NEEDHAM RESEARCH INSTITUTE NEWSLETTER

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AU REVOIR TO GAO CHUAN

This August, after exactly ten years working as Librarian's Assistant at the Institute, Mrs. Gao Chuan will be leaving us. She will be sorely missed! Since starting here in July 1989, Chuan has been an abiding and reassuring fixture of the Institute. Her constant friendly and helpful nature have made visitors, especially from mainland China, feel instantly at home, and made her an ideal companion for those working here. Not only for me these past six years, but for preceding Librarians, her work in the Library -- writing letters, doing cards, typing labels, looking after visitors, etc. -- has been absolutely invaluable, as has her in-depth knowledge of the collection. She leaves us to move with her family to St. Andrews in Scotland, and she goes with my best wishes, and special thanks for all her hard work, support and friendship over the years.

John Moffett
Librarian

SCIENCE AND CIVILISATION IN CHINA

The announcement in our last newsletter gave notice of three major publications in the pipeline, all of which have now moved forward. Volume V:13, *Mining*, by Professor Peter Golas, has now been printed. Outside the *SCC* series it is hard to think of any way in which such a detailed and meticulous study of this topic could have been published in a Western language. Peter Golas's book lays a firm foundation for future parts of *SCC* concerned with metallurgy, and we expect it to receive a warm welcome from scholarly circles all over the world.

Volume VI:6, *Medicine*, by Joseph Needham and Lu Gwei-Djen, and edited by Professor Nathan Sivin, is now in the final stages of production and we expect to see it in print by September 1999.

Volume VI:5, *Fermentations and Food Science* by Dr. H. T. Huang, is also moving through the Press and is scheduled to appear early next year.

Christopher Cullen
Chairman, NRI
Publications Board

SINGAPORE

Let us not forget...

Opening speech for the 9th International Conference of the History of Science in East Asia, National University of Singapore, 23-27 August 1999.

To most historians of East Asian science today, the word 'Singapore' brings to mind only one great name: that of Dr. Lam Lay Yong, the distinguished historian of Chinese mathematics. Yet there are many other connections between Singapore and the history of science in East Asia. Today I wish to give Singapore the recognition it is due by acknowledging the important role it has played not only in relation to the history of science, but also to the NRI and to Dr. Needham himself.

Let me begin with the years 1948 and 1949 when my teacher, Dr. D. J. da Solla Price, was a lecturer in applied mathematics at Raffles College, Singapore. He left in 1950 to do a second Ph.D. degree in the history of science, and collaborated with Dr. Needham and Dr. Wang Ling on *Heavenly Clockwork* before leaving for North America. Later he became Professor of the History of Science and Medicine at Yale University. He and his colleague Professor Arthur Wright were active during the 1970s in soliciting financial support for *SCC* from North American sources.

The first person from Singapore who became a personal friend of the Needhams was Miss Ivy Soh, who came to England to study English language teaching after obtaining her first degree in Singapore. She stayed with the Needhams when she visited Cambridge, and when the Needhams visited Singapore, as they did in 1971, she arranged for their hotel accommodations.

The Needhams had indirect links with Singapore as well. They were close friends of Professor Meredith Jackson and Mrs. Lianli Jackson. Professor Jackson had taught law in Cambridge to Mr. Lee Kuan Yew, who later became the founding father and first Prime Minister of Singapore. Mrs. Jackson once told me, in the presence of Dr. Needham, that in spite of his high position, Mr. Lee used to call on his teacher whenever he visited Cambridge.

Professor Wang Gungwu on a visit to the NRI last year

Inside ...

SINGAPORE *cont'd*

My professor of mathematics at the University of Malaya in Singapore, Sir Alexander Oppenheim, was the one who first suggested that I do research on the history of Chinese science. This was after he had listened to a talk I gave at the Malayan Mathematical Society on some aspects of Chinese mathematics. He became the supervisor for my doctoral dissertation, and in 1953, through the help of Dr. Rayson Huang, he arranged for me to get in touch with Dr. Needham. It was then that Dr. Needham suggested that I do a full, annotated translation of the Astronomical Chapters of the *Jinshu* (the Official History of the Jin Dynasty) for my dissertation. He felt that such a translation would be helpful for his work on the astronomical section of *SCC* Volume III. For his part, Dr. Needham offered to help me polish the translation so as to serve as the first draft of my dissertation.

Dr. Rayson Huang had known Dr. Needham in Sichuan province during WWII. He served as Vice-Chancellor of Nanyang University in Singapore from 1968 to 1972, before moving on to become Vice-Chancellor of the University of Hong Kong (1973-1986). Dr. Needham gave a public lecture at Nanyang University in 1971 and received an Honorary Degree at the University of Hong Kong in 1974.

Another person with a close Singapore connection is Mr. Kenneth Robinson, Dr. Needham's collaborator in the acoustic section of *SCC*, as well as in the main part of the concluding volume. In 1953, when I first corresponded with Dr. Needham, Mr. Robinson was the head of the Chinese section in Singapore Teachers' Training College, Paterson Road. On hearing about me from Dr. Needham, Mr. Robinson invited me to his home for dinner. That was in 1954, four years before I first met Dr. Needham.

I was then lecturer in physics at the University of Malaya, Singapore. The rule was that after serving the university for five years, one would be entitled to a year's sabbatical. By 1957 I had earned this sabbatical. Through the support of Sir Alexander Oppenheim, who was then Dean of the Faculty of Arts, I obtained a sabbatical leave on full salary plus overseas allowance. This arrangement enabled me to spend two years at Cambridge working in collaboration with Dr. Needham on his alchemical volume. Because one of these years would be an advance on my next sabbatical, I knew I would have to serve the University continuously for the next ten years before I could obtain another. On January 3rd, 1958, I first met Dr. Needham and Dr. Lu Gwei-Djen and began my long-standing relationship with them.

During my youth I received much encouragement and inspiration from a friend who was about forty-five years my senior. I was also classmate-and-friend and teacher-and-friend to some of his children. He was Dr. Wu Lien-teh, the world renowned plague fighter from Emmanuel College, Cambridge. He had heard about my collaboration with Dr. Needham. He and Dr. Needham had studied under the same teacher, Sir Frederick Gowland Hopkins, though over twenty years apart. Dr. Wu had an interest in the history of Chinese science, having written a History of Chinese Medicine with K. C. Wong in 1932. To encourage his younger fellow-student of "Hoppy", Dr. Wu approached Dato Dr. Lee Kong Chian and the Tiger Balm King, Mr. Aw Boon Haw, to ask if they could render a helping hand to the *SCC* project. Accordingly Dr. Lee Kong Chian sent a cheque to Dr. Needham, who acknowledged his "splendid contribution" in his Notes to *SCC* Volume IV:1. This "splendid contribution" could have bought a house on Owlstone Road in Newnham, where the Needhams and Dr. Lu Gwei-Djen lived separately at No. 1 and No. 28 respectively.

Towards the end of 1959, I returned from Cambridge to Singapore. The next year I was appointed Reader in the History of Science within the Physics Department at the University of Malaya, which meant that I had to teach physics as well as start a course on the history of science. In 1960 I had three visitors whose names are widely known among historians of East Asian science: Dr. Nakayama Shigeru, Dr. Wang Ling and Dr. H.T. Huang.

Of these three, Dr. H.T. Huang had the strongest Singapore connection. His father worked for the education department of the Straits Settlement, as well as being an Anglican missionary in Malacca. Malacca, as part of the Straits Settlement in those days, came directly under the jurisdiction of Singapore. H.T., as Dr. H.T. Huang was known among his friends, had been a science student at the University of Hong Kong, together with Rayson Huang, when Hong Kong fell to the Japanese army in 1942. They both found their way inland, where H.T. became Dr. Needham's personal secretary in Chongqing. Later, Dr. Needham recommended H.T. to study at Oxford, where he did a D.Phil. degree in chemistry.

I first heard about H.T. from Dr. Lu Gwei-Djen and Dr. Needham. Once, when Dr. Needham had lost touch with H.T. after a lapse in correspondence, I learned from Dr. Rayson Huang that H.T.'s younger brother had been one of his former students and was then lecturer in the Chemistry Department. This was Dr. Peter Huang. I went to meet Peter and told him that I had heard about his eldest brother but had not had the opportunity of meeting him. One day while I was in the physics laboratory, Peter brought H.T. along and we met for the first time. I got his address and sent it to Dr. Needham. Therefore, I can say that Dr. Needham and H.T. were reunited because of something that happened in Singapore. Dr. Peter Huang later became professor of chemistry, and served as Deputy Vice-Chancellor of the National University of Singapore until his retirement just a couple of years ago. Last year he was made Emeritus Professor of the university.

In 1962 the University of Malaya in Singapore became the University of Singapore, and Dr. Lee Kong Chian became its first Chancellor. He was extremely kind to me, perhaps because his friend Dr. Wu Lien-teh had spoken to him about me. He invited me to lunch several times at the Garden Club on top of the then Overseas Chinese Banking Corporation Building. On one of these occasions I brought Nathan Sivin with me, who was then a Harvard University graduate student doing doctoral research on the alchemical work of Sun Simiao. While spending a few months with me in Singapore, Sivin assisted in some of the tutorial work I was doing for students in the history and philosophy of science course. During one of the luncheon meetings at the Garden Club, Dr. Lee Kong Chian introduced me to Tan Sri Tan Chin Tuan, whose name I shall mention again presently.

Dr Lee Kong Chian was an uncle of Lam Lay Yong, who was then working for her Ph.D. degree on the 13th-century Chinese mathematician Yang Hui. Today Lam Lay Yong is well known as a historian of Chinese mathematics, but hardly anyone is aware of the help she gave to Dr. Needham and the NRI. One of Tan Sri Tan Chin Tuan's daughters was her classmate. Through this classmate Lay Yong spoke to Tan Sri Tan Chin Tuan, who subsequently donated £350,000 for the NRI Library Building. Having paved the way this far, she then made arrangements for Dr. Needham and Dr. Lu Gwei-Djen to see Tan Sri Tan Chin Tuan in the year 1984 when they visited Hong Kong, Beijing and Taipei.. This was by far the largest single contribution that had ever been given directly to the NRI. It was also through the good office of Lam Lay Yong that the Lee Foundation offered to make an annual contribution to the NRI. Mr S. T. Lee of the Lee Foundation is an honorary fellow of the NRI as well as an honorary fellow of the British Academy.

The NRI's Librarian, Mr. John Moffett, also has a Singapore connection. He lived in Singapore with his parents for two years from 1969, as I was told, when he was only nine years old, while his father was serving in the British Navy at Sembawang.

I cannot conclude my account without mentioning Mr. George Hicks and Mrs. Julia Hicks who moved from Hong Kong to Singapore in the early nineties. The Hicks have been among the greatest benefactors of the *SCC* project and the NRI. Besides giving a generous personal contribution directly to the Hong Kong Trust, Mr. Hicks was responsible for persuading Mr. K. P. Tin to donate the money for the K. P. Tin Hall at the NRI. I remember that Dr. Needham and Dr. Lu Gwei-Djen once stayed at the Sheraton Hotel in Kowloon for a period of

more than ten days. Mr. Hicks went quietly to the cashier and paid their hotel bill. During the eighties, when one scholar working on the *SCC* project wished to attend a conference overseas, Dr. Needham ruled that Institute money was not to be used for such purposes. Again Mr. Hicks came quietly to the rescue and sent a letter packed with U.S. currency notes directly to the person concerned. Very few people know that one of the contributors to a recent volume of *SCC* was financially supported in his work by the Hicks.

The Hicks now live in an apartment directly above Professor Wang Gungwu and Mrs. Margaret Wang. Wang Gungwu was a director of the Hong Kong Trust when he was Vice-Chancellor of the University of Hong Kong. He is now Director of the newly established East Asia Institute at the National University of Singapore and is serving as a Life Member of the Advisory Committee for the Chinese Civilisation Education Trust (see our Newsletter No. 17). His Institute is one of the co-sponsors of this conference.

I often remind those in Cambridge that the forgotten can also forget. I hope that I have done my duty to Singapore by setting the record straight. This conference provides a further link between Singapore and the history of science. The Dean of the Faculty of Arts and Social Sciences has told me that the history of science will soon be reintroduced into the curriculum at the National University of Singapore for the first time since the course on the history and philosophy of science was abandoned at the University of Singapore almost a quarter of a century ago. I am sure that the other members of the conference will join me in offering him our best wishes.

Prof. Ho Peng Yoke
Director, NRI

THE LIBRARY

DONATIONS: Once again we are very grateful to all those who have so generously made donations of books and articles to the library. These include: Jeon Sang-woon, Caroline Weckerle, Peter Lisowski, Franz-Rudolf Schmidt, Hartmut Walravens, Elisabeth Hsu, Elena Valussi, Sally Church, C. Kaplonski, Ute Engelhardt, Andrea Bréard, Guo Shirong, Caroline Bodolec, Christian Daniels, Sato Ken'ichi, Georges Métailié, Françoise Sabban.

VISITORS: Mr. Yao Licheng returned to the IHNS, Beijing, after a year visiting on a Royal Society Foundation scholarship. Congratulations to our Li Foundation Scholar of 1997-98, Prof. Guo Shirong, who was made a Professor by his University in 1998. He has now returned to Hohhot, and in his turn Dr. Jing Bing (IHNS, Beijing) arrived in November. Dr. Jing is researching the history of calendrical astronomy. Two other scholars have been "nesting" in the Institute this year, completing their Ph.D. degrees: Mr. Choo Youn Sik (Dept. of Archaeology, Seoul National University, and Dept. of Archaeology, Cambridge), writing on "Competition, human choice, and intensification of prehistoric economy", and Kim Taylor (HPS, Cambridge), who is working on the formation of traditional Chinese medicine in 1950's China. Other scholars who have visited so far this year include: Prof. Li Chaoyuan, Dr. Wang Tao, Dr. Togo Tsukahara, Dr. Tony Butler, Dr. Hartmut Walravens, Professor Mark Elvin, Chen Hsiu-fen, Dr. Vivienne Lo, Dr. Roel Sterckx, Caroline Bodolec, Prof. Francesca Bray, Dr. Ji Zhigang, Chloe Starr, Carsten Flohr, Dr. Margaret Pearson, Dr. Bernhard Führer, Dr. Yi-li Wu, Dr. Chang Chia-Feng.

LECTURES AND SEMINARS

Two more terms of our regular Friday text-reading seminars have provided a rich variety of topics, from worms and demonic illness to salt temples, tidal bores, calendars, and Buddhist nuns. Our thanks to all those who presented and attended, making them so enjoyable. Special thanks go to Dr. Elisabeth Hsu for all her efforts organising and chairing the seminars over recent years. The mantle has now passed to Kim Taylor, who did a fine job for the Easter Term.

John Moffett

THE DRAGON'S ASCENT

Alistair Michie is one of the three film directors working on the Dragon's Ascent project, a multi-media presentation of China, its history and culture, inspired by the vision of Joseph Needham. The project is supported by the Hong Kong based Chinese Civilisation Educational Trust, chaired by The Hon. Lee Quo-Wei, GBM JP — see our last issue for the announcement of this project. Alistair Michie contributed these reflections one month before filming was completed.

A quotation from an Egyptologist a year or so ago has stuck in my mind. He reasoned that through the combination of archaeology and modern science, we have so far revealed only about a quarter of what we are capable of understanding of that great civilisation. I am not qualified to place a comparable percentage on our knowledge of Chinese civilisation, but my feelings, after 14 months of continuous travel across the length and breadth of China, are that we are just at the dawn of understanding China's past.

The inspiration for the travels I have undertaken came originally from the writings of Dr. Joseph Needham. His work, combined with our instincts as film producers, led us to coin the following motto for the Dragon's Ascent project: "China is the civilisation that changed the world and the world never knew". This is a civilisation with the potential to excite the world as much as — probably more than — Egypt has done during this century.

The Dragon's Ascent project grew in part from a search in 1994 in the London Library for an answer to the question of when and how the Grand Canal was constructed between Hangzhou and Beijing. As many readers of this newsletter will know, the answer is superbly presented in Volume IV:3 of *SCC*. I am sure

Alistair Michie with film researcher Zhou Xun examining a seed-drill.

that it will be of little surprise to historians of science that when one starts to view China from the perspective of its history of science and technology, many of the mysteries of this great civilisation fall away as the pattern of its evolution comes into view.

Let me try to reveal some small part of my excitement at the way in which we, as film-makers, have been able to use the past to make sense of the present in China today. Finding that seed-drills were first recorded as in use in –85 and are still in use in Shanxi today was just one of many highpoints. Why change a machine that can easily sow an area of 100 mu of land in a day!

Below are more detailed impressions from two of many locations we have filmed in China. The films in the series, which will be ready in six months' time, will enable millions to share our sense of wonder and admiration for China's great technological heritage.

Jingdezhen

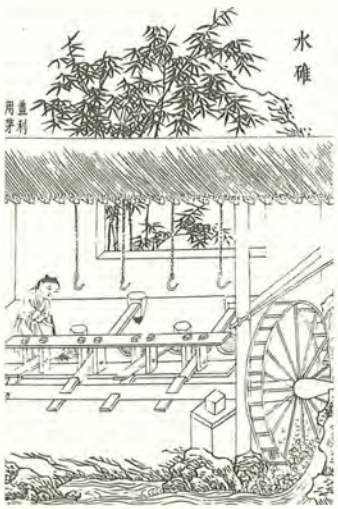
The first industrial city in the world is hard to reach. Flight connections are poor, and it is 10 hours by road or rail to major hubs such as Nanjing. But a visit to Jingdezhen is richly rewarded, especially if one has been briefed in advance by the scholars of the Institute for the History of Natural Science (IHNS) in Beijing and the NRI in Cambridge.

One has to know what one is looking for, because most people in Jingdezhen are far too busy to be interested in their industrial past.

The modern city still claims to be the "porcelain capital of the world", and it is now experiencing explosive growth following a near terminal decline. Over 2000 private businesses have emerged in the last decade, churning out over 300 million units of porcelain tableware every year. Compared to these privately-run businesses, a couple of state owned enterprises are only just surviving.

I baffled the local officials when I asked if any of the water hammers that were formerly used to crush the "china stone" for use in the porcelain clay mix, still existed. I had recalled the quote that in its heyday Jingdezhen had reverberated night and day to the sound of rolling thunder from over 6000 water hammers. Far up a hidden valley, my researcher found a water-hammer site still in operation. When we filmed it, we had a stroke of luck. It had rained heavily the night before and the stream thus had sufficient water to drive three water wheels in parallel. These then drove 12 hammers in a row. It was a glorious sight which all can share when the films are shown! We discovered the reason why the hammers are still operating. Each potter has his own favourite mix for creating plasticity in the clay. The water-driven hammers crush the stone in a way that is not possible with mechanical grinders. So for high-quality porcelain the hammers will live on.

Many firms produce fine porcelain reproductions but all use gas or electricity to fire the objects. This removes the need for the traditional wood-fired kilns which have no thermometers and which therefore require extraordinary skill in temperature control. The master-craftsman's skills in loading the kilns and in judging the temperature is very great indeed. According to local ceramics experts, the overall temperature can reach up to 1320°C, but the front, middle, and rear of the kiln all have to be kept at different temperatures within a range of less than 40°C. Here too we had some luck. We found the younger of the two master-craftsmen who still retain the skills required to fire a traditional kiln. In fact he is virtually the only one left as the other man is elderly and unable to work any more.

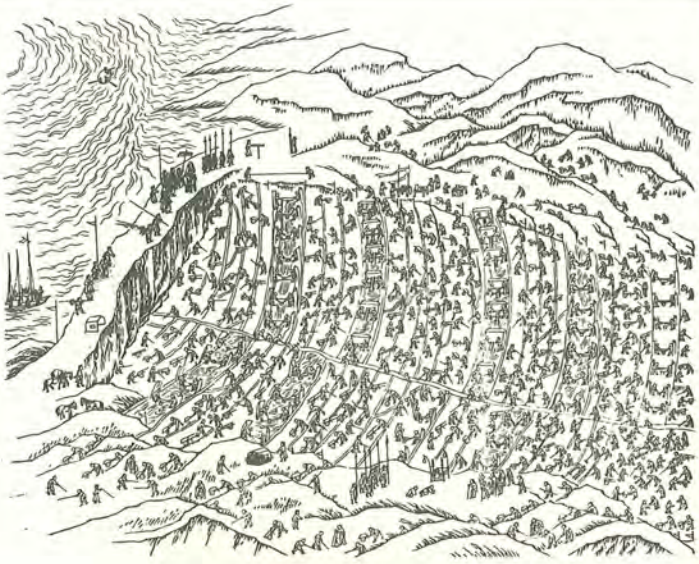


A water-powered pounding mill, Tiangong kaiwu (1637), *1929 ed.*

The original kilns were said to be so numerous and to give off so much light that it was never dark in Jingdezhen. We persuaded our master-craftsman, with a team of ten, to fire up the one remaining traditional kiln. This was last done for former Premier Li Peng three years ago. As far as we know, no book yet in English describes the process in detail, and it is only when one sees it being done that one can grasp the brilliant design of the firebox that creates the massive, controlled airflow required to reach the high firing temperatures. It is as well it has been filmed, as this was almost certain to be the last time the kiln will ever be fired up.

The master-craftsman has to earn a living making daily tableware. He has two daughters but he declares that he will not pass the skills on to them. "It is bad luck having women working kilns", he said. When questioned about teaching another young man, he pointed out that "such skills cannot be handed down outside the family!"

There are many other tales from Jingdezhen, and if we had more time we could have filmed all 72 of the manufacturing processes that gave Jingdezhen its claim to fame as the first industrial city in the world. The city is full of interesting characters, such as the man who must be one of the great archaeological detectives of this century. The 20 tons of smashed official porcelain he has unearthed provide fascinating proof of the influence of other civilisations on the designs of porcelain produced by the official kilns. Only perfect porcelain was allowed to leave Jingdezhen, and seconds were smashed because they could not be allowed into the hands of the common people. No records of the dump existed, but a dogged search over 20 years led to the discovery a few years ago.



Cutting a Canal, Hongxue yinyuan tuji, *1849.*

Dujiangyan

One great wonder of the ancient Chinese world that is still functioning as originally designed is the irrigation system at Dujiangyan, Sichuan. At the site itself, there is a severe paucity of information on how this scheme works, even though it has watered the Chengdu plain for over 2000 years. It is fortunate that the mechanism is well-documented in the Needham volumes. Russian engineers almost wrecked the system with a new dam they built in the 1950's, and we filmed one of China's most senior water engineers touring the scheme and explaining how he helped restore the original one once the Russians had left China. This Professor emphasised that throughout his fifty-year career he has used the same scientific principles that were originally used to create Dujiangyan. Such is his admiration for the designer and builder of this ancient wonder, Li Bing, that he offered incense at the nearby temple, dedicated to that ancient Chinese engineer, in a solemn ritual observance that we managed to capture on film.

Not only does Dujiangyan still operate exactly as designed, but the same flow of water from the intake now irrigates five times the area that it did in 1949. This statistic is a measure of Chinese ingenuity for evolving more and more intensive methods of farming (and water-management) over the past thousands of years. New seed varieties use significantly less water and offer higher yields. Innovative methods of lining canals and irrigation ditches contributes to the reduction in the amount of water — five times less than in 1949 — necessary to grow the same amount of food. Irrigation across all China has expanded by one third since 1949, and much of this expansion was completed during the Mao era.

Farmers who benefit from the water at Dujiangyan are never allowed to forget it. They must offer their own labour to maintain the vast network of canals. Everything is tightly controlled for the most efficient distribution of water. Each December and January the whole system is shut down for fifty days for maintenance and expansion. I will never forget filming 1000 farmers digging to expand one of the main canals. It was exactly like the ancient canal building depicted in an illustration in Volume IV:3 of *SCC.*

This exploration through film across China has only been possible through the extraordinary generosity of donors, led by The Hon. Lee Quo-Wei, GBM JP, recently retired chairman of Hang Seng Bank, as well as the unflagging support of colleagues at the NRI and the IHNS. If we achieve nothing else, we have a unique archive of half a million feet of film capturing China at a pivotal point in its history, which will provide future historians with a rich primary source.

Having lived in China during most of the past 18 months, I have the impression that the international factual reporting and analysis of events and conditions in China is of a truly dismal standard. After travelling so much and to so

many places, I know that much of what is happening now in China today is not being reported, let alone what happened in its history, and it is this history that helps to make sense of China today.

Unless we understand more of China's past, I fear that future fatal collisions between cultures and civilisations may be a real possibility. Just at the moment when one quarter of the world's population seeks to be part of the global community, we may run the risk of misunderstanding them, and they us. Dr. Joseph Needham made an unparalleled contribution to the deepening of the understanding of China in the West. I sincerely hope that the Dragon's Ascent may be well on the way to helping realise one of his dreams, as we attempt to take an understanding of Chinese science and civilisation to a much wider global audience. In this way perhaps we can take a few steps toward making the world a richer and safer place.

Alistair Michie
Series Producer
The Dragon's Ascent
Taiyuan, Shanxi Province
23rd May 1999

NRI BRONZE WORKSHOP, DECEMBER 1998

The Workshop on Bronze Metallurgy in China and the West was convened on 12 Dec. 1998 at the NRI to provide an occasion for intensive and informal discussion that would promote better understanding and co-operation between archaeologists and other scholars in Britain and in China concerned with the history of non-ferrous metallurgy, and particularly bronze. A secondary goal of this workshop was to advance the discussion of the proposed *SCC* volume on bronze metallurgy in China. The tradition of *SCC* that requires technical subjects to be treated in the fullest social and historical context, to include not only China but also all parts of the world, demands extremely careful preliminary investigation and planning, and it was thought that this gathering of so many specialists in an informal setting might provide illuminating instances of contact or comparison and expose issues and areas of interest that might be covered in this volume.

More than two dozen specialists participated in this one-day workshop, representing a wide range of institutions and specialties not only from Britain and China but also from the U.S., Canada, and Taiwan.

The workshop began with a general introduction and welcome by Dr. Christopher Cullen, who introduced Prof. Han Rubin, Director of the Institute of Historical Metallurgy (IHM), The University of Science and Technology, Beijing, and her colleague Dr. Zhou Zhongfu. Dr. Han and Dr. Zhou had been invited to England to give presentations on their recent work in archaeometallurgy and to discuss their work with students and scholars at a number of other institutions as well as at the NRI. In their presentations at the workshop they summarised recent research and also presented important material either not yet published or at least not yet readily available to Western scholars.

Prof. Han summarised the major accomplishments that have been made in the study of early non-ferrous metallurgy in China, including the ongoing analytical work that she and her colleagues are currently undertaking at the IHM. After surveying the fifty copper artifacts excavated from Neolithic contexts datable prior to about 2000 BC, Prof. Han gave a detailed description of the remains discovered at Neolithic Majiayao Culture sites in Gansu province, as well as finds from the earlier Neolithic Yangshao culture site of Jiangzhai, near Xi'an. A comparison of these remains with the late Neolithic Longshan culture specimens found in Jiao Xian, Shandong, and at Weinan, Shaanxi, has led her to conclude that copper workers were reducing local Cu-Zn ores prior to 2000 BC, but the resulting brass alloys were not intentional. Her research has shown an increased quantity of metals and other evidence of copper-based metallurgy across late Neolithic (2500-1900 BC) sites all over China. Among the most interesting of the new discoveries described by Prof. Han are the arsenical copper artifacts that have been found at sites of the Siba culture in Gansu, dating ca. 1800-1600 BC, which, together with other early metallurgical finds in northwest China, will no doubt reinvigorate the debate concerning possible metallurgical influences from central Asia and the Near East.

Participants at the NRI Bronze Workshop.

Dr. Zhou Zhongfu's paper described his recent studies of a lustrous, black patination layer known as *qigu* that is sometimes found on ancient Chinese bronze mirrors. His systematic study of over 600 archaeological specimens has revealed that the *qigu* patination layer is composed mainly of noncrystallinic or nanocrystallinic SnO_2, with a small amount of copper and lead compound. Dr. Zhou suggested that the *qigu* layer was formed by electrochemical corrosion when it was buried in certain types of soils.

The workshop then embarked on an informal discussion of a wide range of issues, loosely organised into three major topics: (1) issues of origin and early development; (2) the social role of bronze metallurgy and issues of ritual, warfare, trade, and production; and (3) technical issues of analysis and interpretation.

During the discussion of origin and early development Dr. Robert Murowchick pointed out some of the major gaps that still exist in our understanding of early metallurgy in China. He described the traditional focus of Chinese archaeology on the North China Plain between the 1920s and the 1970s as one possible reason for the apparent absence of early bronze traditions elsewhere in China.

Dr. Jessica Rawson, Warden, Merton College, Univ. of Oxford, introduced the second session of the workshop by describing six major social aspects of metallurgy that might shed light on our understanding of the development of Chinese metallurgy. These include the notions of invention, technology, function, aesthetics, organization, and issues of how to sustain a technology. She raised the possibility that the importance of invention and innovation seen in some ancient cultures might not necessarily have been a driving force in China, and that the idea of technology transfer (rather than stimulus) might be a useful way to approach the study of technologies such as metallurgy in early China.

A full version of this report will soon be available on the NRI website.

Robert E. Murowchick
Director, International Center for East Asian Archaeology and Cultural History
Boston University

The "Joseph Needham Home Page" (www.soas.ac.uk/Needham/) has links to:

- Joseph Needham, 1900-1995 (a biographical sketch)
- The Needham Research Institute
- The Science and Civilisation Project
- Needham Research Institute Newsletter
- East Asian History of Science Library

The Da zangjing (Tripitaka, *or* Great Buddhist Canon) *and* Wan zi xu zangjing (Supplement to the Buddhist Canon), *generously donated to the Library by the Corporate Body of the Buddha Educational Foundation, Taiwan.*

CHINESE SCIENCE AND THE CHINESE BUDDHIST CANON

Why did the invention of printing in China not have the same impact as the Gutenberg revolution in the West? There is of course no simple answer, but one aspect of the problem which we should not forget is that China in the eighth or ninth century was already at a far more sophisticated stage of coping with the culture of the book than the contemporary West. A large monastic library in western Europe at this time would have been unusual if it could boast six hundred titles (see Giles Brown, on p. 36 of R. McKitterick, ed., *Carolingian Culture: Emulation and Innovation*, CUP, 1994). Yet every major Buddhist monastery in China (and in some towns there would have been several such institutions) would have possessed over one thousand titles (in over five thousand scrolls) simply by virtue of owning a copy of the Chinese Buddhist Canon, to say nothing of any non-Buddhist holdings they may also have kept to hand. More remarkable than that, we now know, thanks to the research of Fang Guangchang (*Fojiao dazangjingshi*, Beijing: Zhongguo shehui kexue chubanshe, 1991), that those copies of the Buddhist canon had by the tenth century come to assume a standard arrangement of their contents whereby each case of ten rolls was marked with a unique coding which allowed any monk or nun with a copy of the master list to locate very rapidly a particular text among so many not only in his or her own monastery library but also in any analogously arranged canon anywhere in the Chinese cultural area.

This stunning breakthrough in information technology seems to have been so far in advance of Western librarianship that no one has bothered to pay it any attention hitherto — perhaps the Western stereotype of the idle bonze, unconcerned with practical matters in a world allegedly deemed illusory, has simply blinded us to its existence. The credit for such a remarkable invention must, of course, go to the Buddhist monk-librarians themselves, since there is plenty of evidence brought forward by Fang to illustrate the steps leading up to their eventual solution to their problems of information storage and retrieval. At the same time, however, we cannot ignore the involvement of the Chinese state in matters of religious bibliography, and in my current research I am exploring the ways in which the introduction both of standardised cataloguing systems and of printing itself might have been found perfectly congruent with the interests of contemporary Chinese regimes whose ideologically motivated excursions into the production of books at this time were of a scale and frequency quite unparalleled anywhere in the West. I hope that the results of this research will help us to understand the nature of the relationship which prevailed in China at this crucial period between society and at least one aspect of technology.

But this is only to touch upon a single aspect of the Buddhist canon as a resource for the investigation of East Asian science. For many other topics, ranging from astronomy through medicine to zoological knowledge, the Chinese Buddhist Canon contains a wealth of indispensable materials, especially when we remember that in the period since the development of printing yet more Buddhist literature was either translated or produced in China itself. Modern editions of the canon attempting to republish all this material in a compact format date back to the Japanese Tokyo edition of 1880-85, though since then two more editions have been produced in Japan, and Chinese Buddhists have responded by reprinting various early versions of the canon by photolithography. Most recently volumes have been appearing from China of a canon incorporating collation notes derived from materials never before used for textual purposes, such as the remarkable Buddhist Canon carved on stone (primarily during the Liao dynasty) at Fangshan.

But there is one edition above all others which scholars prefer to consult, though it is neither the most comprehensive (despite its more than two thousand works relating to China) nor the most up to date. This is the so-called Taishō Canon of 1924-1934. Not only did it incorporate the highest standards of scholarship available at that time (standards which have not yet been surpassed even today) but it became the basis for further scholarship, primarily the production of an index series. While this series falls well short of providing a full concordance for the vast mass of materials in the canon, it does provide an indispensable tool for research purposes which is unlikely to be superseded until the computerisation of the Chinese Buddhist Canon (again, the Taishō Canon almost invariably forms the basis for this innovation) is completed. Despite the recent proliferation of all manner of Buddhist databases (a convenient listing of which is available in the specialist periodical *The Electronic Bodhidharma* 3, July 1993, pp. 27-37) that beatific prospect is still a little way off. Even when it does arrive there will still be, I believe, great virtue (and perhaps even karmic merit) to be derived from having the volumes of the Canon and its indexes conveniently placed on the shelves of the NRI library.

I was delighted therefore when the Buddhist community in Taiwan found it possible to donate these important materials to the Institute. While there is still room for further library purchases of research aids in the field of Buddhist Studies to add to the Institute's collection, a major omission from the basic collection (particularly conspicuous since the donation several years ago of a Taoist Canon) was thereby rectified at a stroke. In Chinese Buddhist circles there was always much talk of Sudden Enlightenment. But if this has arrived, we should remember that many authorities also believed that it should be followed by a period of Gradual Cultivation. Let us hope that this, too, can now begin.

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