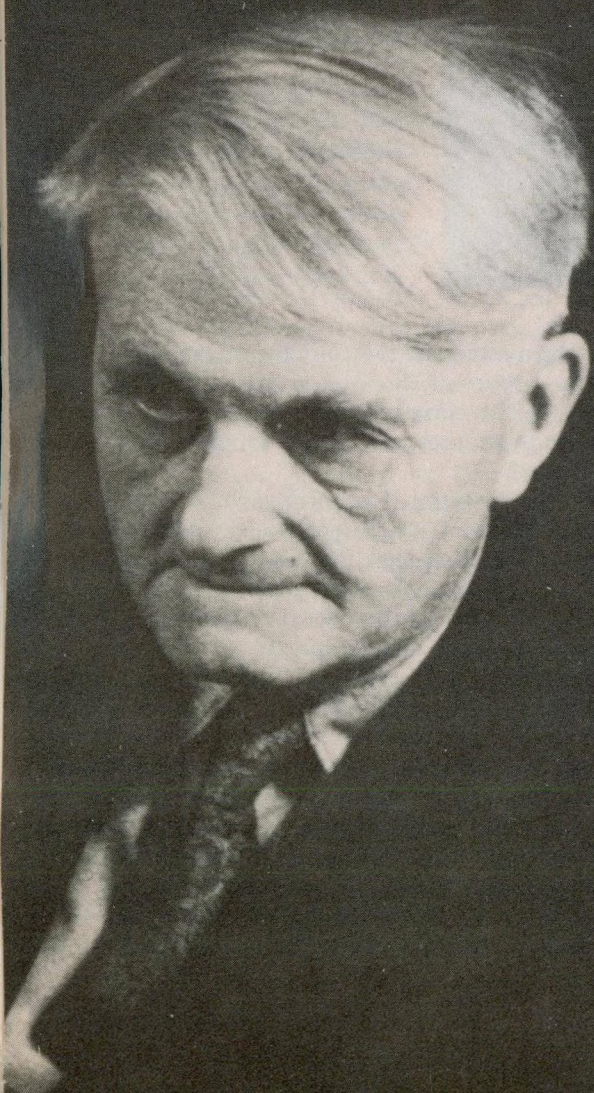


The cluster of cluttered rooms in the old part of Caius College at Cambridge holds a library as extraordinary as the man who inhabits them. Here, in huge files and towering stacks, are piled ancient Chinese manuscripts and texts and modern handbooks that cover a staggering range of human thought and achievement, from astronomy and geography to physics, medicine and animal husbandry; and here Dr. Joseph Needham spends long days immersed in one of the most ambitious historical enterprises of all time: his monumental *Science and Civilisation in China* that will, when completed, run to seven volumes in 10 or 11 parts.

GRAND PLAN. A somewhat retiring man of 71, with a scholar's slight stoop and given to quick, dry speech, Dr. Needham has been described as a kind of medieval polymath to whom "no knowledge is unfamiliar and none to be despised." With the collaboration of a few Chinese scholars he has taken on the task of recording the entire history of Chinese science and technology from the earliest times in all its varied social and cultural settings. Such a comprehensive and systematic survey of the contributions of the Chinese people to the sum total of human knowledge has never before been attempted; in fact very few similar accounts exist for Western science itself. With four volumes in six parts now in print, the work has already been favorably compared in scope and erudition to Arnold Toynbee's *Study of History* and Sir James Frazer's *The Golden Bough*.

HISTORIAN OF SCIENCE



The vast undertaking had its genesis in Dr. Needham's assignment to wartime China in 1942. When England joined China in its struggle against the Japanese it was deemed essential to establish liaison between Chinese scientists and technologists and their western colleagues, and Needham, a biochemist and historian of science who spoke Chinese, was appointed chief of the Sino-British Science Cooperation Office. He was also science counsellor at the British embassy in Chungking and adviser to the Chinese army medical administration, the air force research

ly, that their contributions had included gunpowder, printing and the magnetic compass, but very little more.

At some period during these difficult but rewarding years Needham determined to write a history of the sciences in a civilization that was known to Western minds only in isolated fragments, and one that would compare and contrast the achievements of East and West. He was well aware of the immense problems that lay ahead: not only the difficulty of translating the Chinese ideographs into English, but

Opposite: Dr. Needham is seen in Chinese uniform during World War II and in Chinese dress just after the war. In wartime China he was chief of the Sino-British Science Cooperation Office working as liaison between Chinese and Western scientists.



Dr. Joseph Needham about 1929 with his wife Dr. Dorothy Needham in the Cambridge biochemistry laboratory. When she was elected to the Royal Society in 1948 they became the first couple to achieve that distinction.

bureau and the National Resources Administration.

DISCOVERY. For four years Needham traveled about the country, on foot, by river junk, truck, camel, horseback and goatskin raft, carrying scientific literature, apparatus and advice, visiting almost every scientific institution. He made friends with scholars who gave him a knowledge of the country's literature second to none in the West; these were years of high intellectual excitement as the past grandeurs of China were progressively revealed to his curious mind. On one occasion, visiting the evacuated Honan University in a temple in Shensi province, he stumbled on bundles of dumped books that turned out to be part of the *Tao Tsang* (the Taoist patrology), including a large number of works on alchemy scarcely known outside the country. He found Chinese scholars well versed in the history of their sciences but with little grasp of it in relation to the rest of the world; at the same time he was constantly reminded of the stereotype that most foreigners had formed about Chinese science and technology, name-

also the mastery of the contents of the Chinese classics in a score of disciplines. In short, he planned a study of the comprehensive transmission from one culture to another, the like of which had never been attempted.

THE SCIENTIST. Joseph Needham was born in 1900, the son of Dr. Joseph Needham, professor of anatomy at Aberdeen University and a pioneer in pathologic histology, later a specialist in anesthesia in London. His mother, Alicia Montgomery, was a talented musician and composer.

Needham grew up in an atmosphere of culture and religion, from which came the decision to become a lay brother in the Anglican Oratory of the Good Shepherd, but eventually he decided that monastic life was not for him. Similarly, when he entered Cambridge, his decision to follow in his father's medical footsteps was shortlived. After a brief service as surgeon sub-lieutenant in the Royal Navy during World War I he gave his attention at the university to biochemistry, then taught by Sir Fred-



erick Gowland Hopkins, pioneer in the discovery of vitamins, for which he shared a Nobel Prize with Christiaan Eijkman. He graduated from Cambridge in 1921 and later obtained the degrees of doctor of philosophy and doctor of science.

In 1924 Needham was given a fellowship at Gonville & Caius College, and his life and work have since then been almost continuously connected with that institution; he eventually became president of the college and later master, the highest position.

Needham's field was the investigation of the application of biochemistry to the problem of the development of the embryo, and in 1931 he defined a new area of study in a three-volume work, *Chemical Embryology*. This was a critical period in the history of that subject, and the following decade saw intensive exploration of the chemical properties and physiologic functions of the morphogenetic hormones known as organizers or evocators. In 1933 Needham succeeded J.B.S. Haldane as reader in biochemistry at Cambridge, holding the position until 1966; his treatise, *Biochemistry and Morphogenesis*, was published in 1942.

Over the years Dr. Needham's reputation became international. He held various posts in England (Oxford University, the Royal College of Physicians in London), was visiting professor of physiology at Stanford University in 1929 and at the University of Lyons in France; there were also lectureships at Yale, Cornell, Oberlin and other American Universities,

and at Colombo, Singapore, Peking, Jaipur and Japan.

HISTORIAN. Along the way, Dr. Needham continued a parallel interest in the history and philosophy of science. "History of science ever since my schooldays had been a kind of private passion." He had prefaced *Chemical Embryology* with a long account of embryology from the earliest times, and this appeared as a separate volume in 1935; *History of Embryology* remains the only systematic treatment of the subject. Concerned that Cambridge was



providing no teaching in the history of science, he urged the creation of a committee to organize lectures and courses; today the history and philosophy of science is a half-subject of the natural sciences tripos (honors examination) and the university also possesses a fine collection of historical scientific apparatus in the Whipple Museum.

In 1944, while still in China, Dr. Needham began suggesting the establishment of some kind of international science cooperation agency whose functions would be to maintain a chain of science liaison offices around the world and provide much needed assistance to nongovernmental international scientific organizations.

While visiting Washington and Moscow in 1945 Needham interested other scientists in his idea and ultimately the field of natural science was incorporated in the present United Nations Educational, Scientific and Cultural Organization (UNESCO). When this agency was founded in 1946 Dr. Needham became the first director of the natural sciences

department and since 1948 he has been honorary counsellor. Problems of international cooperation in science was the theme of his Boyle Lecture at Oxford in 1948.

HUMANIST. Needham's intellectual curiosity was too intense to remain forever locked in one field of interest, and through the years he has written extensively on general scientific, theologic and philosophic subjects, taking a broad view of social and historical movements. In his early essays he explained

sitivity, and much of his poetic inspiration derived from his years spent in China with his beloved "black-haired people," as this verse attests:

*And who needs help more than the black-haired people
Whom history did not favour?
Have they not suffered far too long
For lack of the iron wheel, hard glass and
yellow-green syrup
The tamed skyspark and the tethered thunderball?*



his need for inquiring into the structure and history of society; in *The Sceptical Biologist* and *The Great Amphibium* he pointed out the importance of dialectic development in scientific thought. *Time*, *The Refreshing River* assessed the prevailing attitudes concerning time in Chinese civilization, refuting the theory that Europe possessed the only culture with a sense of history. He declared: "The timeless Orient is nonsense." He also edited a number of symposium volumes, such as *Science, Religion and Reality* and *Christianity and the Social Revolution*.

Needham now says that his earliest books of essays were failures because he thought of man solely as an individual. "It is essential to . . . view all forms of human experience in a social context." He scolds scientists of narrow interests because "they tend to be politically the most reactionary. Without history the scientist will know nothing of social evolution, of the origin and progress of human society. Without philosophy he can have no basic world view." In the same vein: "Without religion the scientist will know little of comradeship with the mass of men, he will remain isolated from them in intellectual pride. A scientist should view the world as a whole and the place and course of man and of humanity in it."

In addition, Needham is a poet of charm and sen-

Two friends and collaborators on the monumental Science and Civilization in China are Dr. Wang Ling, left, a student of Chinese history, and Dr. Lu Gwei-Djen, who took her doctorate with Mrs. Needham.

The humanist began to overwhelm the biochemist about 1936, when three young Chinese scientists joined the Hopkins laboratory at Cambridge to work for their doctorates. They too were interested in the history of biochemistry and in turn sparked Dr. Needham's fascination with things Chinese. In his words: "I fell in love with their culture, their language and the whole of their background."*

THE WORK. By the end of the 1930s Needham was fluent in the ideographic language and was reading widely in the Chinese classics. Certain large questions began to intrigue and puzzle him. Many historians assumed that Chinese culture had nothing that could be called science, yet Needham found this was only true of modern science, that between the first and 15th centuries China was much more efficient than the West in applying human knowledge to useful purposes. Further, he asked why China had not undergone a scientific and industrial

*Dr. Needham has the Chinese name of Li Yo-Sè, and does not object to being addressed as Dr. Li.

Europe in the 14th century. While Roman agriculturists despaired of classifying and describing soils, the Chinese in the second century were using more than 50 pedologic terms and laying the foundations of ecology and plant geography. Seismology was established at least as early as the second century AD, when apparatus was devised to locate the direction of the epicenter and record the force of shock. The Chinese devised the eccentric, connecting-rod and piston-rod assembly, the standard method of interconverting rotary and longitudinal motion, used in nearly all steam and internal combustion engines, as early as the sixth century. Among minor Chinese inventions were the fishing reel in the 12th century, 500 years before it came into use in Europe, and the collar harness for horses in the fifth century; 300 years later Europeans were still using the old-style harness that pulled at the throats of horses and choked them. The crossbow, the wheelbarrow, and the kite also came from China.

The publication of the first volume alerted scholars that here was in the making an epic history of science, filtered through a broad vision of social, economic and historical forces. Written with authority, enthusiasm and honed to a fluent style, the book drew this comment from historian Arnold Toynbee: "The author has set himself to interpret the Chinese mind in Western terms, and he is perhaps unique among living scholars in possessing the necessary combination of qualifications for this formidable undertaking. The practical importance of Dr. Needham's work is as great as its intellectual interest."

Volume II assesses the Chinese philosophies in order to discover their relation to successes and failures in the sciences, giving special attention to the organic concept of nature and the development of the concept of natural law; it has been called the best guide to Chinese philosophy in English. The third volume, in three sections, deals with Chinese mathematics, astronomy, meteorology and the earth sciences, and Volume IV surveys physics and the engineering sciences. In his introduction Dr. Needham wrote: "China to Europeans has been like the moon, always showing the same face—a myriad peasant-farmers, a scattering of artists and recluses, an urban minority of scholars, mandarins and shopkeepers. Thus do civilisations acquire 'stereotypes' of one another."

In this voluminous account of mechanical engineering, Dr. Needham points out that Chinese mathematics was algebraic rather than geometric, and that while accomplishments in dynamics were negligible, such fields as magnetic science, acoustics and optics were well developed.

THE FUTURE. Volume V, in preparation, will deal with chemistry, alchemy and chemical technology, alongside martial technology, textile technology, ceramics and mining. The sixth volume is projected to consider biology and biologic technology, including medicine, the agricultural arts, and fisheries.

In addition Dr. Needham periodically publishes

books and monographs on subjects too detailed to be included in the regular text. Such was *Heavenly Clockwork* (1960), an elaborate illustrated study of medieval Chinese texts describing astronomic hydro-mechanical clockwork from the 1st to the 17th century. The Chinese were recording sunspot cycles 1500 years before the Europeans, and the mechanical clock, the key instrument of the industrial revolution, began its career some 600 years before its counterpart appeared in Europe. Another similar monograph was "The Development of Iron and Steel Technology in China."

In *Clerks and Craftsmen in China in the West*, Dr. Needham, noting that many Westerners think of Chinese medicine as little better than a bizarre folk approach, relates the astonishing discovery that back in the 13th century iatrochemists succeeded in preparing mixtures of androgens and estrogens in a purified crystalline form to treat many hypogonadic conditions. This extraordinary development involved the preparation of sex hormones from urine. The use of human and animal placenta was prominent in medieval Chinese organotherapy. He concludes a fascinating section on acupuncture by pointing out the possibility that the method may stimulate the autonomic nervous system to increase the antibody titer in the blood, or possibly to increase the amount of cortisone produced by the adrenal cortex, or again it may lead to a neurosecretory influence on the pituitary gland.

Chinese priorities include the great classification of disease entities, the *Chu Ping Yuan Hou Lun* (Systematic Treatise on Diseases and their Etiology) in 610, and the first handbook of forensic medicine in 1247. In Dr. Needham's opinion, Western medicine did not begin to draw ahead of Asian medicine until 1850, perhaps even later.

His knowledge enlarged by three trips to China in 1952, 1958 and 1964, Dr. Needham has projected the final volume as a retrospective survey of the characteristics of Chinese science and the influence that it underwent. Modern science (testing by systematic mathematized experimentation) began in the West, and the Chinese did not spontaneously come to understand the full scope of the scientific method. The reason for the failure of modern science to originate in the East can be ascribed to a combination of many factors, such as the particular social and political structure of the country, the language, and an isolating geography, perhaps also the passive attitude of Taoism toward nature.

Meanwhile the biochemist-sinologist, his energy unabated, toils at his gargantuan task, the raw material on which generations of later scholarship can be founded. He thinks that if he can go on working until the age of 84 there is a sporting chance that he might complete the work.

SUMMING UP. From a critical review: "... perhaps the greatest single act of synthesis and intercultural communications ever attempted by one man in our lifetime."

