well in society. It is not that they were unable to analyse, but that they were never given the chance to do so. Second, the sons of the merchant classes tried to raise themselves in society not by increasing their wealth, but by attempting to enter the bureaucracy through passing the examinations. The very power that proved so crucial to the development of science in Europe was stifled in China.

We might add another social phenomenon in passing. The examinations were open only to men and not to women. About half of society was never given the chance to contribute. One cannot put too much emphasis on this factor, because it applied everywhere in those days, not merely in China. What we *can* perhaps claim is that women were considerably more oppressed in China than in Europe and were kept even more firmly out of the ranks of those who might contribute intellectually to society.

In the passage where Needham comments on the difference between the physical environments of Europe and China, we noticed in passing a reference to language, especially script. A major scholar to see the scientific spirit as lacking in pre-modern China was the eminent American Sinologist Derk Bodde (1909–2003). Among the many factors that he believed inhibited the development of scientific thinking was a written language ill-adapted to the expression of scientific ideas (Bodde 1991: 133). Interestingly enough, Bodde's 1991 book was actually the result of three years in Cambridge working with Joseph Needham (Le Blanc 2006: 164). Needham was generally much less interested in this factor than Bodde and even came later on to discard it as irrelevant (Cohen 2001: 22). In the light of Needham's exposition of so many scientific ideas expressed in Chinese, my own view is that to discard Chinese language as ill-adapted to the expression of scientific ideas is going too far.

4 Is the Needham Question Worth Asking?

The Needham question has been criticized as being excessively negative. To ask why something did *not* happen in a particular country may be less interesting than asking why it *did* happen. This would mean that we should not ask the question why modern science *did not* emerge in China, but rather why it *did* do so in Europe.

This is a reasonable formulation. However, there are grounds for supporting the validity of the Needham question. Cohen writes (1994: 381) that, in pragmatic terms, knowledge of non-Western science would have been very much smaller without Needham's work: 'After all, Joseph Needham's *Science and Civilisation in China* owes both its origin and the guiding thread holding its many tomes together to the confident expectation that sensible answers can be given to this very question.'

All this does is to tell us what we would have missed had the question not been asked. It does not really lend academic validity to posing the question. However, my own view is that the question is far from irrelevant in academic terms. This is because Needham posed it in the context of China having been a long way ahead of Europe until the sixteenth century, when one might have expected that the great breakthrough that led to modern science could readily have occurred in China.

Another relevance of the Needham question is to ask not so much why China failed, but why no other culture joined effectively in the pursuits of this science for so long. After all, it was centuries after the scientific revolution before China, or indeed other cultures, really joined in the scientific advance. As one scholar notes, 'the Needham question is not about an exercise in what-if history, but it's about favorable cultural infrastructure for science' (Gorelik 2012).

And, from the point of view of the present chapter, it is perhaps just as important to note that Needham raises questions of the utmost importance for global history. As we have seen above, Needham and those who discuss him make constant comparisons between China and Europe, comparisons that involve not only science and technology but also the nature of the physical environment and economic history, as well as philosophy and society.

5 Conclusion

The Needham question is essentially too big to answer. However, I think the tentative suggestions that Needham himself raised contain a lot of sense. In particular, I doubt very much indeed that there is anything essential or 'genetic' in Chinese civilization or people that would make the development of modern science impossible in China. Also, I see a great deal of sense in asking whether cultural, social, economic and political circumstances affect phenomena like the development of science and its use for practical purposes. The question why developments took place at particular historical stages or why they did *not* take place at others is important and definitely worth further research.

We live in the shadow of modern science and it has served human development well on the whole. On the other hand, now we are entering the post-modern world, it may be useful to rethink the overall patterns of modern science. Can modern science help us cope with the new problems of environmental deterioration? At the World Conference on Science, held in Budapest in 1999, the Chinese scholar Liu Dun from the Chinese Academy of Social Sciences posed the question in the following way:

> Can people really find a way of keeping harmony between mankind and nature, science and society, industrial development and a healthy ecological environment, global economic integration and cultural diversity? This is a crucial question for mankind in the new century. In this sense, the 'Needham question' will continue to evoke divergent responses from different parts of the world; and of course, its significance will extend far beyond the more specific matter of science and China.

What becomes obvious is that 'the Needham question' retains global relevance and is likely to do so for the foreseeable future. The relationship between science and modernity still matters, both in China and globally. Science will be able in major ways to help humankind into the indefinite future.

Notes

1. For a well-known and comprehensive biography of Needham, see Winchester (2008).
2. Volume 6, Part 4: Métailie 2015.

3. See Needham's biography on the website of the Needham Research Institute: 'Joseph Needham, 1900–1995,' http://www.nri.org.uk/joseph.html.
4. China is rarely central to Marx's arguments. The 'Asiatic mode' relies more on India than China. Marx believed that, due to the 'climate and territorial conditions, especially the vast tracts of desert' in India, the despotic government must carry out public works, organizing 'artificial irrigation by canals and waterworks,' which form the 'basis of Oriental agriculture' ('The British Rule in India' in Marx and Engels 1969–1970: 489). For a full-length study of the Asiatic mode of production, see Sawer (1977).

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