


# Science, society and planning: Joseph Needham's report to Chiang Kai-shek in 1946

Cultures of Science  
2020, Vol. 3(2) 97–117  
© The Author(s) 2020  
Article reuse guidelines:  
sagepub.com/journals-permissions  
DOI: 10.1177/2096608320917577  
journals.sagepub.com/home/cul  


**Banghong Fu**

University of Science and Technology of China, China

## Abstract

Based on historical materials in the United Kingdom and China, this article analyses Joseph Needham's 1946 report to the national government's then leader, Chiang Kai-shek, on the state and prospects of modern science in China, and discusses its background, main content, characteristics, influences and significance. Needham completed the report at the end of 1945, and kept in mind the rich Eastern and Western contexts while writing it. The report revealed a series of institutional problems to do with science in China and provided a framework for scientific development. It also provided specific measures and essentially formed a plan for the scientific development of China at the institutional level. The report had an impact in China at the time, and the Ministry of Education engaged its content to formulate six specific measures for scientific development. Moreover, the Supreme Council for National Defence promoted China's first 10-year plan for applied science. Needham's report had universal significance for the development of science – not only in China at the time, but even globally today. The report also played an important role in the formation of Needham's monumental book series, *Science and Civilisation in China*.

## Keywords

Chinese modern science, science and society, planning of science, Needham puzzle

In recent years, research on Joseph Needham has focused on his personal experience on the one hand, and a discussion of the 'Needham puzzle' on the other. In both cases, the basis of the discussion is Needham's understanding of ancient Chinese science and technology. In the 1940s, Needham also expressed at length his views on modern Chinese science and culture.

In the winter of 1945, before his departure from China, Needham wrote a 63-page secret report at the invitation of Chiang Kai-shek to discuss the state and prospects of science and technology in China at the time. The report was submitted to Chiang in February 1946. It not only exposed problems in the development of science and technology in China,

but also proposed a series of suggestions for improvement, fully reflecting Needham's thoughts on contemporary Chinese society and culture from the perspective of a foreign scientist. Some of those recommendations had an impact on China's subsequent policies.

This article is based on the report titled *Report to His Excellency President and Generalissimo Chiang Kai-shek on the Position and Prospects of Science*

## Corresponding author:

Banghong Fu, Department of the History of Science and Scientific Archaeology, University of Science and Technology of China, 96 Jinzhai Road, Hefei 230026, Anhui, China.  
Email: bhf@ustc.edu.cn



Creative Commons Non Commercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License (<https://creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed as specified on the SAGE and Open Access page (<https://uk.sagepub.com/aboutus/openaccess.htm>).

and *Technology in China* (Needham, 1945)<sup>1</sup> and analyses its background, content, characteristics, significance and impact.

## I. The historical context of the report

Joseph Needham's visit to China during World War II might have seemed to be on the spur of the moment but had been planned for a long time. The historical background provided here explains his reasons for coming to China, why Chiang Kai-shek asked him for advice on science and technology, and why Needham was able to provide such a detailed report.

### I.1. The science and society movement in Britain

The global economic crisis from 1929 to 1933 affected every country with the exception of the Soviet Union. This was because of the implementation of the Soviet model of a planned economic system, which, as a result, received considerable attention.

The planned economic system of the Soviet Union was initiated in the 1920s, and Nikolai Bukharin played an important role in it. In 1930, after being out-manoeuvred by Stalin, he was sidelined from the Politburo onto the Supreme National Economic Council of the Soviet Union as head of planning research (Gao, 2000). In that position, he began developing scientific research institutions over the next 5 years and, in April 1931, hosted the first Soviet all-union conference on the planning of scientific research, with a view to studying the methodology of 'planning science' (Fu, 2012). It was in that period that, guided by dialectical materialism, he began to organize scientists at the Soviet Academy of Sciences to study historical issues in science. He himself focused in the meanwhile on theoretically expounding the social functions of science and demonstrating the superiority of a science planning system based on socialism. He proposed five aspects of scientific planning that needed to be determined:

- The share of the country's budgetary resources that should be devoted to science;

- The subjects of scientific research;
- Support for scientific research institutions;
- The geographical placement of scientific research institutions;
- The supply of personnel or 'cadres' (Graham, 1964).

From 29 June to 4 July 1931, the Second International Congress on the History of Science was held in London and was attended by Bukharin and his research group. Coincidentally, Needham was one of its main organizers. Presentations by the Soviet delegation, especially the one by Boris Hessen, greatly impressed the participants. Subsequently, the attention of some British scientists was drawn to research on the relationship between science and society. Some activists, such as Solly Zucherman and JD Bernal, organized clubs to discuss the social application of science (Brown, 2005). As a friend of Bernal, Needham was one of those activists.

In 1968, when Gary Werskey interviewed Joseph Needham for his doctoral thesis, 'The visible college: A study of left-wing scientists in Britain, 1918–1939', Needham first asked Gary to relate to two Chinese scholars with him some of Werskey's own ideas about the social relations of British science in the 1930s (Werskey, 1976: 25). The social relationship of science that Needham was referring to can easily be found in publications at the time. Throughout the 1930s, *Nature* and similar natural science journals published many articles on such topics as government and science, science and politics, the social relations of science, and science and national services. The articles reflected how scientists were thinking broadly about the relationship between science and society.

Specialized organizations were established, one of which was the Committee on Science and its Social Relations (CSSR), initiated by the Royal Society and formed by left-wing British scientists in 1937. Its function was to conduct surveys of scientific work in certain fields in order to understand science and its impact on human society and the response of scientific research to the social environment (Anonymous, 1938a).

The CSSR designed a special questionnaire and distributed it to various research institutions and

organizations. The survey received such an enthusiastic response that the Royal Society even set up a special committee to deal with it (Anonymous, 1938b). The CSSR also appointed correspondents and established branches in countries around the world. Liu Xian,<sup>2</sup> the editor-in-chief of *Science*, sponsored by the Science Society of China, was the Chinese correspondent of the CSSR. Other members of the Chinese branch were as follows (Liu, 1938):

Dr Li Heng李珩, a professor at Sichuan University

Dr Yan Jici严济慈, director of the Institute of Physics of the Peiping Academy

Dr Zeng Zhaolun曾昭抡, president of the Chinese Chemical Association and a professor at Southwest Associated University

Wang Jiayi王家楫, director of the Animal and Plant Institute of the Academia Sinica

Dr Li Liangqing李良庆, director of the Specimen Room of the Peiping Jingshen Bio-investigation Institute

Dr Wu Dingliang吴定良, director of the Anthropology Group of the Institute of History and Languages, Academia Sinica

Dr Lu Yudao卢于道, a technician at the Institute of Psychology, Academia Sinica

Professor Zhang Qiyun张其昀, director of the Department of History and Geography, Zhejiang University

Dr Lyu Jiong吕炯, acting director of the Institute of Meteorology, Academia Sinica

Dr Yang Zhongjian杨钟健, a technician at the Geological Survey

Dr Feng Fang冯芳, head of the Central Agricultural Laboratory

Zhang Yanxiang张延祥, an engineer in Hong Kong

Dr Zhu Hengbi朱恒璧, dean of Shanghai National Medical College.

Thus, the areas of research pursued by the members covered mathematics, astronomy, physics, chemistry, zoology, botany, anthropology, archaeology, psychology, geography, meteorology, geology, agriculture, engineering and medical science.

In 1938, to further research the social relationship of science, the Council of the British Association proposed the establishment of a new division – the Division for Social and International Relations of Science – to explore the influence of scientific progress on social welfare and that of social conditions on scientific progress by means of inquiry, publication, and meetings (Anonymous, 1938c). The division formed a committee of 40 people, including Richard Gregory, the editor of *Nature*, and the well-known scientists JD Bernal, PMS Blackett, AV Hill, L Hogben, JS Huxley and FC Bartlett (Anonymous, 1938d).

After the Second International Conference on the History of Science, discussions on the relationship between science and society intensified. Alongside international research by left-wing scientists, enthusiasm for the history of science flourished in Cambridge. In 1936, due in part to efforts by Joseph Needham, Cambridge established a committee of 11 people to lecture on the history of science. Those activities eventually led to the birth of the Department of the History and Philosophy of Science at the university.

The committee invited Ernest Rutherford, Arthur Eddington and other scientists to lecture on the history of their areas of expertise, creating unprecedented grand occasions in Cambridge. At times, audiences were so large that many people had to stand in the aisles or sit on the floor of the lecture room (Needham and Pagel, 1938). Needham himself was an active participant and delivered two lectures: ‘Biology from Galen to Harvey’ and ‘Biology and the social background in the 17th century’ (Needham and Pagel, 1938).

These events show that, well before the establishment of specific investigative and research institutions, Needham not only regarded the history of science as an important field of study but had also begun to study the histories of disciplines from the perspective of the relationship between science and

society. Through these discussions and research on the history of science, prior to the arrival of Dr Lu Gwei-djen<sup>3</sup> at Cambridge, Needham and his left-wing friends had already formed a consensus on a specific question – Why did science originate only in Europe? (Fu, 2011).

The arrival of three Chinese students at the biochemistry laboratories in Cambridge in 1937 naturally attracted Needham's attention to China. He developed a strong interest in Chinese culture, learned Chinese from one of the students, Lu Gwei-djen, and later resolved to write a history of science, technology and medicine in Chinese culture (Wangqian, 1999).

As early as in 1939, he began to plan a visit to China, developing extensive contacts with the British Council and other institutions in Britain and China. In 1942, prompted by a marked improvement in Sino-British relations, the British Government decided to send representatives of the scientific and humanities research communities to China to promote academic relations. Needham, who had a preliminary understanding of Chinese and had been seeking an opportunity to visit China, was the first choice.

In March 1943, Needham arrived in Chongqing, the wartime capital (Needham and Needham, 1948). In June, he established the Sino-British Science Cooperation Office there, with the mission of providing China with assistance in wartime scientific research (Wangqian, 2007). In August, he led some colleagues to the north-west to inspect wartime scientific and technological work in Gansu. This was followed by several other long-distance trips by him and his colleagues, covering the western, north-western, south-eastern and south-western parts of China, all described in the book *Science Outpost* (Needham and Needham, 1948).

In addition, several articles were published in *Nature* in 1943 and 1944, such as 'Science in south-west China', 'Science in Chongqing' and 'Science and technology in southeastern China' (Needham and Needham, 1948), reporting to the Western world on the status of science in unoccupied China. These activities involved both performing the task assigned to him by the British Government and fulfilling the scientific investigative functions of the CSSR.

Meanwhile, the science and society movement that Needham had been involved in before he came to China progressed further. In 1939, the publication of Bernal's book *The Social Function of Science* gave rise to a hotly debated controversy: Should science be planned or free? This is usually referred to as the Bernal–Polanyi dispute (Brookman, 1979). The 'planning of science' group, represented by Needham's friend, Bernal, and the 'freedom of science' group, represented by M Polanyi, debated the question fiercely on the radio, in newspapers and magazines, and at gatherings (Fu, 2012). The dispute was continuing on the eve of Needham's arrival in China, but the 'planners' had achieved notable success (Polanyi, 2002). The Soviet-style system of management of science advocated by Bernal was widely circulated (Fu, 2008). In 1942, Needham joined the Society for Freedom in Science founded in 1941 by Polanyi, although he was in fact a believer in Bernal's 'planning of science'.

### 1.2. The planning movement in China from the 1930s to the 1940s

In China, the exigencies of the war against Japan motivated the government to look for international aid and undertake efforts for the country's prosperity. In 1940, China's military situation deteriorated further. The national government's fiscal revenue fell to less than one-fifth of that before 1937, whereas fiscal expenditure increased several times (Dong, 1997). In those circumstances, to enable the government to continue functioning and support the front line, the government sought foreign aid.

At that time, however, countries such as the United States and Britain had adopted an appeasement policy. Chinese endeavours to borrow money from both were thus unsuccessful (Wang, 2013).<sup>4</sup> Chiang Kai-shek (2015 [1940]) wrote in his diary: 'The British attitude is despicable, the United States is waiting and seeing; this is the fateful day when we must depend on ourselves. If not, how can we succeed in adversity?'. With foreign aid unreliable, Chiang believed that only by girding themselves for the great task could the Chinese people succeed in defeating Japan, and that the first thing to accomplish was to effectively organize the human, material

and financial resources of the country and to strengthen unified organization and control at the national level. This had been the agenda of the national government since the Mukden Incident (September 18 Incident) of 1931.

Since the 1930s, the national government had embarked on a series of measures for economic and cultural construction, such as the New Life Movement and the National Economic Construction Movement. Economic construction was prioritized in both. In this area, the national government adopted an attitude of open learning. At the time, although the United States adopted Roosevelt's New Deal and implemented state intervention in the economy in response to the Great Depression, Japan and Germany adopted state capitalism. Keynesianism also matured during this process to become one of the most important economic theories of the time. However, the scandals associated with Stalin's 'Great Purge' in the Soviet Union had not yet leaked out, and the positive international reputation of the early stages of the planned economy there had not yet been affected. Thus, the national government's natural choice was to learn from the Soviet model.

In 1933, the Chinese intellectual community initiated a discussion on how to build a modern national economy. Yang Duanliu,<sup>5</sup> Tao Mengru<sup>6</sup> and 26 other intellectuals reached a consensus that China should implement a planned economic system (Yang et al., 1933). Prior to this theoretical exploration, the national government had practised some degree of economic planning to strengthen national defence and cope with a possible full-scale Japanese invasion of China.

In November 1932, a secret organization of the Kuomintang (KMT), the National Defence Design Committee (NDDC),<sup>7</sup> was established. The agency was composed of three parts and was divided into 8 groups employing 39 experts and scholars to formulate a national defence plan, map out a national defence-centred construction project and prepare for the emergency organization of national defence (Wu, 1988). After the establishment of the NDDC, based on statistical investigations of the national defence economy and its resources, a number of important programmes were formulated, such as the National Defence Industry Initial Plan, the Five-year Plan for

Heavy Industry Construction, the Wartime Fuel and Petroleum Control Plan, the Preliminary Plan for Mobilization and Control of Transportation and the Food Storage and Control Plan (Wang, 2004). All were gradually implemented.

In April 1935, the NDDC was reorganized into the Resource Committee.<sup>8</sup> In the same period, Chiang Kai-shek launched a national economic construction campaign in Guiyang (National Economic Planning Commission of the Central Committee of KMT Congress (NEPCCCKMTC), 1976). The campaign expanded rapidly, and various 'national economic construction committees' were established from the central government down to the local government level. Their objective was to 'concentrate on the power of various parts of national society' and to use the 'cooperative system', 'military organization', 'academic institutions', 'academic groups', 'industrial institutions', 'production organs' and all the forces of agriculture, industry and commerce to build a sound national economy. The role of the government in this was 'to forcefully expedite the removal of obstacles, and provide all kinds of help and convenience' (Chiang, 1935). Academic institutions such as the Academia Sinica were one of the focuses of the campaign.

In November 1935, the Fifth National Congress of the KMT decided to set up the National Economic Planning Committee to discuss construction projects and collect materials (NEPCCCKMTC, 1976). With the further development of the National Economic Construction Movement, a growing number of people came to believe that, in the face of the turbulent international political situation, the implementation of a planned and controlled economic policy that unified the national economic sectors and was driven by the will of national unity was important (Xu, 1936). By the 1940s, the implementation of the planned economy had become an important principle of the wartime nation-building programme (Fu, 2015).

In addition to promoting economic planning theory and practice in the 1930s, the national government promoted administrative procedure theory.<sup>9</sup> A group of intellectuals in the administrative field, represented by Gan Naiguang,<sup>10</sup> initiated an administrative efficiency movement in the Ministry of the

Interior. They proposed that the ultimate goal of administration could be achieved through five steps: using materials, making plans, implementing decrees, guiding supervision, and assessing rewards and punishments. In this way, fruitless discussions and ineffective measures could be avoided. The most effective way to guide and supervise was to have the right to appoint and remove personnel and to carry out budget and plan reviews of lower-level organizations (Yu, 2019). Gan's theory was widely implemented in the KMT Central Department, and Chiang Kai-shek considered it significant (Chiang, 2015 [1939]).<sup>11</sup>

Faced with the political reality of national poverty, social turbulence and a lack of foreign aid, the dissemination of foreign-planned economic practices and theories as well as China's own pre-war control of economic and administrative efficiency enabled Chiang Kai-shek to develop a strong belief in the need to use centralized planning methods to manage the country.

In 1940, Chiang proposed a planned administrative management model: the Triple System of Administration (TSA).<sup>12</sup> This new system divided various types of work into three parts: planning, execution and assessment. The Central Design Bureau (CDB)<sup>13</sup> of the KMT Central Committee established a plan based on the budget, the practicability of implementation and the results of assessments. Central and local KMT party and government executive organs implemented the plan layer by layer. An assessment committee was later established to evaluate the work of the party and the government. The results of the assessment were provided to the CDB as a reference for the next round of planning (Chiang, 1941).

The national government intended to improve administrative efficiency and achieve state control over a variety of resources, and the TSA was essentially the implementation of a planning system. Chiang Kai-shek (1941) noted that the system was designed to lay the foundation for 'planning politics' and a 'planned economy'. The Academia Sinica and the Ministry of Education, both of which dealt with science, were included in this design and evaluation system. Chiang Kai-shek, as the chief proponent, promoted the theory of the TSA. He placed two TSA

institutions – the CDB and the Party and Government Work Evaluation Committee – under the direct leadership of the Supreme Council for National Defence,<sup>14</sup> which was the highest institution during wartime. He also personally selected the leaders of the two agencies, who reported directly to him, and personally supervised the relevant seminars (Yu, 2019).

When Joseph Needham arrived in China, the TSA was at the peak of its implementation. China's war against Japan had shifted from a stalemate to a counter-attack. Under the framework of the TSA, the national government planned the reconstruction of the country after demobilization. In 1942, the National Council of the Academia Sinica drafted a plan of scientific research for China after the war (Fu, 2008). As the head of government, Chiang Kai-shek emphasized the development of science in China. In the same year, he issued a statement – 'The way of science and the spirit of science' – that required that all scientific workers understand the content of science, embrace the spirit of science, and use scientific methods to exert 10 times their own strength for the rejuvenation of the nation (Needham, 1952). The article was posted in various national laboratories and workshops.

In March 1943, Chiang's (1943) book *The Destiny of China* was published and, by December, had been reprinted more than 200 times. According to the archives in Nanjing, the Academia Sinica and the Peiping Academy were commissioned to study the book and accordingly draw up plans for future research and development.<sup>15</sup> There were indications that Chiang also intended to apply his system of administrative planning to the scientific field. It was against this backdrop that he asked Needham to provide criticism and suggestions on Chinese science and technology.

## 2. The main content, features and essence of the report

Joseph Needham's report is rich in content, documenting many aspects that he had observed and reflected on in China. There are praise, criticism and suggestions; there are also many comparisons with the Western world, reflecting some distinctive features of science in China.

### 2.1. Overview of the report

The report is divided into nine parts, in which 10 recommendations are made. The first page contains an outline, in which the headings of each part are listed:

- The necessity for increased government support for science;
- The necessity for increasing the prestige of Chinese science;
- The necessity for finding political leaders with an understanding of the function and importance of science in the national welfare;
- A special ministry for science and technology;
- The Ministry of Education and the overseas study programme;
- Scientific societies and other organisations;
- Industrial organisations and industrial welfare;
- Wartime science of China and Britain in retrospect;
- International scientific relations.

There are minor differences between the English and Chinese versions of the report with respect to the recommendations. In the Chinese version, the recommendations are placed at the end of the report and, as a result of the translation, differ slightly in meaning from the original text, although that does not affect the overall meaning.<sup>16</sup> In the English version, the 10 suggestions, which precede the main text of the report, are as follows:

1. That the government should embark on a great investment policy by subsidising the Chinese scientific institutions (pure as well as applied) on a scale very much greater than heretofore.
2. That means should be developed for increasing the prestige of science and technology in China, perhaps by the foundation of new orders and decorations, accompanied by suitable publicity, by stricter registration of qualified men, or other methods as may be found good.
3. That great efforts be made to encourage political leaders with a real knowledge and understanding of science and technology in

order to reduce the inhibiting factors which retard the industrialisation and modernisation of the country.

4. That the Ministry of Education be strengthened on the scientific side.
5. That since science cannot flourish except in a democratic and liberal atmosphere, steps be taken to ensure variety and freedom of thought and expression in the universities.
6. That the policy of sending the maximum number possible of scholars, students, and foreman-apprentices abroad for study, in the interests of the industrialisation and modernisation of the country, be vigorously proceeded with, and that western scholars and students be invited to China also.
7. That careful thought be given to the ways in which China's industrialisation might profitably differ from that which was historically gone through by the western countries, for example, in the use of non-ferrous metals, plastics, plant products and chemurgic processes.
8. That special care be taken to ensure sound workers' welfare practice during industrialisation, insofar as the situation permits approximation to western standards.
9. That thought be given to the problem of the provision of scientific advisory bodies at all levels of and to the participation of scientific men in the foreign relations of the country.
10. That China continue her policy of demanding a United Nations Cultural Organisation capable of fulfilling the functions of an international science cooperation service, and that the Chinese scientific movement be strengthened as soon as possible by the arranging of one or more international scientific congresses in China.

### 2.2. The characteristics and essence of the report

Some notable characteristics come to the fore when we consider an overall view of the report.

First of all, Joseph Needham praised the science and technology of China during the war, especially

the work of Chinese scientists. However, most of his observations pertain to criticisms of the environment in which China's science and technology had been developing.

He pointed out that, in circumstances that would have left European and American scientists depressed, the achievements of Chinese education and industrial technology merited sympathy and admiration. China had a group of scientists who had made important contributions to the pure sciences, but the environment that the Chinese Government provided for them had not been sufficiently suitable. The government's investment in science was too low, and resources and personnel were in short supply in many Chinese research institutions. Furthermore, the eagerness for rapid scientific success in China had led to an overemphasis on the applied sciences and the neglect of the pure sciences.

Needham repeatedly referred to the atomic bomb – the most compelling scientific achievement of the time – as an example to illustrate the importance of increasing investment in and attaching importance to the pure sciences. He proposed that the amount of funding for scientific and technological research be increased to 0.5% of national income. In addition, he sharply criticized several aspects: political leaders lacked a modern mind-set and had neglected science or even hindered its development; the Ministry of Education was weak in science, restricted freedom of thought in universities and neglected students' health; the military had destroyed some research institutions.

Needham considered almost all aspects and made appropriate suggestions, from the construction of institutions and the choice of organizational models to the staffing of organizations and the livelihoods of the people. He even analysed the problem of corruption in China. His comments thus included pungent criticisms of prevalent ills at the time and did not avoid sensitive topics. For example, he noted that political leaders lacked scientific literacy, that the Ministry of Education had not performed well in defending freedom of thought, and that the behaviour of the police in 'disappearing professor'<sup>17</sup> incidents was problematic. Some criticisms and suggestions are thought-provoking even today.

Second, Needham paid special attention to the relationship between science and politics. He devoted more than one section to a discussion of this issue. He claimed that politics was the biggest problem facing science in China at the time, commenting, 'If science in China has any shortcomings it is that it is too readily subject to interference by politicians who, however well-intentioned, have neither knowledge of, nor interest in, science'. He highlighted a series of abnormal relations between politics and science, such as

- The restriction of democracy and the freedom of science;
- The lack of understanding of science among political leaders;
- The setting up of scientific positions based solely on the interests of a political group;
- Scientific work completely interrupted by a change of director in an organization;
- The erosion of pharmacological research due to national sentiment;
- The destruction of scientific research facilities by the military;
- Hesitation in implementing science and technology in the education of the masses for fear of their enthusiasm;
- A lack of understanding in the Ministry of Education of the scientific needs of universities, and so on.

He added that most Chinese politicians had accepted only those people with a classical education, had narrow views on nationalism, lacked a modern mind-set, and could not understand the modern world, so it was difficult for them to lead China's industrialization. He cited psychological reasons for politicians and others not appreciating science: the influence of Confucian philosophy, which led them to think of science as a luxury; economic considerations whereby they did not require science to gain wealth; and 2,000 years of bureaucratic influence. In short, the contemporary state of Chinese politics had hindered and damaged the growth of science in China. His references to Sun Yat-sen's political philosophy regarding national construction – the 'Three Principles of the People' and Chiang Kai-shek's

book *The Destiny of China* – showed that Needham had not only paid attention to real political issues, but had also studied the KMT's political programme as well as the interaction between political opinions and science.

Third, when analysing Chinese science, beyond politics, Needham also considered such factors as economics and culture. In terms of the economy, besides industry, he focused on agriculture, forestry, and soil and water conservation. For industry, he made specific proposals for improving the railway transportation network and developing water resources in western China. He even proposed ideas and suggestions on the model to be followed for China's industrialization. Needham believed that China should establish its own model of industrialization based on its own advantages in natural resources, instead of following the old model of the West based on the steel industry. The term 'industrialization' appears 17 times in the report.

Although Needham thought that economic structure – a critical issue – was beyond the scope of the report, he nevertheless discussed several aspects related to it, such as where to establish a natural nitrogen fertilizer plant, where to carry out dairy farming, where to build a canned fruit base, and how to plan water and soil conservation. He even considered the issue of China's economic path:

I often question, however, whether it is necessary for China to retrace all the steps in the weary road of the development of capitalism in Western Europe. The proposals of Sun Chung-shan [Sun Yat-sen] that heavy industry, mining, power production and all communications should be owned and operated by the state, while light industry should be left for individual enterprise, seem to be an excellent compromise.

This supported the implementation of the 'planned economy' model, which was still being hotly debated at the time.

Needham also realized that inflation had had a serious effect on the development of China's industrial technology, and that there would be little hope for Chinese industry in the future unless it was controlled by people possessed of a modern outlook and an industrial mind. At the same time, he emphasized that culture is closely linked to science. China

emphasized only the material culture of the West while abandoning its intellectual and spiritual culture; this was as unreasonable as the West's disregard of China's four inventions and the contribution of Mencius' thought to the French Revolution: 'Modern science cannot be fully understood without understanding the social setting of European civilization in which it took its rise'. Therefore, when analysing Chinese science, he not only observed social phenomena but also made significant efforts to trace the social and historical roots of those phenomena. This method was in line with the Science and Society Movement and 'externalism theory' after the Second International Conference on the History of Science.

Fourth, the report shows Needham's special feelings for ancient Chinese cultural heritage. Needham was disheartened at seeing that the Thousand Buddha Caves at Dunhuang<sup>18</sup> had not been protected by any formal measures, and that the Confucian temples in rural towns were neglected by people or destroyed by the army. He suggested that a special agency – a monuments protection committee – should be set up to work closely with the Academia Sinica and to encourage all politicians to remedy this problem.

In addition, he emphasized that China had already gained international prestige for its art and archaeology, and that the government should provide strong support for archaeologists. Large investments should also be made in the construction of national museums to help retrieve Chinese cultural relics taken abroad. China could easily play an important role in the United Nations Science and Culture Organization, he added, because 'her age-old and famous respect for scholars enables her particularly readily to push forward this public work in the comity of nations, which incidentally may be a source of much prestige for herself'.

Needham also felt that Chinese could be used as a scientific language and could become a language of world communication. Such content, although seemingly not closely related to the subject he was discussing, was expressed in a naturally heartfelt way. An unofficial purpose of his travels in China had been to collect information about China's historical and cultural heritage to deepen his personal academic research (Winchester, 2008), and what he had seen must have stirred him deeply.

Fifth, the purpose of the main body of Needham's suggestions was to establish an orderly system of science and technology in China. To promote the development of China's science and technology after the war, Needham's suggestions included increasing investment in research on science, establishing a reward system, improving the scientific literacy of leaders, improving the Ministry of Education, creating an atmosphere of democracy and freedom, promoting foreign exchange, and establishing a ministry of science and technology.

Regarding the Ministry of Education, he opined that it should be improved by increasing the number of scientists serving in it, ending the censorship of academic works, liberalizing control of universities, caring about the health of students, promoting academic exchanges with foreign countries, improving foreign language teaching, liberalizing Russian studies, changing narrow concepts of nationalism, and learning about Western culture alongside Western science and technology.

The ministry of science and technology should be designed to help Chinese science programmes. Its responsibilities should include managing all research conducted by government organizations; leading national agricultural research bureaus and overseeing provincial agricultural activities; leading industrial research bureaus, national geological survey bureaus, national medical research institutes and national compilation institutions; and maintaining a close relationship with universities and the two national research academies. An important feature of the ministry was that it should be independent of other ministries and should have nothing to do with basic administrative departments so that its long-term programmes would not be at risk of being interrupted by political changes. Needham's suggestion for such a ministry clearly showed his hope that China should have a department responsible for the top-level design of science while ensuring academic autonomy.

Needham's proposals covered multiple facets of the construction of the science and technology system in China. Setting up a ministry of science and technology and improving the Ministry of Education involved both the establishment of a new agency and improvements in the organizational system. Increasing

investment, establishing incentive systems, improving the scientific and technical literacy of leaders, creating a democratic and unfettered research environment and promoting foreign academic exchange were the measures suggested for optimizing the mechanism of operation of the science and technology system (Fang, 1994). Those suggestions were in line with Bernal's 'planning of science' proposed in *The Social Function of Science* – that the national academy of sciences should carry out the planning and management functions of scientific and technological development (Bernal, 1982 [1939]).

Finally, from Needham's criticisms and suggestions, the answer to the famous question of why Chinese science had fallen behind in modern times can also be inferred. During his tenure as head of the Sino-British Science Cooperation Office, he discussed this question with many scholars and made detailed notes. It is clear that solving this problem was a consistent motif throughout his investigations (Liu and Wang, 2002).

In this report, in which Needham summarized the work of the Sino-British Science Cooperation Office, we can easily find his embryonic answer to the 'Needham puzzle'. His views, presented in the article titled 'Science and society in the East and West' in 1964, were already present in this report. He analysed not only reasons why Chinese society failed to develop commercial and industrial capitalism, but also the bureaucratic ideology of Chinese society and the psychological reasons why Chinese politicians had not attached importance to science. He noted how politics had interfered with, and sometimes caused the destruction of, Chinese scientific endeavours in many places (Needham, 2002).

He argued that the psychological reason why scholars, the gentry and bankers had not attached importance to science was that they thought that its purpose was to contribute to comfort and luxury. He added that, in the traditional economy, they could become wealthy as long as they held a high official position or invested in land and banks; they did not consider the investment of capital in industrial production and the country's scientific modernization as a means to personal prosperity.

Needham mentioned all the necessary conditions for the rise of modern science, such as social forces

interested in technological progress, an atmosphere for free debate and people engaged in both mental and physical labour (Graham, 2002). He claimed, however, that China still lacked those conditions, especially that of a democratic and free environment. Aside from deriving Needham's solution to his puzzle solely on the basis of this report, his subtext on science in the Republic of China can be summarized by saying that China's political, economic and technological systems at the time were not conducive to the development of modern science.

### 3. The impact and significance of the report

Needham's report was not intended for Chiang Kai-shek alone. There were many follow-up initiatives as a consequence of it.

#### 3.1. Subsequent distribution and impact of the report

Once the report had been completed, on 28 February 1946, Needham sent it, together with the translated Chinese version, to the British Embassy in Chongqing and requested that the embassy pass it on to Chiang Kai-shek. At the same time, he asked the embassy to send out copies marked 'confidential' a week later to leaders and key personnel of 14 institutions:

Dr Wang Ching-Hsi 汪敬熙, acting secretary-general of the Academia Sinica

Dr Li Shu-Hua 李书华, secretary-general of the Peking Academy

Dr Chu Chia-Hua 朱家骅, Minister of Education

Dr Wong Wen-Hao 翁文灏, Minister of Economic Affairs and vice president of the Executive Yuan

General Yu Ta-Wei 余大维, Army Ordnance Administration

Dr TV Sung 宋子文, chairman, Executive Yuan

Dr Sun Ko 孙科, chairman, the Legislative Yuan

Dr Fu Ssu-Nien 傅斯年, Academia Sinica

President Wu Yo-Hsun 吴有训, National Central University

Dr Tseng Chao-Lun 曾昭抡, Peiching<sup>19</sup> University

Dr Li Sse-Kuang 李四光, Academia Sinica

Dr Chiang Mon-Lin 蒋梦麟, secretary-general, Executive Yuan

General Ling Ko-Hsing 林可胜, Army Medical Administration

Dr Hou Teh-Pang 侯德榜, Yungli Chemical Corporation (Needham, 1946).

Needham also requested that, once the copies had been sent, more copies be printed as soon as possible. They were then secretly issued in his personal name and sent to another group of people:

Dr Hu Shih 胡适, Peiching University

Dr Wang Chia-Chi 王家楫, Academia Sinica

Dr Wu Shioh-Chou 吴学周, Academia Sinica

Dr Yeh Chi-Sun 叶企孙, Nat. [National] SW [Southwest] Associated University 西南联大

Dr Rjen<sup>20</sup> Hung-Chang 任鸿隽, China Foundation

Dr Shen Chih-I 沈其益, Biological Laboratories, National Central University

President Mei Yi-Chi 梅贻琦, Nat. SW Associated University

Dr Chang His-Man 张西曼, Ed[itor], *Democracy and Science*

Mr Mao Tze-Tung 毛泽东, care [of] Kungchangtang<sup>21</sup> Secretariat

Dr Shen Tsung-Han 沈宗瀚, Nat. Agricultural Research Bureau

Dr Chin Bao-Shan 金宝善, National Health Administration

Mr Mao I-Sheng 茅以升, China Bridge Company

Mr Ling Hung-Hsun 凌鴻勛, Vice Minister of Communications

Dr Han Li-Wu 杭立武, Vice Minister of Education (Needham, 1946).

Thus, in addition to Chiang Kai-shek, this report, which Joseph Needham had repeatedly emphasized was confidential, was sent to 28 important figures in the fields of science, technology, culture and politics, including Mao Zedong, the leader of the Communist Party of China (Needham, 1946).

Needham's report was distributed in 1946, just after the war, when travel in China was difficult. The Minister of Education and acting director of the Academia Sinica, Zhu Jiahua, should have received it in early April but did not read it carefully. He simply hurriedly wrote to Needham confirming receipt of the report, placed it in his personal files and sent them to Nanjing (Chu, 1946).

Due to travel restrictions at the time, Zhu did not receive his files in Nanjing until the beginning of 1947 (Chu, 1947). Before then, however, the report had been read by others who were not on the two lists. The most notable of them was Zhu Kezhen. Although Needham did not send him a copy, Zhu read the report on 11 April, only a few days after Zhu Jiahua had received it. He even made an English excerpt and a Chinese summary of the report in his diary for that day (Zhu, 2006). The first sentence of his excerpt was that 'in the United Kingdom, research and organizations are independent of the corresponding ministry'. After quoting in English the democratic university system in the United Kingdom, Needham's promise to help Chinese educationalists to go there to study, and elements that paved the way for the French Revolution, he went on summarizing in Chinese as follows:

Needham narrates the achievements of Chinese science in the past. At present, Blackett's student Hu Qianshan, Max Born's student Peng Huanwu, AV Hill's student Tang Peisong and Tong Dizhou's experimental morphology, and Wu Xian's invention of protein denaturalization are all considered rare achievements. It is necessary to increase funding for the Academia Sinica and Peiping Academy by 100 times . . . Furthermore, too many employees are used in institutions . . . The report also mentions that

universities control ideas and professors go missing. As for academic society, [Needham] insists that scientific journals should be maintained and praises the *Chinese Journal of Psychology*, *Sinensia*,<sup>22</sup> *Science Record*, the *Journal of Meteorology*, and the *Journal of Chemistry*. (Zhu, 2006: 93)

Zhu Kezhen's diary shows that he had read the full text and noted what had impressed him the most. Although it is difficult to verify how individuals felt after receiving and reading the report, we can infer from Zhu's reflection that the report was widely disseminated among scientists, despite Needham's emphasis that it be marked as 'confidential' and only discreetly transmitted.

Chiang Kai-shek should have received the report transmitted by Wang Shijie in March, since Needham had given it to the ambassador on 28 February 1946. On 8 April, Wang told him that he had forwarded it to Chiang a few days before (Wang, 1946). Due to a lack of evidence, any specific steps taken by Chiang after he received the report cannot be verified, but we can find some clues.

In October 1946, the Supreme Council for National Defence (the highest decision-making body at the time) reported good news: the government had decided to 'return science to the scientists' and would increase investment, stating that 'scientific research funds should account for a percentage of the country's entire budget', or 1% of military spending (Hu, 1946). Even more suggestive is the fact that, at the beginning of 1946, Chiang ordered the CDB, the hub of the Triple System, to formulate a Science and Technology Guidance Programme (STGP). In the process of its formulation, Chiang sent a secret order to Zhu Jiahua on 20 January 1946, stating, 'For developing applied science, I hope that the Ministry of Education and the Academia Sinica can propose a 10 year plan, including year by year progress' (Chiang, 1946).

Both orders were issued before Needham's report had been delivered. Afterwards, the two cases were merged. The CDB drafted the STGP. The Academia Sinica and the Ministry of Education convened experts from various institutions to discuss the contents of the report in detail and finally produced a draft – *A Ten-Year Plan for Applied Science Development* (Anonymous, 1946). The STGP

proposed establishing a science and technology steering committee responsible for

- Developing scientific and technological guidelines;
- Preparing a scientific and technological work plan in the national construction programme, and prioritizing procedures for the formulation of scientific and technological work;
- Distributing key work projects to various scientific and technological institutions;
- Reviewing the progress of their work and promoting contact and cooperation among them;
- Gathering information needed for scientific and technological work;
- Investigating technical issues relating to the industrial, mining, agricultural and medical industries, conducting professional or special group research, and implementing it after conference review (Anonymous, 1946).

Overall, the responsibilities of this supreme institution were not different from what Needham had proposed as ‘taking care of all governmentally organized research’. The 10-year plan was proposed under the framework of the STGP. In it, the proposed institution was called the ‘Applied Science Promotion Committee’. The plan proposed that the committee be funded with at least 1% of annual gross national income – twice the 0.5% recommended by Needham. This plan, which was under discussion for a long time, was undoubtedly influenced by his report. The principles in the guidance programme of the Science and Technology Steering Committee, such as the allocation of decision-making power to the scientists, avoiding the duplication of institutional functions and decentralizing the power of the government, were in line with the principles of academic independence that Needham had proposed and Zhu Kezhen had emphasized.

One may conclude that the plan was influenced by Needham’s report for two reasons. One is that the plan was jointly discussed by scientists of the Ministry of Education and the Academia Sinica and was submitted in only December 1946, while a third group of reports had been sent out by Needham well before that, on 3 April 1946 (Bolton, 1946). The

other is that the Ministry of Education had carried out serious deliberations on the report.

Interestingly, Needham did not send the report separately to the then secretary-general of the Academia Sinica, Sa Bendong. Although the report can be found in the archives of the Academia Sinica, its precise origin is unclear. The archives contain neither a record of receipt at the main office nor any record of the processing of the document, and the copy is missing the ‘confidential’ stamp that Needham had emphasized.<sup>23</sup>

Probably because there was no specific criticism of or suggestion to the Academia Sinica in the report, but a number of criticisms aimed at the Ministry of Education, it was treated seriously by the latter, although only a long time after its receipt. The earliest signature by Minister Zhu Jiahua is dated 10 November 1946, on the day he instructed that ‘the two reports, Needham’s scientific research of China and Pound’s report on China’s legal and education systems, should be printed, translated and dealt with rapidly’. A symbol indicating emphasis was added to the word ‘rapidly’.<sup>24</sup>

The instruction shows that Zhu initially had read only the English version, that he had not known that there was a Chinese version, and that he was anxious to solicit the opinions of the Ministry of Education on how to handle it. This shows that, even 6 months after its first circulation, no one in the Ministry of Education had opened and read the report or had known anything about the criticisms of the ministry raised by Needham. It was likely that they got news of this in discussions between the Academia Sinica and the Ministry of Education on the 10-year plan because, at that time, the report to Zhu was still on its way back to Nanjing from Chongqing.

The Department of Higher Education would have obtained the Chinese version not long after. Zhou Hongjing,<sup>25</sup> the director of the department, sorted out the content of the report according to the original text in only three days and presented a preliminary treatment of the relevant parts for the Ministry of Education. In response to the material prepared by Zhou, Zhu Jiahua offered two opinions: ‘First, present detailed methods and an implementation plan for checking and approving promptly. Second, draft a reply to Needham for verification’. Zhou Hongjing

and the executive vice-president of the Ministry of Education, Tian Peilin,<sup>26</sup> contributed to the following detailed measures and an implementation plan, in which they finally formulated eight recommendations and six specific measures.<sup>27</sup>

First, on enhancing facilities for science and research in educational institutions above the college level, they wrote,

It seems that we should actively enrich it in the future . . . We should invite experts from both inside and outside the department to set up a permanent organization working on the research plan (proposed to be called the Science and Technology Education Research Committee (STERC) of the Ministry of Education) to inspect the science and technology teaching and research at each institution. To guarantee that the funds raised are distributed in the most reasonable way . . . The equipment of each institution (学校) should be self-contained.

To this, Zhu added his instructions in the margin: ‘This matter is important; let Mr Zhou discuss with Mr Sa Bendong<sup>28</sup> and Mr Wu Zhengzhi<sup>29</sup> immediately, and formulate an appropriate approach according to Executive Vice-President Tian’s recommendation. As for research equipment, it must be purchased by each institution’.

Second, on enhancing the relationship between the Ministry of Education and various scientific societies, they wrote,

In the past, there was not enough contact. In future, we will learn more about the situation of each society and raise a batch of funds to subsidize the publishing expenses of the societies.

Zhu instructed that ‘the headquarters must pay special attention to this on a regular basis. This should be discussed by Director Zhou and Mr Sa Bendong’.

Third, on the issue of excessive staff members in each institution, Zhou and Tian wrote,

This is a very unreasonable phenomenon, and the number of appointments for each institution should be limited in the future. The abuse of having redundant staff and the waste of expenses thus can be avoided.

On this, Zhu commented, ‘This is the biggest shortcoming of China’s education. This kind of phenomenon has intensified during the war of resistance. When I was in Zhongzheng and Zhongyang universities, I was deeply affected by the fact that it was not easy to get rid of this. The results at Sun Yat-Sen University were better and more thorough; however, at Zhongyang University, it was even more difficult’.

Fourth, concerning the government’s interference with academics, they wrote,

The government has never interfered with the research work of institutions. The examination of faculty members’ qualifications by the Academic Review Committee is equal to the rigorous registration of the qualified personnel needed, as pointed out by Needham. There has never been a problem with the contents of the faculty’s work.<sup>30</sup> Academic awards organized by the Academic Review Committee have encouraged academic research and have been recognized by the academic community. Needham’s comments that ‘in universities, scientists are often disturbed by political activities’ and ‘academic papers for professors should be allowed to develop freely, and the Ministry of Education should not examine them’ are a misunderstanding. In addition to the examination of the qualifications of the faculty members, it seems that our department should increase the number of academic prizes, and those who have made special contributions should be given medals or honours, and if necessary, receive further praise.

Zhu instructed, ‘Explain to Needham. As for reward, Mr Sa, Mr Wu and Director Zhou should discuss effective measures and an increase in the annual budget’.

Fifth, it was recommended that the department determine incentives and encourage the rich to set up research institutes in universities to conduct specialized research. Zhu added the instruction: ‘Do as Vice-President Tian advises’.

Sixth, on sending students abroad, Zhou and Tian wrote,

In the thirty-sixth year [i.e. 1947], students are to be sent abroad as usual and a request is to be submitted to the Executive Yuan to continue sending them.

Concerning the professors who had been sent abroad for further study, they noted,

It seems that the system for sending professors to study abroad in the past was too lax. In the future, they should be strictly examined. They will not be sent if they do not have suitable achievements and research plans, or do not need to do research abroad. In particular, faculty members being sent overseas for inspections should be restricted further. Inviting Western scholars to give lectures in China fulfils an advocacy role for scientific research . . . each subject should have one first-class scholar of physics, chemistry, biology and medicine invited in the thirty-sixth year.

Zhu commented, 'Formulate a detailed plan with the Department of Culture and Education'.

Seventh, on setting up science museums, Zhou and Tian wrote,

Gansu Science Museum was greatly praised by Needham. In the future, it should continue to be funded, and such museums should be set up in various provincial capitals.

Zhu added his approval: 'Sure'.

Eighth, on international scientific cooperation, they wrote,

The International Culture and Education Division has been established in our ministry. When it can be actively promoted in the future, its cultural commissioner should be from among those who majored in science and engineering.

Zhu instructed, 'The Office of Culture and Education should pay special attention to this. The establishment of the commissioner cannot be delayed any longer. Please check and act urgently on it'.

To help execute the plan, the Ministry of Education separately formulated instructions on six main points related to these recommendations.

First, on the set-up of the STERC, in accordance with the opinions of the Ministry of Education, it was decided that a scientific and technological research committee with from 7 to 11 members should be established. It would be divided into two groups: one to investigate the scientific equipment and state of teaching and research in each university,

and another to design ways to enhance teachers and teaching equipment and carry out research work. Furthermore, a regular meeting would be held at the end of each semester.

Second, to strengthen the relationship between the Ministry of Education and various scientific societies, each society would be required to submit reports on time. Those that had not yet been put on record should be recorded as soon as possible. Special funds should be set up to subsidize research and enrich the societies' collections of books and equipment. The Ministry of Education should help them overcome difficulties in scientific research, assist personnel from various groups to conduct research in China and abroad, and hold an annual national science and technology meeting with the Academia Sinica.

Third, for controlling the personnel, standards for the number of teachers in schools for professional training should be worked out by class; standards for the number of teachers in universities and private colleges should be determined by department, and the maximum and minimum number of employees for each department should be clearly stipulated. Flexibility should be reduced as much as possible: 'Firmly restrict the appointment of work staff; each institution should submit a roster of all personnel and strictly prohibit part-time jobs and part-time salaries for faculty and staff'.

Fourth, a reward system for research in each institution should be implemented. National university research institutes should be subsidized according to their needs and results. Depending on the academic value of publications, printing expenses could be subsidized. University professors conducting valuable research would receive a special subsidy, and a bonus would be given to master's graduates whose theses had special value. In addition to the subsidy, a variety of medals would be awarded for exceptional research. Other than these measures, the ministry proposed that 'The research subsidy for the faculty members of national university research institutes should be double that of the general faculty' and that 'in addition to fees and bonuses, graduate students should receive subsidies of half of the minimum salary of a teaching assistant', but both those suggestions were turned down by Zhu Jiahua.

Fifth, wealthy patrons should be encouraged to set up research institutes in universities and rewarded for it. Those making private donations to set up an institute would be commended and given an award according to the amount of the donation, which would be calculated cumulatively, and donations of equipment or real estate would be calculated according to their monetary value at the time.

Finally, to strengthen international cooperation, outstanding scientists would be selected to participate in the United Nations Educational, Scientific and Cultural Organization (UNESCO) Science Committee, establish contacts and collect news and publications, and thus strengthen the role of the STERC of the Ministry of Education as the external contact centre of China.

The processing procedure and outcomes of Needham's report show that the Ministry of Education focused on the recommendations relevant to it and proposed measures mainly concerning universities and colleges, but the ministry's measures lacked the macroscopic design required at the national strategic level. From the outset, the top cadres of the Ministry of Education paid special attention to Needham's accusation that the ministry interfered with academic freedom. Needham's report noted that science in China was often subject to political interference and that, because of the direct connection between science and the ideals of democracy and freedom, the government should allow universities a considerable degree of freedom of thought. On this point, Tian commented, 'The Ministry of Education has paid great attention to this in the past two years. It is also guaranteed in the Constitution'. He countered Needham's criticism that 'professors should be free to develop academic papers, and should not be examined' with a terse '[we] never did this'. Concerning the 'monitoring of the political thought of foreign students', he instructed that 'this will no longer occur'.

Although the Ministry of Education had developed preliminary measures for providing research subsidies and incentives, controlling the redundancy of personnel and encouraging private investment in scientific research, it finished drafting the relevant measures only in April 1947. This coincided with major changes in the domestic political and economic

situation. The national government itself had entered a critical stage in its fight for survival and had lost the ability to realize this new vision for science and technology.

### 3.2. *The significance of the report*

Although Needham's proposals were not substantially implemented during the period of the Republic of China, their significance is clear. First, the report established a model for expert consultation, which was valued by the government authorities. Needham had been asked by Chiang Kai-shek to prepare the report, and would have benefitted from Chiang's commission as it would have helped facilitate his subsequent visits to almost all important institutions related to science and technology in the KMT's territory over his 3 years in China, including military enterprises. Once the report had been submitted, the Ministry of Education, led by the minister, organized personnel to consider it, and the minister deliberated on it himself. The STERC proposed by the Ministry of Education to support university research and the plan to control the number of administrative staff were all practical measures suggested in the report.

Second, the report is an exemplar of academic freedom in the way that it was disseminated. Needham's distribution list included the chiefs of various ministries and the most influential figures in science, technology and culture in China at the time. The report dedicates several paragraphs to highlighting the interference that Chinese academic institutions had faced from the ministry. From the reaction of both the Ministry of Education and Zhu Kezhen, we can infer that both the government's administrative staff and the scientists involved in education were impressed by the report. The rapport felt by scientists and the defensiveness of the politicians highlight the social acceptance of freedom in academic thought at the time.

Third, Needham's interpretation of the relationship between basic and applied science gave Chinese scientists a boost. Throughout the period of the Republic of China, there were disagreements between politicians and scientists on how to deal with the relative importance of basic and applied sciences. A large number of scientists insisted on the

importance of developing basic science, while politicians were always trying to direct resources towards applied science. According to the scientists, applied science could not be developed in isolation; it depended not only on pure science but also on the humanities (Fu, 2015). In times of war, scientists should serve the practical needs of the hour, but, in times of peace, science needs to return to the path of pure science, they claimed.

In 1946, when Chiang Kai-shek asked the Academia Sinica and the Ministry of Education to draw up a 10-year plan for the development of applied science, the two parties proposed a plan only for nurturing talent. This indicates that, even after World War II, reconciling the fundamentally conflicting concepts of the two groups was still a big problem. Perhaps it was Needham's influence that led to the setting up in Taiwan of the Long-term Scientific Development Board in 1959, with three special committees in mathematical sciences, biological sciences, and humanities and social sciences, and the establishment of the Centre for Mathematics and Theoretical Physics for pure scientific research (Academia Sinica's Eighty Years History Compilation Committee, 2007).

The idea of attaching greater importance to basic science was also reflected on the Chinese mainland in the formulation of a 12-year plan for science in the 1950s. Once the principle of 'Tasks Leading Disciplines'<sup>31</sup> had been established, scientists argued for the importance of basic science and gained the support of Premier Zhou Enlai. In the end, to the 56 major tasks in the original plan, 'research on some basic theoretical issues in modern natural science' was added, for a total of 57. Furthermore, a separate plan covering all basic scientific research fields was formulated (Central Committee of the Communist Party of China and Sichuan Provincial Party Committee, 2005).

Fourth, the further dissemination of ideas on planned science and science and technology policy was significant. Needham's report embodied several aspects of Bukharin's theory on the planning of science. For example, he championed dedicating at least 0.5% of national income to scientific and technological research. Other important ideas included the following:

- A study on soil erosion in the Loess Plateau;
- A survey of forest resources in Fujian Province;
- The construction of large-scale reservoirs and irrigation projects at the foot of the Nanshan Mountains;
- A hundred-fold increase in funds for the Academia Sinica and the Peiping Academy;
- The sending abroad of students and the introduction of experts to China to nurture talent at all levels.

Needham also stressed the importance of a reliable supply of funds and talented people to scientific research institutions, their geographical layout, the training of talented researchers and cadres, and project design. Furthermore, he introduced his experience of British national science and technology policy to China. In 1916, the United Kingdom had established the first special department – the Department of Scientific and Industrial Research – which marked the birth of modern British national science and technology policy and coordinated British scientific efforts during the two world wars (Wu, 1998). Needham strongly recommended that China establish a department specializing in the planning of science and industry – a ministry of science and technology – which should not be affiliated with the Executive Yuan and thus should be immune to changes in political leadership.

In modern times, science and technology policy is defined as a collection of measures taken by governments to support the development of science and technology and their use to promote economic and social development. Needham's design contained not only measures that the Chinese Government should have taken to support the development of science and technology, but also measures that used science and technology to promote economic and social development in China. Thus, the report conveyed a clear concept of science and technology policy to the Chinese social elite. All this advice had been offered by the time the secretary-general of the Academia Sinica, Sa Bendong, wrote to V Bush and asked for advice on science and technology policy in post-war China (Sa, 1945) and is commendable.

The content of the report also shows that Needham was being frank about the state of science in China. In the report, he talked about the scientific organizations and individuals that should be heavily funded, management and support that should be given to universities, methods that should be adopted in agriculture and industry, and rewards that the state should offer to science. He even pointed out a number of problems in various areas. In the main, he adopted a broad comparative approach to make his points. For example, on the independence of researchers, he noted, "In the United Kingdom, the principal research organizations of the government are independent of their corresponding ministries . . . In the United States, the government research organizations have to a large extent been safeguarded from the "spoils system". Yet, there were instances when he went very directly to the crux of the matter, such as

Science in China . . . is too readily subject to interference by politicians who, however well-intentioned, have neither the knowledge of, nor interest in, science.

Unless modern-minded and industrially minded men are placed in control, the large industrial accessions, which the circumstances of the ending of the war have mercifully brought intact into Chinese hands, will not be properly exploited.

During the war I've noticed a lot of instances which indicated a failure of the government to appreciate the needs of technology.

All Chinese organizations are overstaffed with bureaucratic personnel, unskilled laborers, business staff and the like.

Party politicians seem unduly nervous of mass education.

Within the universities also, there is undesirable political interference with science.

A contemptuous attitude towards science is found in the army as well as among politicians.

[In Xi'an] The professor of a physics laboratory had to have a hand-turned dynamo supplying current, while

the bacteriologists were unable to use their centrifuge and incubator, although every petty merchant's store and teashop in the city had electric light . . . This is not a way to make China a great nation.

On the part of most British scholars who have visited China in recent years has been one of thankfulness that no such organization is necessary in England.

It would be very worthwhile for a small group of Chinese educationalists to go to England specifically to study our democratic university system, and consider carefully what steps could be taken in China towards the freeing of the Chinese universities from bureaucratic dead weight.

The Confucian temple has been wrecked by the quartering of soldiers, and the terraces of the central shrine of the sage itself, with all its beautiful carving, are today polluted with ordure. This is a disgrace to the nation.

All these comments were heartfelt. It was surely impossible for the authorities to read them with complete indifference.

#### 4. Conclusion

In preparing his report to the leader of the KMT, Needham conducted a comprehensive survey of the situation of China's science, technology and society. From the perspective of a scientist, he carried out a comparison between science in China and that in the West, paying special attention to the historical background and social situation at that time. The breadth and depth of his understanding were unprecedented among Western scholars. This work, therefore, was one of the most important foundations for Joseph Needham's great work, *Science and Civilisation in China*.

In the report, Needham noted the many problems China was facing or would face and showed foresight in the many questions and plans that he proposed. For example, he noticed the shortage of skilled workers in China and pointed out that, to educate people about science and technology, workshop foremen were more urgently needed than well-trained engineers. In view of language problems, he suggested that foreign technical training experts be

invited to China so that foremen could receive intensive training at home. On industrialization, he warned that ‘the Chinese government must ensure that industrialization does not proceed on an unfettered path at the expense of hurting the working people’. On the connection between China’s traditional agrarian society and modern industrial society, he proposed that China’s industrial cooperatives be given a certain amount of space to carry out their activities for a long time. In this way, industrial life and the local family system could gradually be connected. On Chinese culture, he pointed out that the country’s respect for scholars had a long history and was well known around the world. This perhaps also constituted a source of international prestige – one that made it particularly suitable for China to promote international scientific cooperation.

Nowadays, the super-community business model of the direct docking of commerce with farmers and herdsmen, the capacious investment and guidance of the nation in occupational education, and the success of Confucius Institutes, which provide windows into Chinese culture for the world, all remind us that Needham’s proposal from the mid-20th century is still worthy of serious consideration today.

### Acknowledgements

I am grateful to Professor Liu Dun for providing me with the original report obtained from the Needham Research Institute about 10 years ago. Professor Shi Yunli, Professor Wang Zuoyue, Professor Mei Jianjun, and Mr John Moffett, the librarian of the Needham Research Institute, all helped in the formation of this article.

### Declaration of conflicting interests

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

### Funding

The author(s) received no financial support for the research, authorship, and/or publication of this article.

### Notes

1. A copy of the report is housed in the East Asian History of Science Library of Cambridge, Classmark: JN: C/2. All references to the English version of the report in this article are from that copy. A PDF file

is also available on the Needham Research Institute website: [http://www.nri.cam.ac.uk/wartime\\_extras/Wartime\\_report\\_to\\_Chiang\\_Kai-shek.pdf](http://www.nri.cam.ac.uk/wartime_extras/Wartime_report_to_Chiang_Kai-shek.pdf). When quoting from the report, Dr Needham’s spelling of Chinese personal names and institutions is retained.

2. 刘咸.
3. 鲁桂珍.
4. There are more than 80 records in Wang Shijie’s diary discussing loans from Britain and the United States.
5. 杨端六.
6. 陶孟如.
7. 国防设计委员会.
8. 资源委员会.
9. 行政程序论.
10. 甘乃光.
11. On 30 November or 1 December in the chronology of major events scheduled for December, Chiang Kai-shek wrote: ‘First, the party and government efficiency organization (design, implementation, assessment) of the Trinity organization. Gan’. Here, ‘Gan’ should be ‘Gan Naiguang’.
12. 行政三联制.
13. 中央设计局.
14. 国防最高委员会.
15. In the Second Historical Archives of China, there are files in the archive of the Academia Sinica (Issue 393) and Peiping Academy (Issue 394) containing study notes on this book and drawing up research plans according to it.
16. See archive: ‘The position and prospects of science and technology in China’ written by Joseph Needham and translated by Sino-British Science Cooperation Office and signed verification opinions of various institutions. Issue 5, no. 42. Nanjing: The Second Historical Archives of China.
17. What Needham referred to was high-ranking scholars being arrested and held incommunicado for long periods by the police on quite inadequate grounds. He criticized this in a footnote to his report and named it the ‘disappearing professor’ phenomenon.
18. 敦煌千佛洞.
19. This was Needham’s special spelling; it should be ‘Peking’.
20. This was Needham’s special spelling; it should be ‘Ren’.
21. The Communist Party of China.
22. *The Journal of Zoology*, sponsored by the Academia Sinica in the Republic of China period.
23. From the *Daily Information Bulletin* of the Information Office of the Government, *Daily News Bulletin* of the Nanjing American News Agency, etc. (in English). Issue 393, no. 2360(3), Nanjing: The Second Historical Archives of China.

24. See Zhu Jiahua's (1946) instructions. In archive: 'The position and prospects of science and technology in China' written by Joseph Needham and translated by Sino-British Science Cooperation Office and signed verification opinions of various institutions. Issue 5, no. 42. Nanjing: The Second Historical Archives of China.
25. 周鸿经.
26. 田培林.
27. All the following citations are from the archive: 'The position and prospects of science and technology in China' written by Joseph Needham and translated by Sino-British Science Cooperation Office and signed verification opinions of various institutions. Issue 5, no. 42. Nanjing: The Second Historical Archives of China.
28. 萨本栋.
29. 吴正之.
30. This means that the Ministry of Education had never prevented a book from being published due to its content.
31. 以任务带学科.

## References

- Academia Sinica's Eighty Years History Compilation Committee (2007) *Pursuing Excellence: Eighty Years of the Academia Sinica*. Taipei: Academia Sinica.
- Anonymous (1938a) Science and a world foundation. *Nature* 142(3588): 227–229.
- Anonymous (1938b) International committee on social relations of science. *Nature* 142(3589): 278–279.
- Anonymous (1938c) Social and international relations of science. *Nature* 142(3591): 380–381.
- Anonymous (1938d) Social and international relations of science. *Nature* 142(3605): 987–988.
- Anonymous (1946) *A Ten-Year Plan for Applied Science Development* (Draft). Nanjing: The Second Historical Archives of China (in Chinese).
- Bernal JD (1982 [1939]) *The Social Function of Science* (trans. Chen TF). Beijing: The Commercial Press (in Chinese).
- Bolton W (1946) Letter to Needham. File C101, Joseph Needham Archive, Cambridge University Library, 3 April.
- Brookman FH (1979) *The making of a science policy: A historical study of the institutional and conceptual background to Dutch science policy in a West-European perspective*. PhD Thesis, Vrije Universiteit Amsterdam, Amsterdam.
- Brown A (2005) *J.D. Bernal: The Sage of Science*. New York: Oxford University Press.
- Central Committee of the Communist Party of China and Sichuan Provincial Party Committee (2005) *Portrait Biography of Zhou Enlai, 1898–1976*. Chengdu: Sichuan People's Publishing House (in Chinese).
- Chiang K (1935) The significance and implementation of the National Economic Construction Movement. *Huangpu* 4(4): 1–6 (in Chinese).
- Chiang K (1941) Outline of the triple system of administration. *Government Communique of Zhejiang Province* 3280: 22–36 (in Chinese).
- Chiang K (1943) *The Destiny of China*. Chongqing: Zhengzhong Press (in Chinese).
- Chiang K (1946) Order no. 9126, Issue 5, no. 1950. Nanjing: The Second Historical Archives of China (in Chinese).
- Chiang K (2015 [1939]) *Diary of Chiang Kai-Shek* (ed. China Taiwan Anti-Japanese War History Research Association). Taipei, unpublished (in Chinese).
- Chiang K (2015 [1940]) *Diary of Chiang Kai-Shek* (ed. China Taiwan Anti-Japanese War History Research Association). Taipei, unpublished (in Chinese).
- Chu C (1946) Letter to Joseph Needham. File C101, Joseph Needham Archive, Cambridge University Library, 6 April.
- Chu C (1947) Letter to Joseph Needham. File C101, Joseph Needham Archive, Cambridge University Library, 25 January.
- Dong CZ (1997) *Financial and Economic History of the Republic of China*. Dalian: Liaoning Normal University Press (in Chinese).
- Fang X (1994) An analytical framework in the system of science and technology. *Studies in Science of Science* 12(4): 66–75 (in Chinese).
- Fu BH (2008) A restricted view of planning of science of Wu Xue-Zhou. *Studies in Science of Science* 26(6): 1149–1156 (in Chinese).
- Fu BH (2011) New exploration concerning the motivation for Needham's research on the history of Chinese science and technology. *Journal of Dialectics of Nature* 33(196): 47–54 (in Chinese).
- Fu BH (2012) Can science be planned? The controversy centring on Britain in the 1930s and 1940s. *Studies in Science of Science* 30(7): 961–975 (in Chinese).
- Fu BH (2015) *Plan of Science and Planning of Science in Republican China: An Investigation Centered on the Academia Sinica*. Beijing: China Science and Technology Press (in Chinese).
- Gao JW (2000) The reasons for the end of the Soviet Union New Economic Policy in the 1920s. *Journal of Yanshan University* 4: 34–38 (in Chinese).
- Graham AC (2002) China, Europe, and the origins of modern science: Needham's grand titration. In: Liu D and Wang YZ (eds) *Science and Scientific Revolution in China: Selected Research Works on*

- the Needham Puzzle and Related Issues*. Shenyang: Liaoning Education Press, pp. 137–160 (in Chinese).
- Graham LR (1964) Bukharin and the planning of science. *Russian Review* 23(2): 135–148.
- Hu SZ (1946) Speech on the third meeting of the Second Council of the Academia Sinica. *Da Gong Bao*, 21 October, p. 3 (in Chinese).
- Liu D and Wang YZ (eds) (2002) *Science and Scientific Revolution in China: Selected Research Works on the Needham Puzzle and Related Issues*. Shenyang: Liaoning Education Press (in Chinese).
- Liu X (1938) The relationship between science and society. *Science* 22(11–12): 539–542 (in Chinese).
- National Economic Planning Commission of the Central Committee of KMT Congress (1976) The preamble. In: *The Ten Years of China's Economic Construction (1927–1937)*. Taipei: The Party History Committee of the Central Committee of the Chinese KMT (in Chinese).
- Needham J (1945) Report to His Excellency President and Generalissimo Chiang Kai-Shek on the Position and Prospects of Science and Technology in China. Cambridge: East Asian History of Science Library.
- Needham J (1946) Letter to Mr Peng and Miss Liu. File C101, Joseph Needham Archive, Cambridge University Library, 28 February.
- Needham J (1952) *Science in Wartime China* (trans. Zhang YZ). Taipei: Chinese Culture Publishing Committee (in Chinese).
- Needham J (2002) Science and society in the East and West. In: Liu D and Wang YZ (eds) *Science and Scientific Revolution in China: Selected Research Works on the Needham Puzzle and Related Issues*. Shenyang: Liaoning Education Press, pp. 83–101 (in Chinese).
- Needham J and Needham D (1948) *Science Outpost*. London: The Pilot Press Ltd.
- Needham J and Pagel W (1938) *Background to Modern Science: Ten Lectures at Cambridge Arranged by the History of Science Committee in 1936*. Cambridge: Cambridge University Press.
- Polanyi M (2002) *The Logic of Freedom* (trans. Feng YJ). Changchun: Jilin People's Press (in Chinese).
- Sa BD (1945) Letter to Dr V Bush, President, Carnegie Institution of Washington. Issue 393, no. 2360(2). Nanjing: The Second Historical Archives of China, 1 December.
- Wang SC (1946) Letter to Joseph Needham. File C101, Joseph Needham Archive, Cambridge University Library, 8 April.
- Wang SJ (2013) *Diary of Wang Shijie*. Taipei: Institute of Modern History, Academia Sinica (in Chinese).
- Wang WX (2004) On the national defense design committee. *Academia Bimestris* 2004(6): 52–53 (in Chinese).
- Wangqian GZ (1999) *Illustrated Biography of Joseph Needham*. Guiyang: Guizhou People's Press (in Chinese).
- Wangqian GZ (2007) *Biography of Joseph Needham*. Shanghai: Shanghai Science Popularization Press (in Chinese).
- Werskey G (1976) Understanding Needham. In: Needham J (ed.) *Moulds of Understanding*. London: George Allen & Unwin Ltd, pp. 13–28.
- Winchester S (2008) *The Man Who Loved China*. London: HarperCollins.
- Wu BK (1998) *Power and Knowledge: History of Science and Technology Policy in the UK and the USA*. Fuzhou: Fujian People's Press (in Chinese).
- Wu ZH (1988) The resources committee I know. In: The Committee for the Study of Cultural and Historical Materials of the National Committee of the Chinese People's Political Consultative Conference (eds), *Memories of the KMT Government Resources Committee*. Beijing: Chinese Literature and History Press, pp. 63–141 (in Chinese).
- Xu SY (1936) National economic construction and planned control policy. *Guomin Jingji Jianshe* 1(1): 16–29.
- Yang DL, Tao MR and Zhang LF (1933) Special issue on China's modernization. *Shenbao Yuekan* 2(7): 1–89 (in Chinese).
- Yu TT (2019) *The Party and Government Work Evaluation Commission and its assessment of science and education authorities (1940–1948)*. Master's Thesis, University of Science and Technology of China, Hefei.
- Zhu KZ (2006) *The Collected Works of Zhu Kezhen*. Shanghai: Shanghai Science and Technology Press (in Chinese).

### Author biography

Banghong Fu, PhD, is an associate professor in the Department of the History of Science and Scientific Archaeology at the University of Science and Technology of China. Her expertise is in the history of science and technology, scientific policy in modern China and knowledge exchange between China and other countries. Her representative works include *Plan of Science and Planning of Science in Republican China: An Investigation Centred on the Academia Sinica* and the article 'Can science be planned? The controversy centering on Britain in the 1930s and 1940s'.