Fifty years of Science and Technology in China: A Personal Account

By

Geoffrey Oldham
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My interest in China began and developed in an unexpected way. In 1960 I was invited to help initiate a scientific exchange between the Geophysics Department at the University of Toronto and the Geophysics Institute of the Chinese Academy of Sciences in Beijing. Although the exchange programme did not work out as planned it did lead to a long-standing and rewarding involvement with Chinese science and Chinese scientists. This involvement has lasted for more than fifty years.

On a visit to China in 2010 I was invited to a dinner with a former Chinese Minister of Science and Technology and several other distinguished Chinese science policy authorities. We spent the evening reminiscing about the changes that had taken place in Chinese science since my first visit in 1964. At the end of the evening my Chinese hosts pressed me to record my experiences and recollections of Chinese science policy gained from more than fifty visits to China over a fifty-year period. They stressed that this should be a personal account and not an academic review. This account is my response to their request.

Background

After studying geology and physics at the University of Reading in England I went to Toronto University in 1951 to study for a PhD in geophysics. The head of the geophysics department at that time was Professor Tuzo Wilson a distinguished Canadian scientist who became famous for his pioneering work on Plate Tectonics. He was my supervisor. After graduation I joined the Standard Oil Company of California (now Chevron), first with their exploration research laboratory and then with their foreign exploration subsidiary.

In 1958 Professor Wilson visited China in his capacity as President of the International Union of Geodesy and Geophysics. He was surprised and impressed with the quality of geophysics research in China and believed that the time had come to initiate scientific research exchanges between China and the West. He proposed that Toronto start such exchanges in geophysics between his Department and the Academy of Sciences in Beijing. He invited me to help start the programme by spending two years studying the Chinese language and then two more years carrying out research in China. An incentive was the possibility of a job at the end of the Fellowship at the University of Toronto half time in geophysics and half time in Chinese studies.

Before deciding on this proposal I consulted Joseph Needham at Cambridge University. Needham had started to publish his series of volumes on Science and Civilisation in China and was a Foreign Fellow of the Chinese Academy of Sciences. His view was that it would be unlikely for the Chinese Academy of Sciences to welcome a foreign scientist to spend two years carrying out research. He thought a

visit of two months might be possible. But if I had the opportunity to study the Chinese language and its history and art then I should take it.

It was a difficult decision. In the end I was swayed by Needham's advice and did accept. However I added a caveat. If I could not get a visa to do geophysical research in China then I proposed that I use the last two years of the Fellowship to study the state of science in Asia. This caveat was accepted. A few weeks later the Oldham family travelled to England where I had chosen to begin my Chinese language studies at the School of Oriental and African Studies in London.

On Learning Chinese

The year in London was a totally new experience. At SOAS I was not only immersed in learning the Chinese language I was also immersed in lectures on Chinese history, art and archaeology. The non-degree class was a mixed group of people having very different reasons for studying Chinese. The majority of the students were from the British Foreign Office, who were likely to be posted to Beijing.

The general view is that Chinese is a difficult language to master, especially at the age at which I had started. (I was 29!) . I remember coming across an article published in the late 19th century, which discussed the relative merits of the Chinese learning science in the medium of the English or Chinese languages. The article came down in favour of using the Chinese language provided that Chinese teachers taught it. The alternative of it being taught by foreigners "who had had their faculties paralyzed by the task of mastering the Chinese language" was thought to be very unwise. In fact studying Chinese was rewarding. I particularly enjoyed learning the characters. Needham had likened the make up of characters to the make up of molecules from atoms in chemistry. This helped me in the early days a great deal.

Towards the end of the course the Holborn Technical College also in London began an evening course on Chinese for Scientists. I added this to my schedule of courses.

At the end of the first year the whole class moved to Hong Kong and continued their studies at the Hong Kong University Language School. The School had some difficulty in knowing how to deal with me given my scientific interests. Most of the others were being taught from Chinese newspapers. But this was not my main interest and I found a series of booklets published in Shanghai but also sold in Hong Kong called Shi Wan Ge Weishenme or in English "A hundred thousand whys". They gave clear scientific explanations of simple questions such as why is the sky blue. They were probably meant for secondary school students but were just right for my level of Chinese, and provided ideal textbooks for me.

About half way through this second year Tuzo Wilson wrote to the Chinese Academy of Science and formally proposed the exchange of geophysicists. The Secretary of the Academy replied saying that it was too soon for the Chinese to begin such an exchange but a short visit might be possible to arrange. This was exactly what Needham had predicted. Although it was disappointing news it was not totally unexpected. It was time for plan B.

Plan B was the switch from just being interested in geophysics in China to taking a much wider view of science in Asia. I immediately left the Language School and stopped studying Mandarin. This was a choice that in later years I came to regret.

Another six months at the Language School would have made a considerable difference to my fluency in the Chinese language.

Science in Asia

I began to study science and technology policy in Asia, starting with how Hong Kong was using science and technology in its development. I wrote a number of articles about science in Hong Kong. These led to my being co-opted on to the Hong Kong Committee for Scientific Coordination and then sent as one of the Hong Kong delegates to the first major UN Conference on Science and Technology for Development. This was held in Geneva in 1963. It had a major influence on my future career. Before the Conference I still thought of myself primarily as a geophysicist. Afterwards I thought that the topic of science, technology and development warranted academic study in its own right and I wanted to prove this with my study of science in Asia.

I began a series of visits to The Philippines, Thailand, Malaysia, Nepal, India and Japan. In each country I explored the science and technology policy issues that the respective governments thought to be the key science and technology issues in their country. I had just spent a month in India when I heard from Tuzo Wilson that the China International Travel Service had invited a Toronto travel agency to send a tourist group to visit China in October 1964. Wilson suggested I might like to apply. I did so, and was accepted as a member of the tourist group.

About two weeks before the start of the tour I received another letter from the Toronto travel agency. All the other members of the group had withdrawn at the last minute, but the agency had ascertained from the China Travel Service that I could travel as a group of one.

I felt confident that I was well prepared for the trip. My Chinese language ability was at a reasonable level. I could chat with people I met on general topics, although I was not yet able to engage in technical discussions. My reading ability was a little better than my spoken ability and I could get the gist of most articles in the People's Daily. By now I had considerable experience of other Asian countries approach to using science and technology to meet development objectives. It would be interesting to see how China compared.

My first visit to China in October 1964

The original plan for the group visit was for a two-week tour. However once in China I was able to get this extended to a month. The route included Guangzhou, Beijing, Nanjing, Suzhou, Shanghai and Hangzhou. These were most of the cities that were open to foreigners at the time. I was accompanied by China International Travel Service staff and in each city was asked what my special interests were. Apart from Beijing that was limited to the usual tourist highlights, I was able to visit most of what I asked for. In total I visited four universities, eight communes, four research institutes and five middle schools. On my return to Hong Kong I wrote a paper for the journal Science about my observations.

In this account I intend to respond to the request of my Chinese dinner hosts to capture my impressions of the visit rather than provide a detailed description of each place I visited.

My first impression of the research institutes that I visited was positive. I had found in visits to research institutes in other Asian countries that even on a short visit it was possible to assess the overall standing of the Institute. I judged on the basis of the enthusiasm of the scientists, the vision of the leadership, and the quality of the instrumentation and the status of the library especially with regard to foreign journals. The Chinese institutes seemed to be on a par with many of the Indian research institutes that I had recently visited.

My second impression was just how politicised the management of the Institutes had become. Everyone was urged to be "red and expert", this meant each individual must strive to be politically correct and technically excellent. Another slogan urged everyone to be self-reliant. This applied to both the individual and to relationships with foreign countries. This political indoctrination was pervasive not only in the research institutes but in all the organisations that I visited. It was something that was explicit and something in which the exponents seemed proud. I found this difficult to understand.

A third impression was that a major effort was underway to link research with production. However it was hard to find evidence that showed how successful these efforts had been. Studies carried out in the US at about this time showed that expenditures on research, development and production in several industrial sectors were roughly in the ratio of 1:10:100. When I discussed this with my Chinese hosts they speculated that in China the ratio was more like 1:0.5: several hundred. That is, they thought that China was heavily under investing in the D of R&D. They also thought that there was a lack of experienced project leaders.

The fourth impression was that a major effort was underway to increase the number of trained scientists and engineers. At Middle School level there was a stress on science courses with experiments based on instruments made in China. At University level I found that in physics the laboratory experiments were very similar to ones that I had helped supervise when I was a tutor in the Physics Department at the University of Toronto.

The fifth impression, and possibly the most important, was the effort that was being made to inculcate the scientific approach of combining theory with experiment at all levels of society. A popular slogan at the time was "Support the three great revolutionary movements; the class struggle; the struggle for production; and scientific experiment." Science was to replace the Dragon King, ghosts and other manifestations of superstitious beliefs. With the scientific method peasants and factory workers could bring about innovations and increase productivity. Every commune I visited had its own experimental plots and two had research institutes. Every factory took pride in showing me innovations that had been introduced by workers.

I was impressed by the extent to which the system encouraged innovations. But in hindsight I realised that these were all small incremental innovations. There were few incentives for introducing major innovations in a command economy. If a factory manger tried to introduce radical innovations it would mean stopping production while the new technology was introduced. Probably this would mean that production targets set by the State could not be reached and the manager would be criticised. There was little incentive to take risks.

There was one incident on this memorable trip that stands out. I was assigned a berth on the overnight train from Beijing to Nanjing along with three army officers from the People's Liberation Army. One of them asked me where I was from. I replied "England." He then said "Oh that was where Watt invented the steam engine. This led to England having its industrial revolution, then America had hers, and now China is beginning to have its industrial revolution". The day after I arrived in Nanjing China exploded its first atomic bomb demonstrating the accuracy of the Army Officer's analysis!

There was a sentence in a letter I wrote to my parents shortly after this trip to China that sums up my impressions. It was:

I was impressed with the genuine friendliness of the Chinese people I met and their work in science and its application in the communes were particularly impressive. I believe it will be twenty to thirty years before China really blossoms forth and then the rest of the world is in for some surprises. ***(This was written in 1964!)***

It was soon after this China trip that I completed my review of Asian science and technology policy and was given the opportunity to spend a year with the Organization of Economic Cooperation and Development (OECD) in Paris.

Travel by train from Hong Kong to London May 1965

The journey from Hong Kong to Paris was made with my wife, and our four children by train. En route we stopped in Guangzhou, Wuhan and Beijing. We were in the capital for May Day and were invited to participate in the May Day celebrations. It was in one of the parks that we noticed two important looking Chinese men mingling with the crowds. One was Zhu De who had been commander in chief of the military during the Long March, and the other was Peng Jen the mayor of Beijing.

There was less opportunity on this trip to visit schools, universities and research institutes. In fact travelling with the family rather than on my own led to enhanced tourist visits, but there was less opportunity to interact with Chinese people.

Science and the Cultural Revolution

After a year in Paris at the OECD I was invited to join Chris Freeman in starting The Science Policy Research Unit (SPRU) at the University of Sussex in 1966. I was responsible for building the work in the Unit on science and technology policy in the Developing World. It had been my hope that we would soon be able to develop cooperative projects with Chinese researchers. That hope turned out to be premature as the year SPRU started coincided with the beginning of the Cultural Revolution. Western interest in China grew and I was invited to give many talks about Chinese science and education in the UK and the US.

We did start a programme on Chinese science and technology at SPRU. This was funded by the Ford Foundation and was largely based on the translations of Chinese papers and Chinese language radio programmes that were available in England. It enabled a small SPRU group of China watchers to monitor what was being reported in the Chinese press about science and technology. The group consisted of Gennie Dean,

Sue Rifkin and Jon Sigurdson. Jon had been Swedish science attaché in Beijing during the Cultural Revolution, We learned for example that initially in the Cultural Revolution the scientists were protected. Chou En Lai was generally credited with this protection. However it did not last long and very soon scientists and engineers were caught up in the turmoil of the revolution.

A few years later I learned that my 1964 trip to China had led to at least one person being sent to a labour camp. This was the China International Travel Service driver who had been assigned to drive me in Shanghai. At the end of a week with this driver he drove me with other Travel Service personnel to the railway station. He had shown consideration for other road users and did not constantly blow the horn like many car drivers at that time. As we were all saying our goodbyes I thanked the driver for being such a good driver and hoped that if ever I came back to Shanghai he would drive me again .In the Cultural Revolution, on the basis of my publically thanking him for being a good driver, he was accused of helping a spy!! He must have done something for me, a foreigner, which had led to my thanking him. No one, it was suggested, would have thanked a driver for just being a good driver.

During this period the SPRU China programme focussed mainly on industrial innovation, health care, and technology for small and medium enterprises.

The Technological and Industrial Policy in China and Europe (TIPCE) Conferences

By the end of the 1970's the Swedish Science Attache, Jon Sigurdson had returned to Sweden to join the Research Policy Institute at the University of Lund. By then China was beginning to open up to the West and Sigurdson and the SPRU China team decided it was time to try to establish science and technology policy research contacts with China. The first question was whom should we approach. From his time as Swedish Science Attaché in Beijing Jon had heard a lot about Wu Ming Yu who had often been referred to as Mr Science Policy. We decided to contact him and propose collaboration between Lund, Sussex and China on the theme of Technology and Industry policy in China and Europe. The proposal was to organise three conferences in successive years. The first was to be held in Lund, the second in Sussex and the third in China.

Wu Ming Yu agreed and proposed that the Chinese Research Society of Technological Economics be the participating organisation. The first conference took place in 1981 in Lund. I followed this with a short visit to Shanghai and Beijing later in the same year. It was 16 years since my previous visit. I was amazed by the changes that had taken place. It was three years after the third plenum of the 11 meeting of the Chinese Communist Party where Deng Xiao Bin had been elected Chairman. China was beginning to open to the West and that was evident from the warm reception I received at every institution I visited.

The main objective of this visit was to learn about the Chinese interest in science and technology policy research. There were three different groupings of individuals and institutions that were working in this area. There were government and academic institutions, Techno Economic Societies, and groups interested in the Science of Science. Compared with SPRU interests the Chinese groups were more theoretically oriented. However there was a lot of interest and enthusiasm for learning more about SPRU's experience. There was curiosity too about why British industrial innovation

was lagging behind other OECD countries given that SPRU research was apparently so good!

It was at the second conference in Sussex in 1982 that Wu Ming Yu said that the Science and Technology Commission were establishing a new science policy research institute and that he had been invited to be the first Director. The new institute was to be called The Chinese National Research Centre for Science Technology and Development. (CNRCSTD) Wu Ming Yu proposed that a twinning link be established between this Centre and SPRU and that cooperative programmes be launched. Some years later, Wu MingYu told me how influenced he had been on this visit by a number of SPRU researchers. He especially mentioned Roy Rothwell's work which had led him to establish Venture Tech within the Commission on Science and Technology.

SPRU was able to get British Council funding to enable the exchange programme to be implemented. The Chinese side asked that Chinese staff members of the new Centre come to SPRU for training purposes for spells of 3 months whereas SPRU staff went to China for conferences and research activities. Over the next ten years SPRU received more than thirty Chinese researchers for training purposes.

At the third TIPCE conference held in Beijing in 1983 Wu Ming Yu and I discussed the possibility of our two organisations collaborating in a joint research project. It seemed that an appropriate subject might be technology transfer from the West to China. In particular it was suggested that we jointly explore problems that were being encountered between Western oil companies that were exploring for oil in the South China Seas and their joint venture partners, the Chinese National Offshore Oil Corporation (CNOOC). The contracts for the joint ventures required the foreign oil companies to transfer their technology to CNOOC. CNOOC said this was not happening, whereas the foreign companies claimed they were transferring their technology. The joint China /SPRU project was aimed at resolving the impasse.

Shortly after the third TIPCE conference Wu Ming Yu was appointed Vice Chairman of the Science and Technology Commission and a new Director was appointed to head the CNRCSTD. However the SPRU link with that organisation continued and prospered.

Technology Transfer to the Chinese National Offshore Oil Corporation

The joint SPRU/CNRCSTD project got underway in 1983. By that time China was already following its 'open door' policy and inviting joint venture agreements between foreign and Chinese companies. Many of these agreements required that there be a technology transfer clause requiring the foreign company to transfer the technology it was using in China to the Chinese. This clause had been included in the agreements between CNOOC and the foreign oil companies who had received contracts to explore for oil in the South and East China seas. Not all foreign companies agreed to this clause and those that did not were not awarded concessions.

After about two years of exploration, the technology transfer clause was proving to be contentious. CNOOC said that despite the contract terms the foreign companies were not transferring their technology. They believed they could take the companies to court, but to do so would ruin the good relations they wished to cultivate.

If CNOOC could understand the foreign company's motivation for not transferring their technology then they might be able to address these concerns. For example they believed that perhaps the foreign companies were concerned that the technology would be leaked to other companies working in China. Or perhaps they were concerned that CNOOC would use this technology to compete with the foreign companies in other parts of the world.

The foreign oil companies said they were transferring their technology and could not understand why CNOOC was so adamant that they were not. Other countries had similar clauses in their contracts and they had been satisfied. Both the foreign companies and CNOOC welcomed the proposed study and confirmed their willingness to collaborate.

Wu Ming Yu appointed two young members of his Centre to work on the project. They were Zhang Xiao Bin and Lao Yuan Yi. The latter had been one of the leaders of the Red Guards in Shanghai during the Cultural Revolution. He had fallen out with one of the Gang of Four and was put in prison for several years. During this time he studied English and when he was released he applied to Harvard University to read for an MBA degree. He was the first Chinese student from China to be awarded a Harvard MBA.

The SPRU personnel involved in the project were Alyson Warhurst, Martin Bell, Sally Wyatt and myself. The project involved interviews with the foreign oil company staff both in China and in their home countries. CNOOC staff both from their headquarters in Beijing and their operating company subsidiaries was also interviewed. In the UK British Petroleum invited senior CNOOC officials to tour BP's North Sea operations, and Martin Bell studied how British drilling companies innovated.

The CNRCSTD team and Alyson Warhurst and myself jointly carried out the interviews in China. It was in the early days of the opening up process and at times hotel policy did not permit the Chinese and British teams to eat together in the same restaurant. But most of the time the four interviewees received equal treatment and got along very well together. It was extremely interesting to spend so much time with a former Shanghai leader of the Red Guards.

The fact that I was trained as a geophysicist and had worked with an American oil company, and in addition had studied how technology was transferred from the company's exploration research laboratories to its operating subsidiaries was an asset for our project. It helped us understand the nature of the difficulties between CNOOC and the foreign companies

Our main conclusion was that each side had a very different understanding of the two words "Technology Transfer". For the foreign companies it meant "Training the Chinese to do in China tomorrow what we do in China today" As a consequence most of their efforts went into designing and implementing training programmes.

CNOOC wanted those training programmes but in addition it wanted access to the secret technology that the foreign companies possessed. They said they wanted access to the "know why" as well as the "know how".

The foreign company's response was that they were not using their secret technology in China. Even their own staff working in China was not aware of the details of their secret exploration technology. The companies research laboratories located in the foreign country possessed that knowledge. If CNOOC wanted access to this knowledge they needed different contracts. But it was unlikely that the foreign companies would be willing to share this knowledge. It was rarely patented and the advantage it provided over other companies could be measured in months rather than in years. Once it was known that a particular company had a new worthwhile technology all the other companies research laboratories tried to copy it. Furthermore most of the exploration innovations were now produced by service companies rather than by oil companies.

Our report was widely distributed by CNOOC amongst its own personnel in both the head office and its own operating subsidiaries. The SPRU team were invited to attend a hot spring resort conference with about 100 CNOOC staff. This meeting revealed that most of the operating company personnel were quite content with their relations with the foreign companies on the technology transfer issue. It was the head quarter's staff that was most concerned about the long-term implications.

Our joint report was also widely distributed within the foreign oil companies. Both these companies and CNOOC seemed to be satisfied with our findings and two years later when a member of the SPRU team carried out a survey they found that relations between both sides were much improved.

The impression from this experience was that the Chinese were asking worthwhile questions, but were not sufficiently aware of the complexity of the oil exploration industry working in a market economy. However they learned quickly!

Links between Provincial level science and technology policy research and policymaking.

During the 1980s SPRU came under increasing pressure from the UK Research Councils to demonstrate the impact the organisation was having on science and technology policy making. It was difficult to comply with this request and when I received a six-month sabbatical in 1988 I chose to study the link between science and technology policy research and policy making from the perspective of the policy maker. Most of the sabbatical was spent with the Prime Minister's Science and Technology Advisory Council in Australia.

When Wu Ming Yu heard about my project he asked me to spend a month looking at science policy research and policy-making links at provincial government level in China. He pointed out that a number of science and technology policy research groups had been established at provincial government level over the past few years and it would be interesting to know how these had impacted on provincial or local policies. He had chosen several provinces, autonomous regions and cities reflecting different stages in development for me to visit. These included Hainan, Szechwan, Tibet, Shanghai and Jiangsu. In each location the local representatives of the Ministry of Science and Technology would make arrangements for my visit, which would be a part of the SPRU/CNRCSTD link.

The project was fascinating but not very productive. I saw a lot of the Provinces and Regions and observed just how varied they were in their state of development. But

with a few exceptions it was difficult to get a measure of the impact that the policy research was having on local policy. It would perhaps have been better to have spent the month in just one or two locations.

Tibet was particularly interesting. The officials in Beijing were concerned about the effect on my health of the height of Lhasa and other locations in Tibet. They did not encourage foreign visitors over the age of 50 to visit because of the shortage of oxygen. I was 60 at the time and therefore they insisted that a staff member of the CNRCSTD accompany me. This was to help with my evacuation from Tibet if I became ill. In point of fact I found I coped much better with the altitude than did the much younger researcher from Beijing.

The Deputy Director of the Science and Technology Policy research centre was Tibetan, but all the other professionals were Han Chinese. The briefing I received about their research was well prepared but I did not get a sense of its impact.

Hainan had just become a Province in its own right and I was given a memorable tour of the island visiting several scientific research centres en route. But I did not get a good sense of the impact policy research had made on science and technology policy in Hainan

The Shanghai visit was one of the most interesting both from a personal and work point of view. I was met at the airport by the representatives of the Shanghai Science Policy Research Centre and taken to my hotel. En route I coughed once or twice as I was getting over a cold. At the hotel I was allocated the suite where President Nixon had stayed. It had three bedrooms, a large living room and a kitchen. The next morning I found the suite was buzzing with people. The other bed rooms were occupied and I was introduced to a doctor of Chinese medicine. He had been hired to cure me of my cold! It turned out that he was to accompany me to all my meetings and interviews throughout my time in Shanghai! The suite was filled with people because all of my discussions with the research centre were to take place in my suite.

I asked the Director how he went about communicating the results of the Centre's research to policy makers in Shanghai. He gave me a fascinating explanation. He first of all set about identifying the key person he needed to reach with the results of the research. This was not always the person in charge. It could be someone who was a few places down in the hierarchy. But the individual would be the authority in the subject matter of the research. The Director then identified the person's favourite type of cuisine. Was it Shanghai cuisine or Beijing or Szechwan cuisine? He then selected a restaurant that specialised in this cuisine and invited the chosen person to lunch at that restaurant.

The next challenge was to decide at what stage in the lunch he should introduce the topic and the results he wanted to convey to the guest. It could not be too early or too late. He had a good success rate in influencing policy with this technique. I thought about trying to get a Director's entertainment budget when I returned to SPRU to see if this approach would work in England. Unfortunately I did not succeed!

My Chinese doctor insisted on accompanying me to the railway station when I left to travel to Nanjing for the four-hour train journey. Unfortunately I coughed again at the station. He was taken aback that I was still coughing and felt guilty that he had not

cured me. The next day he turned up at my Nanjing hotel room with a carrier bag of new traditional Chinese medicine.

By the time I returned to Beijing I had learned a lot about life in several Chinese Provinces and Regions. But I still had very little knowledge about the impact of Provincial level science policy research. In hindsight it would have been better if I had visited fewer places and spent longer in each.

Wu Ming Yu and science and technology policy in a market economy

It was in 1984 that Deng Xiao Ping recalled Wu Ming Yu from a trip to Australia to take charge of the design and implementation of the reforms to China's science and technology policies. These reforms were to convert science and technology from serving a command economy to serving a market economy. At approximately the same time he was made Deputy Director of the Development Research Centre (DRC) of the State Council. The DRC was largely responsible for the research that led to the reforms across the entire range of Government economic and social policies. It was one of the key players in the Deng transformation of China.

In early 1988 the DRC applied to the United Nations Development Programme (UNDP) for a grant to cover the foreign exchange costs of the research that was to inform the next phase of the reforms. This was to cover everything from science and technology to the banking system. When UNDP received the proposal they found it to be a collection of about forty separate projects rather than an integrated programme. It was unlikely to be approved by the UN appraisal process. They therefore suggested to the DRC that they engage two foreigners familiar with the UN and research proposal writing, to work with them to redraft the proposal and make it more likely to go through the UN system. It was left to the DRC to choose the foreigners. They chose Nathan Rosenberg from Stanford University and myself.

We spent time together in Beijing in the autumn of 1988 working with the DRC to redraft their proposal. By the time we had finished it was more of an integrated programme. The proposal was resubmitted to the UNDP's Beijing office in late autumn the same year.

We heard nothing further about the proposal. Then in late summer 1989 the student protests began in Beijing and the world became familiar with Tian An Men and the bloody massacre. I thought that would be the end of the reforms and the UNDP grant. To my surprise about a month after the Tian An Men incident the UN announced that the grant had been approved. There was one change from our draft, there was to be a steering committee comprised of the Director and Deputy Director of the DRC, the Resident Representative of UNDP, six vice ministers from relevant Ministries and two foreigners. I was invited to be one of the foreigners. This committee was to meet every six months during the lifetime of the project and its terms of reference were to ensure the DRC kept to the objectives of the proposal we had drafted

I then heard that Wu Ming Yu had been dismissed from his post as Deputy Director of the DRC mainly because he had been indirectly too supportive of the students. I contacted him and said I could not accept my position on the committee given what was happening to himself. His reply was intriguing. He said he had known me for almost ten years. During that time we had met frequently and he knew a little about how I thought. Without himself on the Steering Committee it was even more

important that my thoughts were present. Also if I did not join the committee no one would know I had been asked to join. If I did join and the objectives of the project were being ignored or changed I could always resign. The fact that a foreigner was prepared to resign would have a considerable political impact. Therefore I should accept to be a member of the committee.

I took his advice and joined. The first meeting of the committee took place about two months later. I flew into Beijing from Japan on a Pakistan International Airline's Boeing 747 and found I was the only passenger alighting. Beijing was once again almost devoid of foreigners.

Ma Hong the Director of the DRC and a very distinguished economist chaired the meeting. He began by asking me to report to the committee what the foreign response had been to the recent events in China. It gave me the opportunity to tell the members of the committee what I thought!

One of the Chinese members was Zhu Li Lan who was the Vice Minister of the Ministry of Science and Technology. I found that her comments made a lot of sense and were always constructive. In a few years time she became the Minister and our time together on the DRC committee proved to be very productive.

The first two or three meetings of the committee were somewhat strained and at times even boring. Then at the next meeting there was a different mood. The State Council was beginning to resume the reform programmes and once again was seeking inputs from the DRC. The research agenda stayed quite close to the original plan and there was no need to resign. It was an amazing opportunity to be at the heart of China's reforms and to learn how they were designed and implemented.

Most of the times I visited Beijing I tried to meet with Wu Ming Yu. He was now running his own consulting company and we met in his office. Other times we would go to a restaurant for dinner. On one occasion I asked him what life was like having lost his job for political reasons? He said that it was not as bad as it might have been in earlier times. For example he had taken me to a restaurant frequented by political figures. The person on the next table that he had introduced me to was one of Deng Xiao Ping's daughters!

The International Development Research Centre's (IDRC) China connections regarding science and technology policy

In 1992 I completed my second term as SPRU Director and went to Canada as Keith Bezanson's Science and Technology Adviser. Keith had just been appointed President of IDRC. A year later IDRC received a visit from Soong Jian who was the Minister of Science and Technology in China. Keith had never visited that country and when Soong Jian invited him to visit he accepted.

Soon after arriving in Beijing we were invited for dinner in the Great Hall of the People. In the course of the meal we discovered that 1994 marked two anniversaries. The first was the twentieth anniversary of the first IDRC grant to China. The second was the tenth anniversary of the start of the Chinese science and technology policy reforms. Soong Jian suggested that the Ministry of Science and Technology and IDRC should launch a joint activity that would help celebrate these two anniversaries.

I had recently returned from participating in the IDRC review of South African science and technology. It was a review that had been welcomed both by the Nationalist Government and the ANC. I asked whether a similar IDRC review of the Chinese science and technology reforms might be a topic for a joint activity. Was China ready to open its doors to a team of foreigners who would carry out an independent review of the reforms? It was about two months later that we got a letter accepting the proposal. Soong Jian suggested that members of the review team should be from advanced market economies and should focus on a limited number of topics. These were: basic scientific research, high technology industry, state enterprises, agriculture and environment.

IDRC put together a team of three Canadians, two Australians, one American and one UK citizen. Each had expertise in one or other of the main themes identified by the Ministry of Science and Technology. The team interviewed more than three hundred Chinese stakeholders affected by the science and technology reforms. We were told that the purpose of the reforms had been to mobilise S&T such that it served a market economy rather than the previous command economy. It was up to the team to judge how effective China had been in attaining that goal. The team identified the type of stakeholder it wanted to meet but left it to the Ministry to choose the specific institutions and individuals we would interview.

The team decided to carry out some interviews together, but also divided itself into two groups. One group focussed mainly on industry and the other group on agriculture and environment. We covered several different parts of China. The Industrial sub group carried out most of their interviews in the North East of China and the Agricultural and Environmental sub group concentrated on the West in the vicinity of Xian. The main group met together in Beijing , Shanghai and Guangzhou. In total the Group interviewed more than three hundred stakeholders.

Following the interviews and discussions the international team prepared its report and submitted it to the Ministry of Science and Technology in Beijing. The Ministry translated it into Chinese and distributed it widely to the various stakeholders. The international team then returned to China in May 1996 for the discussion Fora in Beijing, Shenyang, Xi'an, and Shanghai. At the Beijing meeting there were about a hundred stakeholders and the meeting was chaired by Madam Zhu Li Lan who was the Vice Minister. Soon after the meeting she was appointed the new Minister of Science and Technology succeeding Soong Jian .

The international team made four main general observations. These were:

- Much care and thought had been devoted to developing S&T policies that contributed to the goal of creating a socialist market economy.
- Implementation of the policies seemed to be variable -where managers were still in the mind set of the command economy implementation was slower than where managers had embraced reform and were prepared to innovate.
- There appears to be a rigid demarcation of responsibilities among commissions and ministries at all levels of government, leading to a plethora of policies, schemes, and initiatives with little coordination.
- A number of S&T policy issues that are considered important in other countries have been relatively neglected in China. These include mechanisms for providing independent science policy advice, a

National Systems of Innovation approach to policymaking, and the use of foresight techniques in priority setting for strategic research.

These general observations were followed by more specific observations in each of the areas identified by the Chinese as being of particular significance. These observations and the Chinese responses are included in the book "A Decade of Reform: Science and Technology Policy in China" which was published jointly by IDRC and the Chinese State Science and Technology Commission in 1997. The book contains the report of the International team and a summary of the follow up discussions.

The two issues which were referred to in the International report and which were followed up most assiduously by the Ministry were the ideas of establishing a Chinese National System of Innovation, and establishing a strategy for international collaboration on science and technology. In our report we had mentioned that very few of the people we had interviewed had used the word "innovation". We speculated that if the review had been carried out in other countries there would have been frequent discussions about establishing a national system of innovation. We expressed some surprise that no one had mentioned setting up a "Chinese system of innovation"

The report also expressed some surprise at the widespread enthusiasm that we had found regarding the benefits of international collaboration in science and technology. We pointed out that in market economies there was often tension between collaboration and competition, and some countries had formulated a national strategy for international S&T collaboration. There was no evidence of a similar Chinese strategy.

The first of these interests was followed up through a series of workshops and meetings throughout China that were entirely organised by the Chinese themselves. The formulation of a strategy for international collaboration however did involve some foreign inputs. A small advisory committee was established consisting of three Chinese, an American and myself. We were asked to carry out studies in China, the United States and Europe and then suggest a number of options for China which if implemented would help ensure that within 15 years China would be among the world leaders in science and technology. We were told that in becoming a world leader China would also wish to be a socially responsible world player.

Some members of the Science and Technology Ministry were concerned that foreigners were going to be involved in the development of a Chinese strategy on international collaboration. Madam Zhu explained that inputs of the foreigners were useful and provided new insights to the discussions. Chinese policy makers would finally agree any Chinese strategy.

The international collaboration advisory group carried out studies in China and abroad as requested by the Minister. The findings were discussed at an international workshop held in Beijing and the group then prepared its report. This was published by the Chinese Ministry of Science and Technology and is appended to this paper. We gather that the Minister had implemented several of the suggested ideas by the time of her retirement.

The experience of participating in the review of China's Science and Technology policy reforms together with the follow up studies, demonstrated clearly that the top

S&T leadership was willing to learn from foreign experience and where appropriate apply that knowledge to China's needs. This was a far cry from the self reliance attitude which pervaded China in the early 1960s.

The China Council for International Cooperation on Environment and Development (CCICED)

The CCICED was another manifestation of China's willingness to learn from foreign experience. The Council was chaired by a Chinese Vice Minister and consisted of Chinese and foreign authorities on environment and development. Its purpose was to study a variety of environmental issues and to make recommendations to the Chinese Government. In the 1990s it worked through a number of working groups, each consisting of about four Chinese experts and four foreigners. I was fortunate to be invited to serve on the Trade and Environment working group.

The usual practice was for Chinese researchers to be commissioned to do research on topics identified by the working groups and after detailed analysis of the results each working group made recommendations to the Council. One of the topics selected by the Trade and Environment working group was the issue of the transfer of clean coal technology from Western countries to China. In this case it was decided to put together a team of Chinese and foreign researchers, and SPRU was asked to join that team.

Participation in the Trade and Environment Working Group and the clean coal project provided opportunities for extensive travel within China. This travel included visits to highly polluted areas as well as visits to sites of outstanding natural beauty. The Chinese people we worked with and met on our visits were very well aware of the extent of China's environmental problems and were committed to doing things to rectify matters. In one rural area outside Kunming in the southwest of China we noted that there were a number of factories that had been closed. They had failed to meet environmental standards set by the State and as a consequence had been shut down.

Huge environmental problems remain but the government and researchers seem determined to improve the situation.

Review of China/IDRC Collaboration

The mid 1990s marked the 20th anniversary of IDRC support to Chinese research and the Chinese Ministry of Science and Technology proposed that a review be made of this collaboration. One of the objectives of the review was to inform the Chinese who at that time were considering setting up a similar organisation to IDRC that might help provide Chinese aid to the lesser-developed countries. The Ministry of Science and Technology asked me to join the team carrying out this assessment.

This assignment involved my joining the Chinese team in visits to completed and ongoing research projects supported by IDRC. The overall impression was one of good satisfaction with the IDRC programme staff that had helped administer the various projects. Mainly they had provided help and advice that was greatly appreciated. They had put the Chinese researchers in touch with a network of researchers working on similar problems in other countries. Just occasionally an IDRC staffer had been too bossy and had tried to direct the project in an overbearing way.

Another concern was that IDRC stopped funding when the research was complete. It often meant that there was no funding from Canada or China for the pilot plant or experimental field activities. What might have been a successful innovation was stalled at the end of the research stage. Having been a member of the team that drafted the IDRC Act and deliberately limited the Centre to providing research funding, I felt somewhat responsible!

In the course of this assessment I also asked IDRC staff what their views had been on their collaboration with the Chinese. One issue to come from these interviews was that when the collaboration had begun twenty years earlier the quality of Chinese social science research had been relatively weak. However over the twenty years it had improved a great deal.

Intellectual Property Issues

One of the science and technology issues that have caused a great deal of concern in China/ Western discussions has been the question of intellectual property. Many Western companies have felt that China has not honoured internationally agreed conventions on intellectual property and patent rights. I have two short experiences with this issue. The first took place in Shanghai during the IDRC review in 1994. The visiting team were visiting a Shanghai research institute working on the development of technologies for small and medium enterprises.

We were discussing the impact of the government science and technology reforms. The Director told us that the need to raise funds from industry to cover part of their total costs had made both their staff and clients aware of the monetary value of technology. One result had been the increase in moonlighting where members of their staff had spent time after work secretly passing on the research results developed in the Institute. It was this experience that had convinced the Director of the need to protect intellectual property rather than the complaints of foreign corporations!

My other experience was on a visit to China with members of a Commission set up by the UK Minister of International Development to explore how the poor could benefit from intellectual property legislation. As part of their work members of the Commission visited several countries to inquire about those countries experiences with this issue. I had been invited to join the team investigating China's experiences. In the discussion with the State Intellectual Property Organisation there seemed to be little interest in the issue the UK team were investigating. All we heard was the case for protecting intellectual property. It was as though we were representing the interests of British corporations. We tried to engage the Chinese team on a discussion on how intellectual property could also benefit the poor, but we had no success.

Conclusions

It is now 50 years since my first visit to China in 1964. Although I was impressed with the education system at that time and noted the Chinese objective of catching up

with the West in science and technology within 30 years. However I doubted that this goal would be achieved.

It was a shock to visit China again in 1981 and to note the huge difference in attitude between then and my previous visits. China had gone through its Cultural Revolution but it was much more open and I did not encounter the intense political propaganda that had pervaded all aspects of Chinese life in the sixties. Subsequent visits to China were always full of surprises. There was the growth of the "soft sciences" the name given by the Chinese to science and technology policy research. The tremendous growth in traffic in the cities leading to gridlock, the increase of scientific publications in Western scientific journals, the steady increase in the number of Chinese patents taken out in the United States. Every time I visited China I was unprepared for the changes that had taken place since my previous visit.

Most of my visits to China gave me an opportunity to explore a small part of the science and technology system. A few visits were broader in scope and enabled me to get an overview of the whole system at different points in time. The visits taken together tell a tale of great change in the growth of the science and technology and its mobilisation for economic growth.

The changes were not uniform across the whole of China. They tended to be concentrated in the Eastern corridor. I travelled by train in 2001 from Urumuchi in the far West to Beijing. What was striking was the similarity in the scenes of rural China to what we had seen on our train journeys in 1965. There was still limited mechanisation in agriculture, and factory chimneys still issued huge plumes of smoke.

The double-digit growth rates over several decades have made huge differences to the economic and social conditions of many Chinese, but not all have benefited. Many of the major technical changes that have occurred have emanated from Western and joint venture firms. The rate of domestic technological innovation has disappointed some Chinese policy makers and there is deep concern about the education system. It still focuses heavily on rote learning and the ability to pass exams and, and does not sufficiently reward creativity.

Nevertheless China is going through one of the great transformations in the history of the world and I am grateful to have been able to witness this transformation from close quarters. I would especially like to thank my many Chinese friends who have mentored me on this amazing journey. I would particularly like to acknowledge the contributions that Wu Ming Yu and Zhu LiLan have personally made to the Chinese transformation.

ANNEX

The following memorandum was prepared for Madam Zhu Li Lan as a contribution to the preparation of a Chinese strategy for international collaboration. It was first published by the Ministry of Science and Technology. It is now somewhat out of date but it summarises some of the debate about international collaboration that took place at the turn of the century.

MEMORANDUM

To: Madam Zhu Li Lan, Minister of Science and Technology

From: Fang Xin, Geoffrey Oldham, Peter Suttmeier, Wu Yi Kang, Xue Lan

Subject: **SOME SUGGESTED INITIATIVES ON INTERNATIONAL SCIENTIFIC AND TECHNOLOGICAL COLLABORATION**

In November 1998 you asked us to undertake investigations aimed at providing policy advice on two interrelated issues:

1. To what extent does China need a strategy for international collaboration in science and technology?
2. If needed, what would be some of the principal ingredients that might go into such a strategy?

In order to respond to your request we commissioned a number of background studies aimed at:

- A systematic appreciation and evaluation of the current state of China's international collaboration in science and technology, and
- An appreciation of the experiences of other countries and of the policy lessons that might be derived from those experiences.

An international workshop in Beijing on 17-19 January 2000 reviewed these studies, arrived at policy conclusions, and formulated a number of recommendations for your consideration. You asked that any recommendations we might make be specific and pragmatic and we hope that we responded adequately to this challenge.

THE NEED

On the first question as to whether China needs a strategy for international collaboration in S&T, the review leaves us in no doubt:

- Over the past decade, China has made enormous strides in building international collaborative linkages in many areas of science and technology. This has established a solid foundation. China, however, remains a modest contributor to the major global debates surrounding S&T. Indeed, China is completely absent from many of the key fora in which these debates occur. This situation is at striking variance with the importance of China in the world and the position that it will assume in the 21st century.

- Assuming a continuation of current trends, China will become the world's largest economy within the next two decades and one of the principal forces in

World trade. There are no guarantees, however, that present trends will continue and one of the key forces bearing on this is the speed and intensity of advances in S&T. What is most likely is that no country can expect to maintain its international comparative advantage unless it is able to keep fully apace with these advances. In the case of China, this will require a considerable intensification of effort towards international collaboration in S&T. This, in turn, will require an appropriate strategy.

- The Beijing workshop also concluded that a national strategy for international collaboration is required in order that China may confront both the promise of greater economic integration and the threat of a new era of protectionism. Clearly, the dominant economic characteristic at the turn of the millennium is the accelerating force of globalisation, leading to open markets and liberalised economies. There is, however, a second and conflicting trend towards protectionism and a retreat into economic nationalism. Recent events at the World Trade Organisation meeting in Seattle confirm a ground swell of grassroots opinion, particularly in the most industrially advanced countries, which wishes to reverse globalisation trends. What cannot be ruled out is that these forces will grow and will lead to a resurgence of barriers to trade and prohibitions on the export of technology. Another potential obstacle to greater collaboration is the possibility of increased political and military antagonisms. No country can risk everything on the assumption that the globalisation trend will continue

.

- The implication of these contradictory trends is that China requires strategies of S&T collaboration that are sufficiently robust to meet national development goals in the face of both opportunity and of externally induced shocks. A collaboration strategy, therefore, should seek to maximise the benefits that can be drawn from an open liberalised world economy, but at the same time should ensure that China continues to strengthen its indigenous scientific and technical capabilities, especially in those areas which are essential for economic, social and political security.

- Finally, the Beijing workshop concluded that there are aspects of an S&T strategy for international collaboration that can contribute significantly to China assuming its place at the table of leading nations.

SUGGESTED INGREDIENTS FOR INTERNATIONAL S&T COLLABORATION

The following are a set of initiatives and actions which China might take and which, taken together, would be consistent with the idea of a robust S&T collaboration strategy.

1. **Continue to expand the opportunities for Chinese collaboration with foreign entities in both science and technology.**
   At a national level China has signed many scientific collaboration agreements with foreign governments. This should be continued, although it should also be noted that many foreign governments are not enthusiastic about government-to-government collaboration in science. They believe that the most useful collaborations are those that are ‘bottom up’ and come from the

scientists. Therefore in addition to the formal governmental collaborations, China should encourage members of the scientific community to forge their own collaborative programmes with their overseas peers. All organisations which fund research should be encouraged to set aside some of these funds to finance the costs of international collaboration

2. **Ensure China participates in setting international standards and the 'rules of the game' that affect collaboration in science and technology.** At the present time standards and rules are set by international organisations only some of which China is a member. It is recommended that China review the different fields of science and technology in which international standards are important, identify the bodies which set the standards; and decide the steps which must be taken to ensure that China can participate in setting the rules and standards. For example, in the telecommunication field the important bodies are WTO, OECD, WIPO and ITU. China belongs to some of these bodies, is endeavouring to join the WTO, but is not a member of OECD. It is likely that over the next year or so important decisions will be made on e-commerce and electronic publications. China should be involved in making those decisions. There are also organisations that are useful for the exchange of ideas and information such as the Global Knowledge Partnerships where the World Bank provides the secretariat. China should aim to participate in these discussions. China's participation should be through well qualified representatives. It will be important that China gains the respect of the international community through its active and constructive contributions.

3. **China should become an observer at the OECD Science Policy Committee and the Global Science Forum.** One step that China could take immediately would be to apply for observer status in the above Committee and Forum at OECD. Russia, South Africa, Israel, and Slovakia are currently observers. They are able to participate in all the debates and discussions held by these bodies. It is likely that OECD would welcome Chinese participation. Membership would enable China to participate in the discussion on many of the global science issues from which China is excluded at present.

4. **Monitor the foreign investment in Chinese R&D.** There has been a growing investment by foreign corporations in R&D in China. Some companies have established their own R&D laboratories in China. Many more have placed R&D contracts with Chinese universities and research organisations. Our review of the pros and cons of these arrangements leads to the belief that at the moment the benefits exceed the disadvantages. However, there remains the possibility that if the trend continues then a sizeable proportion of the best Chinese scientific talent may end up working for foreign corporations. This may not matter if their work ultimately benefits the Chinese economy. We recommend that the Chinese government, through the Ministry of Science and Technology and other agencies, monitor this situation.

5. **Introduce measure to encourage the assimilation of foreign technology.** Foreign technology has played an important role in the modernisation of the Chinese economy. Technology transfer, however, is a complex process requiring considerable domestic investment if the technology is to be mastered or assimilated. There is some evidence that the resources to assimilate technology are not always committed by Chinese enterprises. This is short

sighted because assimilation and mastery are required if improvements are to be made to the technology and efficiency increased. It is also necessary for China's economic security. Hence, whenever possible, technology transfer agreements should include a clause which addresses this issue.

6. **Encourage international collaboration between clusters of SMEs.**
   The experience of Italy is developing clusters of SMEs has been very positive. Government has been able to assist by helping to blend modern, high technology with more traditional low technology activities. The Italian clusters are becoming more international in their scope, and there are opportunities for joint ventures between Chinese SMEs and those of other countries, especially Italy. Collaboration through international organisations such as APEC on this issue, should also be explored.

7. **Continue to strengthen the protection of intellectual property rights.**
   By most accounts the IPR regulations that China has put in place over the past decade is up to international standards and provides a good starting point for both domestic and international IPR protection. There is still a widespread foreign perception that the implementation of this legislation is weak. It is thought that the legislation is not widely understood in China, the laws are not always enforced, and penalties for breaking the law are not severe. This is the general perception although more informed opinion, both foreign and Chinese, suggests that the situation has improved over the past two years. We recommend that there be continued effort to enforce existing legislation rigorously, and that a publication be prepared of recent cases of international IPR disputes documenting how these disputes have been resolved. Such a publication may go some way to improving the international perception on the IPR issue. Chinese representatives in international negotiations on IPR issues should be highly qualified, and should play a constructive role in the negotiations.

Our next three suggestions are aimed at demonstrating that China has become a good global citizen and is taking its responsibilities very seriously.

8. **Contributing to China's standing in Big Science: An opportunity in Radio Astronomy.** China is already contributing to big scientific fields such as high energy physics, optical astronomy, and radio astronomy. All of these areas require expensive equipment that often exceeds the resources available from any single country. As a result there are a growing number of big science facilities which are international in their funding and management. Chinese scientists already participate in a limited way in some of these schemes.

   If China is to be a major player in international big science it will be desirable for it to develop some of its own facilities that other scientists are keen to use. One such field might be radio astronomy. European scientists are impressed by a new approach that is being developed in China of building radio telescopes in basins in the Karst topography found especially in Guijhou Province. Using these naturally formed amphitheatres it is possible to construct radio telescopes for a fraction of the cost of conventional telescopes. If the current relatively small-scale telescopes are successful then a much larger telescope built in China but with international funding would be a

possibility. We recommend that the Chinese Government monitor these developments, and if appropriate assist in making a Chinese bid to host a new international radio telescope. Other topics may also prove to be ripe for major Chinese initiatives.

9. **Establish a new institution to fund research in lesser developed countries.** China has benefited a good deal over the past twenty years from international support for Chinese research and development. The time seems appropriate to demonstrate that China can also help build research capacity and solve problems facing the lesser developed countries. A part of this support will require funding for research in these countries, and a part will be to build research partnerships between Chinese researchers and those from other countries.

   It will be necessary, as a first step, for China to learn the lessons from foreign donors that have funded research in China. The IDRC/China assessment project has made a good start. The lessons from other collaborative programmes should also be learned. The possibility of working jointly with such organisations as IDRC and the proposed European Foundation for Research for Development to support research in developing countries could also be explored.

10 **Initiate a major research programme aimed at solving an important global problem.** This might be a Chinese initiative that aims to attract other partners and funders. It should have relevance to China, but to gain international recognition it should have wider, even global, significance. Possible topics might be environmental topics related to climate change, or health-related topics. We recommend that a review be made of possible topics for such an initiative and funds be allocated for its implementation.

These ten suggestions, if implemented, would be important ingredients in a Chinese strategy for international science and technology collaboration. They would help ensure China maximises its benefits from collaboration and minimises any harmful effects. We commend them to you for your consideration and possible action.