China–USA Governmental Cooperation in Science and Technology

Toufiq A. Siddiqi, Jin Xiaoming, and Shi Minghao
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by
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The United States of America and the People's Republic of China normalized diplomatic relations in 1979. Almost simultaneously, they signed an agreement to cooperate in science and technology. The first high-level delegation from China to visit the United States after the normalization of relations was a delegation of scientists. Five protocols and two memoranda of understanding were signed during 1979. During the past seven years the number of such agreements increased to 27. (The U.S. count is 29. The Chinese do not consider the memoranda of understanding dealing with Landsat, and with Basic Biomedical Sciences as equivalents of protocols.) The number of individual programs has also increased to more than 500, and the number of participating scientists now exceeds 5,000. For both countries, the exchanges represent the largest program in international cooperation in science and technology. Most of the major ministries in China and their counterparts in the United States are now involved in such exchanges.

It is timely to examine how well the programs have worked, and the extent to which the goals and aspirations of the various parties have been realized. An assessment of the first two years of the program was undertaken by Richard P. Suttmeier (1981), under a contract from the U.S. Department of State. To the best of our knowledge, no subsequent study of a similar nature has been undertaken. A great deal of valuable information is included in the reports presented at the biannual meetings of the Joint Commission, but the reports are designed to meet different needs.

The authors of this report have attempted to provide at least a partial study of the present status of cooperation between the United States and China in science and technology. The authors interviewed persons who had been closely involved in implementing the protocols, either as managers or as scientists, in more than 40 organizations in China and the United States. Given constraints of resources, as well as time, it was not
possible to interview all the people from organizations that have participated in the cooperative programs. Thus this report should be seen as illustrative of the achievements, problems, and current status of the cooperation, rather than a comprehensive one covering all aspects of all the agreements.

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SUMMARY OF FINDINGS AND RECOMMENDATIONS

Findings

1. In the seven years since the umbrella agreement for cooperation between the People's Republic of China and the United States of America was signed, more than 500 new projects have been initiated, and the number of persons exchanged is in the thousands. For both countries, the programs represent the largest such arrangement with any country. In qualitative as well as quantitative terms, the cooperation between China and the United States in science and technology has been a success.

2. The signing or implementation of some protocols had been delayed due to a number of factors such as bureaucratic red tape on both sides, differing views on patents and copyright protection, and inadequate funding. Although some of these difficulties still remain, considerable progress has been made as the two sides became better acquainted and understood the differing operating procedures in the two countries.

3. The cooperative program has enjoyed the support of the highest levels of government in both countries. China set up a special fund for technical cooperation with the United States. Due to budgetary constraints in the United States, the high-level support was not accompanied by any additional funds to the U.S. government agencies for implementing the cooperative programs with China. The willingness and ability of the agencies to support these activities from domestic budgets is an indication that the projects could be justified on sound scientific grounds, as well as contributing to a strengthening of political and cultural ties between the two countries.

4. Both countries have benefited from the cooperative programs, sometimes in different ways. The benefits to China have primarily been in the form of enhanced training
opportunities for its scientists and engineers, as well as access to advanced equipment and technology. Their counterparts from the United States have in turn been able to carry out research in some unique areas previously closed to foreign nationals, and have received access to historical records dating back several decades (sometimes centuries), dealing with natural phenomena such as earthquakes and floods. In specific areas such as health and agriculture, they have also benefited from state-of-the-art research being undertaken in China.

5. The "umbrella agreement" on cooperation in science and technology continues to be useful in facilitating the working out of individual agreements. In a few cases, some of the agencies find their funding arrangements (i.e., "The receiving side pays," discussed in item 7) too restrictive and would prefer greater flexibility in working out their own arrangements.

6. The Joint Commission consisting of the principal science advisers and agency heads continues to perform a very useful function. As the programs have matured, the view is being expressed that the meetings of the Commission should be held every other year and become less ceremonial and more forward-looking and comprehensive, covering the entire USA-PRC relationship.

7. China prefers to continue with the original funding arrangement based on "The receiving side pays." Under this arrangement, the country sending a group picks up the airfares, whereas the country being visited picks up the costs of rooms, meals, local transportation, etc. A number of U.S. organizations would like, due to budgetary constraints, to operate under a "Sending side pays all costs" principle (now called "Technical assistance by the U.S. side"). A shortage of foreign currency makes this an undesirable option for the Chinese side. A number of ad hoc arrangements outside the official protocols have been negotiated to cope with this situation.
8. As part of its decentralization policy, China is encouraging organizations throughout the country to deal directly with U.S. institutions and giving them greater flexibility to work out their arrangements. Thus the total number of cooperative projects between the two countries now greatly exceeds those covered by the official protocols.

Recommendations

During our meetings with the scientists and program managers in China and the United States, a number of suggestions were made and discussed to facilitate further the implementation of the programs. We have consolidated these, and added a few recommendations of our own, for consideration by the Joint Commission and other organizations involved in the cooperative programs.

1. A modest amount of funding be made available to U.S. departments and agencies interested in cooperative programs with China, but who have not been able to find such funding out of their regular budgets. This would be in the form of "seed money" to initiate programs, with the expectation that as sound scientific and technical projects are developed, funds would be requested as part of the regular budgets.

2. It may be timely to change the nature of the meetings of the Joint Commission, focusing more on scientific and technological issues of global importance in which China and the United States could cooperate.

3. Although a great deal of progress has been made, some projects still suffer from delays due to export controls caused by differing interpretations among agencies about what might be exported to China. While maintaining the legitimate security interests of the United States, it may still be possible to
expedite procedures further (e.g., by maintaining a list of the type of equipment previously approved, as well as equipment whose export was disapproved). Persons responsible for such decisions in different agencies might meet every few months to arrive at an agreed interpretation of current policies.

4. The shortage of patent and copyright lawyers in China is a major factor in delays in the signing and implementation of several protocols. It would be desirable to organize a few seminars in the country to clarify the reasons for U.S. concern with intellectual property, and the implications of various approaches that have been adopted around the world to deal with this situation.

5. The level of funding provided by China for a large number of students enrolled in degree programs in U.S. universities continues to be inadequate and places a considerable burden on the students and host institutions. If the major difficulty is shortage of foreign currency, it would be preferable to send fewer students and provide them with stipends equal to those provided by other developing countries.

6. Whereas visiting groups from China are generally expected to bring their own interpreters (NASA is one of the few U.S. organizations that provides interpreters for visiting groups from China), visitors from the United States to China expect the Chinese side to provide interpreters during their visits. It would be desirable for several reasons if visiting U.S. teams would take at least one interpreter with them. Not only would this be more equitable and reduce the burden on the host organizations, but if followed in exchanges with other countries as well, it could also provide a much-needed boost to the study of foreign languages in the United States.

7. In some cases, visiting teams have arrived without the hosts having sufficient information about the current research
interests of the individual team members. More effective use could be made of visits if details about the major objectives of the visits, present areas of research, and recent biodata of the visiting group were made available at least a month or two in advance.

8. Delays in communication still plague some protocols. These are not due to hardware problems, since adequate telex facilities and postal services are available. It would be preferable to communicate more frequently with partial answers and status reports, rather than wait several months for complete replies. To facilitate communication, greater use could also be made of the offices of the science attaches at the embassies of each country in the other.

9. Greater flexibility needs to be built into the administrative arrangements, so that unsuccessful projects can be quickly terminated and new projects desired by both sides rapidly initiated. There seems to be no easy way for doing these at the moment.

10. A number of U.S. scientists would like to undertake field research in China, but have inadequate funds for such research. The National Science Foundation of China might be helpful as a mechanism for U.S. scientists to get funding for fieldwork in China on China-USA cooperative projects. A peer-review system could be used to select proposals for funding. In return, the U.S. National Science Foundation or another designated organization could similarly fund field research for selected Chinese scientists in the United States.

11. Whereas U.S.-based insurance companies are usually able to provide medical coverage to U.S. scholars and scientists visiting China, similar coverage is not available to Chinese scientists visiting the United States. The different health insurance system in China, along with a shortage of foreign
currency at present, would make it considerably easier if one or more U.S. agencies could arrange such coverage.

12. During the early years of the cooperative programs, it was essential to establish institutional linkages and for the scientists and administrators in the different organizations to get to know one another. Now that this goal has been largely achieved, it may be more productive to have visits by fewer groups and to emphasize the quality of programs, visits of longer duration, and in-depth scientific projects.

13. More emphasis could be given to joint research projects, rather than to short visits. About one-half of the total funding available in each country for the collaborative program may be allocated to research projects, with the remainder for shorter visits and joint seminars. Also, given the funding constraints, it may be advisable to have a smaller number of projects and make more resources available to each country, rather than have a large number of inadequately supported projects.
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role for our visit to the Argonne National Laboratory.

Our sincere thanks go to all the persons previously named, as well as to all those (see next section) who agreed to meet with us and share their knowledge of the status of cooperation in science and technology between the United States and China. We have tried to take into consideration the views of those persons we interviewed in preparing this report. However, the views and conclusions reached in the report are solely those of the present authors and do not necessarily reflect those of either the persons interviewed or the organizations with which the authors are associated.
LIST OF PERSONS INTERVIEWED

The following persons were interviewed in China and the United States to seek information and views concerning the achievements, difficulties, and the present status of the official cooperative program:

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INTRODUCTION

Historical Background

Exchanges in science and technology between China and the United States date back to the early days of this century. Up to 1950, there had been many academic exchanges between the scientists of the two countries. Such relations ceased during the years of mutual suspicion, lasting until the historic visit of President Nixon to China in 1972.

The initial exchanges during the early 1970s were mainly through nongovernmental channels such as the China Association for Science and Technology and the Committee on Scholarly Communications with the People's Republic of China. Although the scope of these exchanges, as well as the number of persons involved, was limited, these early exchanges laid a solid foundation for future cooperation. Some of these exchanges led to the signing of Memoranda of Understanding, such as those on the Exchange of Scholars and Students, on Agriculture, and on Space Technology. These were subsumed under the umbrella agreement signed in 1979.

Immediately after the establishment of diplomatic relations between China and the United States, the "Agreement on Co-operation in Science and Technology" was signed on January 31, 1979, by Vice-Premier Deng Xiaoping and President Carter during the Vice-Premier's visit to the United States. This accord has served as the umbrella under which a large number of protocols have been signed, covering a broad range of scientific areas, including space technology, high-energy physics, environmental protection, earthquake studies, nuclear safety, transportation, and statistics. (The full list of the active agreements, together with the major organizations involved, is given in the Appendix.)

Within three years of the signing of the umbrella agreement, the number of protocols had tripled. During this period, the counterpart organizations in both countries concentrated on
working out cooperative programs and project implementation plans. Thus working-level meetings and visits of a general nature comprised about two-thirds of the exchanges during this period. The proportion of such visits decreased as research programs began to be implemented and had declined to 39 percent of all visits by 1983. In recent years, the emphasis has been on in-depth research visits and on academic symposia.

China and the United States, pleased with the progress made in science and technological cooperation under the umbrella agreement, extended it for another similar period. The renewal of the agreement was signed by SSTC Vice-Chairman Mr. Zhao Dongwan and the President's Science Adviser, Dr. George Keyworth, during the visit of Premier Zhao Ziyang to the United States in January 1984. The number of bilateral agreements (protocols and memoranda of understanding) between PRC and U.S. government organizations has reached 27 (or 29, depending on what is included in the official count), covering a multitude of scientific and technical disciplines, and have resulted in more than 500 cooperative undertakings involving almost every major ministry, department, or agency in the two countries.

Goals of the Program

China and the United States had a number of common objectives in signing the cooperative agreement in science and technology. The importance of each objective to the two countries would, of course, be expected to differ. The overall goals of the cooperation could be summarized as follows:

- Promoting the overall bilateral relationship between China and the United States,
- Advancing scientific and technological knowledge,
- Promoting trade and commercial interests,
- Bringing benefits to domestic research and development capabilities, and
• Enriching the research experience of individual scientists.

Implementation of Protocols

The conditions that led to the current level of exchanges and cooperation were rather unique and are therefore worth noting. The umbrella agreement on cooperation in science and technology immediately followed the normalization of diplomatic relations between the two countries. Both governments assigned a high priority to developing closer relations and regarded the cooperation in science and technology as an important manifestation of this relationship. Individual ministries, departments, and agencies received encouragement from the highest levels of government to develop cooperative programs.

It is important to keep in mind that, on the U.S. side, the high-level support was not accompanied by any additional funding that was specifically earmarked for the cooperative programs with China. Thus the individual departments and agencies had to find funding for such activities from their domestic budgets. The projects thus have had to be justified on scientific grounds, as well as on political and cultural benefits.

On the Chinese side, there has always been guaranteed funding for cooperative science and technology activities with foreign countries, including the United States. Funding for such activities is allocated by the PRC Ministry of Finance directly to the individual ministries. Thus, when a cooperative project has been agreed upon, funds can be immediately allocated to the project. With the attention and support of the highest levels of the Chinese government, each ministry has attached high priority to cooperative projects with the United States.

In addition, China and the United States have very different social and economic systems and levels of scientific and technological development. Despite these differences, the cooperative agreements have expanded to become the largest of
such programs in both countries. The high level of cooperation is a testimony to the determination of both sides to make it succeed.

The extent of the cooperative activities that have taken place has varied considerably from one protocol to another. Some of the accords date from 1979, and 12 protocols have been renewed so far. Others were signed as recently as December 1986. In a few cases, concerns related to patents and the protection of intellectual property held up the signing or implementation of the protocols. In others, although the protocol was signed, reductions in the budget of a department or agency made it difficult to find adequate funding for the cooperative programs. Similarly, difficulties associated with access to sites, absence of participation by private industry, and lack of understanding of each other's needs delayed the implementation of some protocols.

Events beyond the control of the cooperating organizations have sometimes also been critical in affecting the pace of implementation. For example, the unfortunate accident to the U.S. space shuttle Challenger has significantly delayed the conclusion of the new protocol on space science and technology and on plans to include a Chinese astronaut on one of the missions.

The more active and productive accords include those dealing with the exchange of scholars and students, basic sciences, agriculture, atmospheric sciences, environmental protection, high-energy physics, industrial science and technology management, marine and fishery sciences, medicine and public health, and seismology. In each of these areas, a great deal of exchange of expertise and information has taken place, with scientific and educational results beneficial to both countries. In some areas such as atmospheric sciences, space technology, high-energy physics, and marine and fishery sciences, opportunities have been provided to U.S. industry to explore commercial markets in China. In turn, China has had the opportunity to train many of its scientists and engineers in
fields it deems to be of high priority for the future. (Examples of some of the very successful projects undertaken are listed in the section on "Achievements.")

The most recent protocols to be signed are those dealing with railway science and technology, and with the conservation of nature. Interest has also been expressed in exploring the possibility of signing new protocols dealing with biotechnology, microelectronics, mining and metallurgy, and labor statistics.

Role of the Joint Commission

The umbrella agreement on science and technology provides for a PRC-USA Joint Commission on Scientific and Technological Cooperation. The cochairmen of the commission are (1) the Chairman of the State Science and Technology Commission of China, and (2) the Science Adviser to the President of the United States, who is usually also the Director of the Office of Science and Technology Policy. During the early years of the agreement, the Joint Commission met every year. As both sides became more familiar with the arrangements, it was considered adequate to meet every two years. Four meetings of the Joint Commission have been held so far, with the fifth meeting held in June 1987 in Beijing.

The persons interviewed during this study were generally of the opinion that the Commission still served a very useful purpose. It serves as an expression of very high-level interest on both sides of continuing with the collaboration. Further, it provides an opportunity for discussing important issues of mutual concern and for settling at the policymaker level any problems that may have arisen in the implementation of the cooperative programs. It also provides a forum for sharing information and experience regarding the types of arrangements that have been made and those that have worked better than others.

Several persons who had participated in the work of the Joint Commission expressed the view that the meetings of the
Joint Commission were too long on ceremony and too short on substance. While it would be inappropriate to discuss working-level problems in detail at these meetings, it might be advantageous to spend a part of the meeting looking at major systemic and global issues, where scientific and technical cooperation between China and the United States could make an important contribution. These could be sessions oriented toward the future, where topics not necessarily included in the present agreements could also be discussed.

The reports of the Joint Commission show a progressive increase in size. As more protocols are added and programs increase, preparing the reports could become a major undertaking by itself, requiring a substantial amount of staff time on both sides. Much information is provided in the reports of committees from both countries dealing with individual protocols. Perhaps the report of the Joint Commission could simply refer to these and primarily address broad policy issues and major achievements.

During the early years of the agreement, the Joint Commission, perhaps out of necessity, had to be involved in the details of individual projects. It may now be timely for this high-powered group to expand the scope of its meetings and explore new challenges and directions.

ACHIEVEMENTS

Exchange of Scholars and Students

The People's Republic of China and the United States of America resumed educational and scientific exchanges during the mid-1970s. Following the normalization of Sino-American diplomatic relations in 1979, the exchange of scholars, students, and scientists has grown rapidly and constitutes one of the largest and most successful exchange programs between any two nations. Approximately 1,200 students and scholars from the
People's Republic of China have been sent to the United States each year since 1979 through official channels. A much larger number (about 19,000) have come through ad hoc arrangements.

Currently, about 9,000 long-term students from the PRC are studying in the United States under exchange visas. In addition, about 8,000 are studying on a self-supporting basis. According to estimates by official Chinese sources, about 6,000 short-term students and scholars from the United States have visited China to undertake research and study from 1979 to 1985. About two-thirds of those who have conducted research have done so in the fields of social sciences and humanities.

A detailed study on *A Relationship Restored: Trends in U.S.-China Educational Exchanges, 1978-1984* by Lampton et al. (1986) has recently been published by the Committee on Scholarly Communication with the People's Republic of China. The study provides a wealth of information on a number of subjects including fields of study by students, number of faculty members sent abroad by different Chinese universities, and university-to-university exchanges.

The rapid initial increase and the subsequent leveling-off in the number of officially sponsored scholars and students from China in the United States are shown in Figure 1.

Of the numbers shown in the figure, roughly two-thirds are students. According to the Institute of International Education (IIE 1986), the number of students from the PRC studying in the United States increased 38.4 percent in 1985-86 from the previous year, reaching a total of 13,980. To put this number in some perspective, the corresponding number of students from Malaysia and Taiwan exceeded 23,000 from each country, and from South Korea 18,000. The number of students from China was also exceeded by those from India, Canada, and Iran. During the same period, the number of students from Hong Kong was 10,710.

The scope of the program for Chinese students in the United States has changed during the past few years. Initially, mid-career persons were being sent to U.S. universities for just one year. This was followed by a period during which younger
students came for a full degree program. The academic training of the incoming students has also improved, and the American universities are generally quite pleased with the quality of the students coming from China, particularly those sponsored by the Chinese government. Although the Education Commission spends about 400 million yuan every year on Chinese students going abroad (about 60 percent of these go to the United States), the level of funding available to the students from China in the United States continues to be a source of concern, and is discussed in the section titled "Problem Areas: Funding."

The student program has recently been re-examined, arising from questions about the extent to which the training of students had been meeting China's needs and conditions, and whether the returning students were being put to good use. Once again the
policy is shifting to emphasize the needs of the country and its drive to modernization. A major goal would be that the returning students apply what they have learned abroad to the modernization of China. This change in policy is expected to result in fewer younger students pursuing degree programs, while the number of older, mid-career professionals and scholars going abroad is expected to increase.

Despite the change in the type of students going abroad for training, the total number of scholars and students sent abroad is expected to continue growing. A larger proportion of those going abroad for study or research will come from research institutes rather than university degree programs. This will help in meeting the needs of the institutes. At the same time, China will attempt to train most of its graduate students in its own universities.

Cooperation over the longer term requires that both countries benefit from the arrangements. This is clearly being achieved in the exchange of scholars and students. To achieve its goals of modernization, China needs large numbers of talented and well-trained individuals who are familiar with state-of-the-art science and technology (China SSTC 1985). About two-thirds of the Chinese scholars and students who have come to the United States since 1979 have worked in the fields of engineering, physical sciences, computer sciences, mathematics, life sciences, and health. Those who have already returned to China have made important contributions to the improvement of educational programs and research facilities in their home institutions. Further, the contacts they made during their stay in the United States have resulted in the establishment of several interinstitutional agreements between the United States and Chinese organizations.

The main benefits to U.S. scientists and scholars have been in the form of gaining "access to natural, social, and historical phenomena of China" (Simon 1986). Examples of these include access to some sites with unique geological characteristics, historical information on earthquakes, and the study of
biological predators for particular pests that also occur in the United States. Many U.S. universities have also benefited from having high-quality Chinese students in their degree programs.

An example of a highly innovative and successful cooperative educational program is provided by the National Center for Industrial Science and Technology Management Development at Dalian, China (Figure 2). This Center was jointly planned and established in 1980 with the aim of helping China upgrade its managerial skills and management practices. Through a variety of programs, the Center has so far trained more than 1,500 participants, including directors and managers of industrial enterprises, senior or middle-level managers from technologically oriented departments, and instructors in management programs at universities and other academic institutions. The Center now also offers a three-year Young Executive Program, which is operated for the Center by the State University of New York (SUNY) at Buffalo and leads to a Master's degree in Business Administration from that university. The first such group of 38 students received M.B.A. degrees in December 1986.

The students at Dalian spend the last semester of the M.B.A. program at SUNY-Buffalo, where they complete a thesis and work as interns for four weeks in a U.S. company. The arrangement is expected to be beneficial to both sides. The Chinese students gain from learning modern management techniques first-hand. The United States is expected to benefit through the contacts made and the familiarity the Chinese acquire with equipment manufactured in the United States.

Joint Research

China and the United States have signed about 30 agreements so far, providing for joint research in almost every field. In an overview such as this, it would be impossible for us to list the achievements in every field; thus, the interested reader is referred to the Reports of the Joint Commission (Appendix C) for details.
Figure 2. A view of the National Center at Dalian, China.
The interest in joint research is largest, and the benefits for both sides easier to document, when the research being undertaken in selective fields is at comparable levels in both countries. Examples cited during our meeting include (1) earthquake studies, (2) biological control of pests, (3) forest pathology, (4) germ plasm, (5) medicine and public health, (6) air pollution and epidemiology, and (7) marine sciences and fisheries. Some of these topics are briefly discussed in the following paragraphs.

Cooperation in agriculture actually started in 1974 and was placed under the umbrella agreement in 1979. More than 100 teams--exceeding 400 persons from government, academic institutions, and the private sector--have participated in the exchanges since 1980. The exchanges have covered almost all aspects of agriculture. The U.S. side has benefited through acquiring from China more than 40 species of selected predators that prey on gypsy moths and other pests. Experiments with these are being undertaken in the United States with mixed results. China has a germ plasm bank with more than 700,000 species that attracts the interest of scientists all over the world. U.S. scientists were able to bring back from China 15 species of wild soybeans and 50 soybean species altogether.

China has benefited from improvements in some species of cotton and peanuts as a result of cooperation with the United States.

The U.S. Department of Agriculture has cooperative research programs with 28 countries. The four in which U.S. scientists show the greatest interest are those with Australia, China, West Germany, and the USSR. The quality of the proposals received by the department has increased greatly in recent years.

The protocol on atmospheric science and technology was signed in 1979, and renewed in 1984 for another five years. Projects undertaken jointly include those dealing with monsoons, mountain meteorology, and agriculture-related factors. China has carried out large-scale and comprehensive measurements in the
meteorology of the Tibetan plateau since 1979 and recorded a wealth of relevant data. Some of these were made available to U.S. scientists, who were also provided with opportunities to collect additional data themselves in that area. Under the training part of the protocol, a number of Chinese meteorologists were sent for study or training in the United States in fields such as satellite data processing, development of operational agroclimatic impact assessment, quality control of meteorological data, and archiving of meteorological records.

In some fields, joint research requires earlier collaboration in building the tools for research. One of the most successful undertakings in the China-USA collaboration has been the construction of an electron-positron collider (Figure 3) in Beijing, where teams from the two countries have been working closely. The protocol in high-energy physics, which has enjoyed particular support at high levels of the Chinese government, was one of the first to be signed between the two countries. One reason for this is the expectation that, in addition to high-energy physics itself, there may be valuable spinoffs for the scientific equipment and precision tools industries in China.

The earthquake studies protocol was signed in 1980 and renewed in 1985. The eight annexes to the protocol deal with premonitory phenomena, intraplate active faults, deep crust structures, rock mechanics, earthquake engineering and hazards mitigation, long period seismographic studies, and exchanges of data and films of seismographs. During the past six years, more than 35 joint projects have been conducted by the scientists from the two countries. During the six years the protocol has been in operation, more than 200 U.S. scientists have visited China, and about 170 Chinese scientists have visited the United States.

China has a high incidence of damaging earthquakes and has consequently carried out an extensive and successful earthquake program for more than 20 years. A modern data base is being set up to supplement the unequaled catalog of earthquakes for the past 2,000 years. Under the joint research program, U.S.
Figure 3. Construction of the Beijing electron-positron collider.
scientists were the first to obtain access to seismically active regions such as the Yunnan Province and northeast China, where scientists from a number of other countries were also keen to enter. They were also able to receive access to historical records (e.g., Zhang et al. 1986). In turn, Chinese scientists have benefited from access to modern equipment and experimental techniques developed in the West. A network for predicting and monitoring earthquakes has been set up in western Yunnan and northeast China with the cooperation of Chinese and American scientists. This allows both sides to test and evaluate hypotheses and equipment in geographical areas where damaging earthquakes are frequent.

Scientists from both countries also designed and are completing work on the development of the China Digital Seismic Network, a 9-station, state-of-the-art system (Figure 4). Installation of the prototype station in Beijing was completed in July 1986, and tests are now being conducted. The entire system could be put into operation by the end of 1987. Data collected by the network will be incorporated into the publicly distributed World Day Tape and will provide an outstanding opportunity to increase global knowledge of the causes and nature of earthquakes in east Asia.

Joint research in earthquake studies has already resulted in important additions to knowledge concerning the fundamental characteristics of earthquakes and new insights into mitigating earthquake hazards. Some of the research results were presented by a joint team of Chinese and U.S. scientists at the 1985 fall meeting of the American Geophysical Union. The papers were presented at the sessions on tectonophysics and on seismology, and some have been published in prominent scientific journals (e.g., Kan et al. 1986). Other results were presented at the China-United States Symposium on Crustal Deformation and Earthquakes held at Wuhan in October 1985. The proceedings of the symposium have been published. The good field experience and
Figure 4. Location of the stations in China's Digital Seismic Network.
practical knowledge of data collection provided by the Chinese scientists, and the good theoretical background and equipment contributed by American scientists combined to produce much more valuable results than either group could have obtained on its own.

The protocol on the Science and Technology of Medicine and Public Health was signed in 1979 and extended in 1984 and 1986. Cooperation under the protocol has taken place in ten fields: (1) infectious and parasitic diseases, (2) cardiovascular diseases, (3) cancer, (4) public health and health services, (5) medical information science, (6) immunology, (7) human genetics, (8) reproductive physiology and family planning techniques, (9) mental health, (10) food and drugs, including pharmacology.

Joint research in many of these fields has proceeded successfully, with benefits accruing to both countries. Examples include the development of a vaccine against Hepatitis B, and an epidemiological study of cardiovascular disease in selected populations in China. An efficacy trial in newborn infants whose mothers were persistently infected with Hepatitis B virus (HBV) was conducted from 1982 to 1984. More than 200 cases were observed and studied within three years. The results suggest that a potent Hepatitis B vaccine, if administered within hours of birth, can prevent most maternal-fetal transmission of chronic HBV infection.

As for the cardiovascular disease, a 5-year epidemiological study was carried out in urban and rural populations (12,000 persons in and around Beijing and Guangzhou). Preliminary data show a higher rate of hypertension prevalent in the North than in the South, and a higher dietary intake of salt in the North than in the South. The data from China have been compared with the data from the United States, enabling a unique comparison between countries that differ greatly in cultural, genetic, and socioeconomic characteristics. Research results are now being published jointly in international journals.
The marine and fishery sciences protocol was signed in 1979, covering 21 research topics in the broad fields of oceanography and fisheries. The cooperation on fisheries has barely begun, but the oceanography field is one in which the Chinese have made a great deal of resources available, including research vessels, crews, scientists, and finances. (It is estimated that the Chinese spent 24 million yuan on eight cruises.) The U.S. contribution has been mainly in the form of scientists and equipment. Much important research was undertaken in sedimentation dynamics, air-sea atmospheric interactions, and on El Niño. Despite some problems with a winch on the TOGA missions, the scientists from both countries worked very well as a team and were able to gather data of global importance.

The aeronautical sciences provide another good example of benefits to both sides. In its research, NASA has been using strain gauges built in Beijing in its research, because no other country has manufactured a gauge as good as China's. In astronomy, U.S. scientists have been collaborating with counterparts at the Shanghai Observatory on long-baseline interferometry. Using triangulation on a quasar, they hope to get an accurate measurement of the wobble in the Earth's orbit. In the new field of space geodynamics, NASA scientists have been collaborating with counterparts at the Shanghai Observatory on measurements of the movement of tectonic plates through satellite laser ranging.

Information Exchange

The exchange of information has been included as a major component in almost every protocol, and a great deal of such exchange has already taken place. Both countries have benefited from this activity, although the benefits to each side might not have been equal in each protocol. The United States is clearly the world leader in many fields of science and technology, and China has benefited considerably from increased access to them.
At the same time, China has very valuable and extensive historical records, such as on earthquakes and climate, that are of practical importance to the United States. Scientists from the United States have benefited from their ability to make use of this information.

A widespread impression in the United States is that, in the exchange of scientific and technical information with the developing countries, the United States gains little. While this may be the case in exchanges with a number of other developing countries, the situation with respect to U.S.-China exchanges is generally different. Most of the programs have been designed to cover fields in which both sides benefit. A few examples are cited here.

In the field of meteorology, Chinese scientists have shared with their American colleagues "the drought and flood records of the last 500 years," based on the analysis of the historical data. In turn, they have learned from their U.S. colleagues research techniques dealing with sedimentary and tree-ring records, which are of importance for palaeoclimatic study.

In the field of public health, an atlas of cancer distribution in China was edited by the Chinese medical scientists who carried out a large-scale investigation involving 2.4 billion events (sometimes there were several events for the same person). These data were made available to the U.S. scientists. The different cancers found in China are regionally localized, providing researchers an opportunity to study carcinogenic factors present in some localities and absent in others. The geographic pattern of cancer mortality greatly aided subsequent epidemiological studies, involving a comparison of the geographic patterns of cancer in the United States and China. In turn, researchers from China received advanced training and access to state-of-the-art instrumentation and techniques developed in the United States.

The program on air-sea interaction studies in the Tropical Western Pacific Ocean between China and the United States is another example of an exchange of information that has benefited
both countries. The sharing of oceanographic and climatic data will contribute to the study of climate variation and abnormal meteorological phenomena.

In the field of earthquake studies, China's State Seismological Bureau has sent more than 40,000 microfilms of data to the United States. In return, they have received data on seismicity in all parts of the world that were recorded in the United States.

The Institute of Scientific and Technical Information of China (ISTIC) works closely with the National Technical Information Service (NTIS) of the United States. China has imported a number of books and reports from NTIS at the North American list prices, including two copies of all documents that have not been published in the normal fashion. Expenditures for such purchases have averaged $450,000 annually. Longer-term benefits may accrue to U.S. manufacturers who are mentioned in these publications, as the Chinese scientists acquire greater familiarity with them and subsequently place orders for their products.

ISTIC has also acted on behalf of the United States to obtain a number of Chinese periodicals and technical reports, so that they could be included in the NTIS data base. About 100 technical reports have been received so far, covering 25 topics. The titles and abstracts of these are now available in English, facilitating potential use by American users. With respect to material published in Chinese, many Americans felt that the United States would receive greater benefits by having a much larger number of English language abstracts of papers than a few fully translated papers.

ISTIC and NTIS have also jointly sponsored a Conference on Consumer Goods Industries. The Conference, held in May 1986, brought together manufacturers in China and the United States, and provided an excellent opportunity for the exchange of information, as well as possible collaboration in manufacturing.

NTIS has also proposed that a U.S. reading room be established at the new ISTIC headquarters. The reading room,
with an intern from the United States, would be supported by an American private industry. It was proposed that the Chinese side provide accommodation for the intern.

**PROBLEM AREAS**

**Funding**

From the time of the initial signing of the umbrella agreement in 1979, U.S. administrations have actively encouraged government departments and agencies to undertake cooperative programs with China. At the same time, they were also advised that funding of such activities was to be undertaken on a mutual reciprocity basis. The approach to funding visits by scientists and administrators within the protocols has been that each country pays the airfares for its nationals traveling to the other country, and the host country picks up the cost of hotels, meals, and transportation within the country (this arrangement has come to be known as "receiving side pays"). Where this was not possible, ad hoc arrangements have been worked out, frequently outside the protocols. An example of this would be "the benefiting side pays" type of arrangement, which is now called "technical assistance" by the United States. Under this type of arrangement, a technical service is provided by the United States, but the costs are covered by China.

In most cases, departments and agencies of the U.S. government have not been given any additional funds specifically earmarked for cooperative activities with China. Thus the funds must be taken out of the domestic budgets of the departments and need to be justified on the usual scientific or technological grounds. The extent to which this can be done varies greatly from one organization to another and is a major reason for the differences in the extent to which the individual protocols have been implemented.

In a few cases, like the U.S. Bureau of Mines, it has been
particularly difficult to find funds from the domestic budget, since the mission of the agency is limited to the United States. The absence of a protocol, however, has not prevented persons from China's Ministry of Coal Industry from visiting the Bureau of Mines, but both sides would like to find a way to bring the cooperation under the umbrella agreement.

The U.S. Department of Transportation is also a domestic agency with no funds earmarked for international cooperative programs. When the broad agreement with the Ministry of Communications was signed in 1983, and several specific annexes signed subsequently, the Department of Transportation clearly stated that implementation of programs could not be effected under the "receiving side pays" principle.

In contrast, the U.S. Department of Agriculture, for example, continues to send more than a dozen teams from the United States to China each year, and to receive an approximately equal number of persons from China. The department, however, has altered the way in which such trips are funded, by requiring universities and the private sector organizations to which team members may belong, to contribute a substantial portion of the costs of such visits. The proceedings of the 1984 Symposium on Soybeans, jointly organized by the U.S. Department of Agriculture and the Chinese Ministry of Agriculture, Animal Husbandry, and Fisheries, were published with the financial support of several U.S. companies (Du Pont, Monsanto, Pecten Chemicals, Pioneer, and Potash/Phosphate Institute).

Due to the large number of organizations involved, an accurate number for the total expenditure on science and technology cooperation between China and the United States is not available. However, about $10-20 million dollars per year is spent by the U.S. government on such exchanges. The expenditure by China is likely to be comparable. This amount is relatively small, when compared to the expenditures incurred, for example, for all scholars and students from PRC in the United States. The latter figure has been estimated by Lampton et al. (1986) at $111 million in 1983.
One possibility for increasing the level of funding for the cooperative programs would be to seek additional participation from the private sector in the United States. The current level of industry participation in the implementation of the protocols, while increasing, is still very low. The private sector is clearly in a position to initiate and carry out cooperative technological ventures and likely to be interested in doing so in fields that are commercially attractive. It is also in an excellent position to undertake transfer of technologies if China provides adequate incentives for doing so. This, and the related issues of patents and intellectual property, are discussed in other parts of this section.

 Greater flexibility in funding arrangements is being advocated by a number of institutions. It has been suggested that scientists in many fields will be able to work out their own arrangements for funding in many cases where department or ministry funds are not available. Examples cited include the joint project for testing of the Hepatitis B vaccine and the cardiovascular research.

 The memorandum of understanding signed among the U.S. National Academy of Sciences, the U.S. Academy of Engineering, and the State Science and Technology Commission of China for cooperation in applied science and technology provides another mechanism for greater involvement of the U.S. industry. Under this arrangement, which is outside the umbrella agreement, scientists from the industrial and research sectors are brought together in workshops dealing with topics such as clean coal technology, food processing, control of post-harvest losses, and transfer of research results to production.

 The likelihood of industry participation is clearly strongest where the private sector sees reasonable opportunities in the short or medium term to make a decent profit. Thus cooperative projects must be carefully designed so that they provide some opportunities for meaningful participation by industry.

 The past three years have been ones of tight funding in both
countries. Budget deficits in the United States exceeding $200 billion have led to funding cutbacks in many agencies. On the Chinese side, the sharp drop in the price of oil has reduced export revenues by several hundred million dollars per year and particularly affected expenditures requiring foreign currency.

While the counterpart agencies in China and the United States would like to add to the programs, the current funding situation makes it difficult even to maintain ongoing ones. For example, the U.S. Geological Survey has ongoing programs in remote sensing studies, assessment of oil and gas potential of limestone deposits in Southwest China, and a coal basin study. Although these projects are adequately funded for two years, they may subsequently have to be terminated due to a lack of funds.

Reductions in funding have also affected several programs. For example, during 1987, only three Chinese meteorologists will be going to the United States for mountain meteorology, instead of the ten originally planned.

**Communication**

Included in this section are communication problems between individuals due to difficulties in understanding each other's language, as well as difficulties in communication between two countries geographically separated from each other by several thousand kilometers, and where the government agencies work under very different systems.

In the early days of the cooperation between the two countries, the English language capabilities of the Chinese teams were weak, and sometimes the interpreters brought by the teams were not sufficiently familiar with the technical vocabularies required by the scientists. In a few cases, the problem became so severe that some visits had to be terminated earlier than originally planned. For scientists and other technical persons who now come to the United States for longer periods, almost all the agencies now require a proficiency in English.
The situation has gradually improved, as English has become the most popular second language learned by the Chinese, and additional programs for the teaching of foreign languages have been established. Further improvement is expected as the tens of thousands of Chinese students now in the United States and in other English-speaking countries return to China.

There has been no corresponding increase in the number of Americans learning Chinese. With English having become established as the global language for science and technology, as well as for business, there has been little pressure for native speakers of English to learn other languages, particularly those that have a different structure and alphabet (or other characters as in Mandarin). This is likely to continue to be a major obstacle limiting the number of American scholars and students undertaking research in China.

While teams coming from China are always expected to bring their own interpreters, the same has not been true for U.S. teams visiting China. In almost all cases, the Chinese hosts have been expected to provide interpreters for the visitors. On occasions a number of groups from English-speaking countries are in Beijing or Shanghai at the same time, and the interpreters of choice may not be available. Alternately, some of the technically most appropriate interpreters might be accompanying Chinese delegations visiting other countries, and thus are not available. Sometimes, the substitutes found were not in a position to translate the subtleties involved in explaining research at the frontiers of knowledge.

We would like to urge the Joint Commission to consider encouraging U.S. groups to take at least one highly proficient interpreter with them to China. Not only would this be of considerable benefit to the visiting group and its counterpart in China, but it would also provide much needed encouragement to those in the scientific and technical community to start learning Chinese and other foreign languages during their student years and to become proficient in at least one foreign language.

Lack of information (i.e., the technical background and
specific interests of the members of some visiting Chinese delegations) was mentioned as another example of inadequate communication that made the planning of visits to the United States difficult on occasions. It is suggested that more information regarding the objectives of the visit and the current research interests of the scientists be made available to the host organizations.

Communication between departments or ministries within the same country can also be a problem in large countries like China or the United States. From a substantive point of view, it would frequently be desirable to have visiting groups or research teams consist of persons from several ministries or departments, but this has been difficult to implement. The PRC Ministry of Agriculture was cited as one example of a ministry that has been quite effective in drawing persons from other Chinese organizations into its research program with its United States counterpart.

The direct communication between counterpart organizations in the two countries has also been slow at times. Instances were cited in which replies to letters were not received for several months. To some extent, this could be due to a shortage of Chinese staff able to write technical English. At other times, it may have been due to differing views within each organization regarding how best to proceed. It was even suggested on one occasion that the delay was due to trying to guess what might be of interest to the counterpart organization. It would be desirable to communicate quickly and more often than to wait and try to resolve everything at one pass. Greater use could be made of the science attaches and their staffs in Beijing and Washington, D.C., both of which have persons monitoring the protocols.

**Technology Transfer**

The transfer of technology from the United States to China
had been banned until the early 1970s. Following the historic visit of President Nixon to China, policies were changed to transfer some technologies to China on a basis similar to those of the Soviet Union. After the normalization of diplomatic relations with China and the signing of the umbrella agreement on cooperation in science and technology, China rapidly expanded its imports of advanced commercial equipment and technology from the West, particularly the United States.

As the political relations between the two countries deepened, the U.S. export control policy toward China was liberalized. Recognizing China as a "friendly, non-allied country," President Reagan announced in June 1983 that China, for the purposes of export controls, would be shifted to "Country Group V" (a group that includes most friendly countries of Europe, Africa, and Asia). The revised export control regulations were published in November 1983.

Technical guidelines (the so-called "Green Lines") were established to describe products in seven categories that would be routinely approved for export to satisfactory end-users in China. The categories were computers, computerized instruments, microcircuits, electronic instruments, recording equipment, semiconductor production equipment, and oscilloscopes.

For products falling within the "Green Lines," the application licenses would only need to be reviewed by the Department of Commerce, rather than go through an interagency review. However, applications for even these products continued to be subject to review by the COCOM (the Co-ordinating Committee for Multilateral Export Controls), a Paris-based organization consisting of all the NATO countries (except Iceland) and Japan. The major goal of COCOM is to implement a system of uniform export controls on items to be shipped from these countries to Eastern Europe and other selected countries.

With the new policy in place, it was expected that the granting of licenses would be expedited. Unfortunately, this did not always turn out to be the case. On many occasions during the past few years, Chinese officials, including a number of
top-ranking leaders, have expressed concern and frustration at delays in the granting of licenses. Some have described the disparity between the stated policy and its implementation as "Big thunder, little rain."

A good example of the delays and the gradual improvement in the situation is provided by the Landsat-D ground station that started operation in December 1986. The station receives satellite data covering petroleum exploration, land-use patterns, crop yield estimates, monitoring of natural calamities, and resource planning. The 1979 Understanding on Space Technology provided that China could purchase such a station from the U.S. industry. From early 1979 to late 1984, export control considerations, as well as procurement difficulties, delayed implementing the sale. Extensive negotiations were undertaken by the Chinese Academy of Sciences and NASA, as well as among the various U.S. agencies. Finally a solution was found under which an American Company, Systems and Applied Sciences Corporation (SASC)—now STX Corporation—was able to conclude the contract and obtain the export license for purchasing the necessary equipment.

Even a high-visibility and high-priority project like the Beijing electron-positron collider (BEPC) has had its share of delays, in part due to the time required to obtain export licenses. Some of the sophisticated instruments required for the project have potential military uses as well, and this has required lengthy periods for clearances. The situation has improved considerably as the Chinese officials have become familiar with the U.S. export process. The U.S. Department of Energy (DOE) has also helped greatly by making available a staff member from DOE to work closely with a counterpart from China in keeping track of the current status of the different applications for export licenses. Both persons are located at the Stanford Linear Accelerator Center (SLAC), where much of the planning and design for the project has taken place.

One of the most recent protocols to be signed deals with telecommunications. A number of items required for the
cooperative program in this field—for example, fiber-optics technology—will require special export licenses.

The Chinese feel that the major reason for the delays in the granting of export licenses on many items is that the Commerce and Defense departments have vastly different interpretations of the guidelines, particularly when export items subject to COCOM controls are concerned. The feeling also exists that the United States has been more restrictive in export licensing than Western European and Japanese suppliers. As a consequence, there have been instances where China eventually turned to other countries for importing certain technologies and equipment. The number of contracts for technology imports signed with Japan during 1985 (Figure 5), for example, exceeded the number signed with the United States (Liu Hu 1986). In terms of the total value of the

![Pie chart showing technology imports, 1985](chart.png)
Figure 6. China technology imports, 1985 (in $100 million).

imported technology, the imports from the Federal Republic of Germany exceeded that from the United States, as shown in Figure 6.

Consultations between the United States and its COCOM partners were initiated in early 1985 with a view to streamlining approval of applications for exports of routine technology to China. An agreement, effective December 27, 1985, was reached that listed items falling within 27 product categories would no longer require COCOM review. Three additional items were added to the product list in 1986.

A number of high-technology items dealing with national security concerns (e.g., nuclear weapons and delivery systems, intelligence gathering, electronic warfare, antisubmarine warfare, and air superiority) continue to be on the list of controlled exports.
The number of licenses for export to China that were approved by the U.S. Department of Commerce increased steadily from 1982 to 1985, as shown in Figure 7 (U.S. Department of State 1987). They decreased in 1986, possibly due to foreign exchange shortages in China.

A number of companies within the United States have also voiced concern about the possible loss of business to other countries supplying high-technology items. As a result, a high-level group on the Impact of National Security Controls on International Technology Transfer was set up under the auspices of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine to undertake a comprehensive study of the situation. The group's report, entitled *Balancing the National Interest: U.S. National Security Export Controls and Global Economic Competition*, was published early in 1987 and contains a number of important recommendations, which are difficult to summarize in the limited space available.
here, but which could go a long way toward overcoming some of the past difficulties associated with technology transfer between the United States and China.

**Patents and Intellectual Property**

The safeguarding of patents and intellectual property has become of major concern in the United States. American companies spend billions of dollars each year on the development of products, many of which have been copied all over the world without payment of royalties to the companies that would enable the latter to recover their research and development costs. Book publishers and writers have also been dismayed that in some countries only one or two copies of their books are purchased, and then thousands of copies are made for re-sale within those countries without any of the proceeds accruing to the author or publisher.

In many countries where the State is the major producer and seller of goods, there are few provisions to safeguard the interests of private parties, domestic or foreign. There is also a shortage of lawyers with expertise in international patent and copyright laws. China is one of the countries that had been in this position. Recognizing that it would otherwise be difficult to obtain advanced technologies required for its modernization program, China enacted a new patent law that went into effect on April 1, 1985.

Article 1 of the General Provisions of the Patent Law states that "This law is formulated in order to protect patent rights for inventions and creations, help promote their popularization and application, and accelerate the development of science and technology to meet the requirements of socialist modernization." Article 2 defines inventions and creations as "inventions, practical new models and exterior designs" (Xinhua 1984).

Article 25 of the law states that the following items will not be granted patent rights: scientific discoveries; rules and
methods of intellectual activities; methods of diagnosis and treatment of diseases; foodstuffs, beverages, and seasonings; medicines and materials obtained by chemical methods; breeds and varieties of animals and plants; and materials obtained by methods of nuclear mutation.

These provisions exclude the granting of patents for computer software, chemicals, and pharmaceuticals and has raised concerns by some American and other foreign manufacturers who have been able to obtain patents on similar products in other countries. In a few cases, this exclusion has delayed the signing or implementation of protocols.

In terms of the duration of a patent, Article 45 states that "The time limit for an invention patent is 15 years. The period is counted from the day an application is submitted. The time limit for a patent for a practical new model, or an exterior design, is 5 years, and the period is counted from the day an application is submitted." Before a patent expires, the patent holder may apply for an extension of three years. Although the 15-year protection for inventions is shorter than the 20 years usually provided in the patents of industrialized countries, this provision in China's patent law is not considered to be a deterrent to technology transfer.

From April 1985 (when China's patent law was enacted) through September 1986, about 25,000 applications had been filed with the State Patent Bureau. About 35 percent of these applications came from overseas, with Japan filing for 12 percent of the total, and the United States about 8 percent. In contrast, in countries like Australia and Canada, about 90 percent of the patent applications are from other countries (Shearin 1987). A lack of familiarity with China's patent law may be one reason for the relatively smaller proportion of applications coming from overseas.

The implementation of some protocols has been delayed while the issues dealing with intellectual property and patents are being worked out. Examples include the protocols on aeronautical
science and technology, and nuclear physics.

Components of the Public Health Service, such as the Center for Disease Control and the National Eye Institute, NIH, have developed draft agreements with Chinese counterparts. These agreements, however, have not been brought under the official "umbrella agreement," and one of the reasons given for the delay was that the provisions for the patents and copyrights need additional work.

The current approach preferred by both sides for dealing with the safeguarding of intellectual property is to use essentially the same language in the relevant protocols wherever possible. Thus the language used in Appendix 1 to the high-energy physics protocol (the appendix dealing with intellectual property issues) is also essentially the language used in the protocols dealing with fossil energy and nuclear fusion. This should lead to quicker approval of protocols and annexes where the patent and intellectual property considerations are a significant factor.

Access to Particular Sites

The issue of "access" has frequently been raised in the implementation of cooperative science and technology programs between China and the United States. As with technology transfer, it is a complex issue that requires a great deal of mutual understanding, patience, and concerted efforts over a long time.

On a number of occasions, American scientists and administrators have complained about limitations on field research in China and on access to archival material. An example is provided by the interest of U.S. scientists in obtaining data on atmospheric chemistry and monsoons by flying a suitably equipped C-130 turboprop aircraft over parts of China. An offer was made to permit PRC military pilots on board, or take other steps to reassure China, but the proposal has not yet been accepted.
The Chinese have recognized the problems, and good-faith attempts have been made to accommodate the needs of American scientists. A great deal of progress has been made, particularly since 1982, as China opened up areas of the country, as well as institutions, that were previously closed to foreigners. Examples of this are provided by the opening up to foreign scientists and government officials of a satellite launch center and an aerodynamics research center, both located in Sichuan Province and operated by the military.

Although access to militarily sensitive sites is restricted in China, as it is in every other major country in the world including the United States, the trend toward openness in China is expected to continue, and access is expected to be a decreasing problem in the future.

Chinese scholars and students have also complained on occasion that they were denied entrance to some conferences or courses such as computer sciences, where national security policy requires exclusion of nationals from all communist countries. This issue has not only been discussed between China and the United States, but has been a subject of heated debate within the United States itself. Although government laboratories and private industry are required to take action to stem the flow of sensitive and proprietary technology, American universities have generally sought to remain free of such controls. The academic programs in all the major universities in the country continue to provide equal access to American and all foreign students, including those from China. Some restrictions on foreign students may exist, when externally supported research is being undertaken at special laboratories, and the funding provisions require limiting use to U.S. students.

Some of the reasons for the complexity of the "access" problem deserve further discussion. In common with all sovereign nations, the United States and China have information and data that are proprietary or classified. It is appropriate that each side take steps to safeguard such material. These were the reasons Chinese groups visiting the United States were denied
access to certain government and private research laboratories. For similar reasons, the Chinese were unwilling to share their large-scale topographic maps with the U.S. Geological Survey.

Further, the national and local laws of both countries restrict certain types of activity in particular areas. The collection or removal of unique animal, plant, or mineral specimens are not allowed in National or State parks and similar areas in the United States, as well as in China. Other activities of this type might require prior clearance, which might take considerable time.

A third factor limiting access to some sites in China is associated with the infrastructure situation in the country. A shortage of housing that would be considered acceptable for foreign visitors, lack of suitable roads for vehicular traffic, and absence of facilities that could provide Western-style food are difficulties that place a considerable burden on the hosting Chinese institution. Although the foreign visitors themselves might be willing to "rough it," as they do in other remote parts of developing countries, the Chinese tradition of hospitality and ensuring the comfort of the visitors works against providing access to sites where the minimum expectations of hospitality cannot be met.

In a few cases where access has been permitted, the American scientists spent considerable time traveling between sites so that relatively little time was actually available to undertake the research. A general improvement in this situation would have to await the development of infrastructure in the remote parts of China.

With respect to historic records and archives, these suffered severe damage and destruction during the Cultural Revolution. Much of the material still has not been sorted out and restored. Work is underway to improve the situation, but the rate of progress has been slowed down by the current austerity program. When requests for access to such materials are received, they may be denied, because the material is still being sorted out and organized. This has particularly hampered the
work of U.S. social scientists desiring to do field research in China. Also, U.S. meteorologists desiring raw data stored in museums on 500 years of floods in China have had to wait since these records are commingled with other nonrelated material, which are still being sorted out.

**Continuity in Research Projects**

In the United States, the cooperative research projects funded by the National Science Foundation are based on "peer review." The grant is actually made to the institution with which the principal scientist is associated, and the institution is thereby also committed to a successful completion of the project. The nature of the selection process used by different ministries in China is not known to their U.S. counterparts. It would be helpful if more information about the process and the provisions is made available to U.S. scientists. There have been cases in which projects have floundered because the senior Chinese scientist moved to another institution, and the organization with which he was previously associated felt under no obligation to complete it.

A National Natural Science Foundation of China (NSFC) was established in February 1986. The organization, which operates on a "peer review" basis, might help in the future to reduce the likelihood of projects not being completed due to a lack of institutional commitment. The responsibilities of NSFC include formulating policies and strategies for developing basic research and some applied research, as well as undertaking international collaborative research and academic exchanges.

Although most of the funding for NSTC will be provided by the Chinese government, donations from individuals and collectives at home and abroad can be accepted. Such funds can be used as stipulated by the donors, provided they are beneficial to China and consistent with the aims of NSFC.

Since the National Natural Science Foundation of China is
likely to play a very important role in future basic and applied research in China, its organizational chart is shown in Figure 8.

Figure 8. Organizational chart of the National Natural Science Foundation of China.
CONCLUSION

In the relatively short span of eight years, the People's Republic of China and the United States have established levels of official and unofficial cooperation in science and technology that are unparalleled in history. This is especially remarkable, if one takes into consideration the two countries had harbored a great deal of mutual suspicion until the beginning of such cooperation. Great differences in the political, social, and economic systems of the two countries, as well as the disparities in the levels of affluence enjoyed by the two societies, were also obstacles that needed to be overcome.

It would, we feel, be appropriate to say that the first phase of the cooperation in science and technology between the two countries is drawing to a successful conclusion. Decision-makers and scientists in each country have gotten to know their counterparts and gradually learned to appreciate the interests and concerns of each other. The initial difficulties arising primarily from a lack of understanding of how the two societies work have, to a considerable extent, been overcome and better procedures worked out. A great number of visits by scientific groups from one country to the other have taken place, and many cooperative research projects initiated. In a few cases, useful findings have already been published.

There was a general feeling among the persons we interviewed in China and the United States that, highly successful as the past has been, it is time to move on and reach a new level of cooperation in science and technology. Some elements of what might emerge as the new level of cooperation were becoming clearer—more emphasis on joint research, rather than on short visits and seminars; fewer but more high-quality research projects. Other aspects of future cooperation may need to be spelled out at high-level meetings, such as that of the Joint Commission held in June 1987.

The opportunities for building on the firm foundation that has been established are great. Some difficulties remain, to a
large extent related to the tight budgetary situation in both countries. However, China's commitment to modernization is firm, and the role of science and technology in achieving this goal is well appreciated. The United States continues to view China's modernization as a major, positive factor in the world. In addition, the policymakers, scientists, and technologists of the two countries have gotten to know one another and have identified a number of important areas where joint research projects would be beneficial to both, as well as to the world community. With such positive commitment and goals, there is good reason for believing that scientific and technological cooperation between China and the United States will continue to develop and be a source of strength and satisfaction to both countries.
## APPENDIX

### Active Governmental Agreements in Science and Technology Cooperation Between PRC and USA

<table>
<thead>
<tr>
<th>Agreement/protocol</th>
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<th>Extended</th>
<th>Chinese agency</th>
<th>U.S. agency</th>
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<td>10/78</td>
<td>Unlimited</td>
<td>Ministry of Education (MOE), Chinese Academy of Social Sciences (CASS), State Science and Technology Commission (SSTC)</td>
<td>U.S. Information Agency (USIA), Dept. of Education, National Science Foundation (NSF), National Academy of Sciences (NAS), National Endowment for the Humanities (NEH)</td>
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<td>Ministry of Agriculture, Animal Husbandry, and Fisheries</td>
<td>U.S. Dept. of Agriculture (USDA); U.S. Geological Survey (USGS) and Fish and Wildlife Service, both of the Dept. of Interior (DOI)</td>
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<td>Unlimited</td>
<td>Chinese Academy of Space Technology (Ministry of Astronautics), and Chinese Academy of Sciences (CAS)</td>
<td>National Aeronautics and Space Administration</td>
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<td>2/84</td>
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<td>5/84</td>
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<td>National Oceanic and Atmospheric Administration (NOAA) and NSF</td>
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<td>NSF</td>
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REFERENCES


Xinhua Domestic Service, 13 March.

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