Proceedings of the China-U.S. Forum on Science and Technology Policy

Section I ─ Executive Summary

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A. Rationale

For several years, there have been discussions of a China-U.S. Science and Technology (S&T) Policy Forum to: (1) compare the development and implementation of science policies in China and the United States, and (2) explore timely S&T policy issues of importance to current important bilateral issues facing the U.S. and China. It was agreed by both sides that the he overall objective would be to address issues important to the future China-U.S. S&T relationship.

A common element of these discussions was a desire to be useful to policy makers, governmental and non-governmental, in both countries. This would be accomplished by addressing policy issues relevant to both China and the United States in a realistic, thorough, and scholarly fashion. While this effort was to be forward looking, it was also to be rooted firmly in lessons learned from past experience, focusing on issues of real importance to policy makers. One part of this effort was to provide a credible, comprehensive, and helpful record of the development, implementation, and evolution of the S&T policies that have shaped the China-U.S. relationship, utilizing contributions from those originally involved in establishing the policies whenever possible.

Recognizing the desirability of incorporating specific governmental needs in projecting outcomes from such a Forum (in addition to the broader academic, industrial, and policy benefits), the 11th U.S.-China Joint Commission on Scientific and Technological Cooperation Meeting (JCM), chaired on the Chinese side by the Minister of Science and Technology and on the U.S. side by the Science Advisor to the President and Director of the Office of Science and Technology Policy addressed the issue of such a Forum. Held in Washington DC on October 12, 2004, the 11th JCM took the following action:

> *A proposed U.S.-China Forum on Science and Technology Policy, potentially to be linked with the next (12th) JCM, was discussed. This Forum will compare the development and implementation of science policies in China and the United States.*
>
> *Action: Both sides approved the concept of holding a U.S.-China Forum on Science and Technology Policy, linked with the 12th JCM to be held in 2006.*

Subsequently, it was agreed that the 12th JCM would be held in Beijing on October 18-19, 2006; accordingly, the China-U.S. Science and Technology Policy Forum was held in Beijing on October 15-17, the three days immediately preceding the 12th meeting of the JCM, with a reception in honor of the US participants held on the evening of October 15, with the Forum proper held on October 16 and 17. Reports on the Forum were made to the JCM by U.S. and Chinese representatives on October 19.

B. Organization, Objectives, and Participants

Organization. The Forum was organized by the **George Mason University Science and Trade Policy Program**, under a grant from the U.S. **National Science Foundation** (NSF), and the **National Research Center for Science and Technology for Development** (NRCSTD) of China's **Ministry of Science and Technology** (MOST). It was supported by **MOST**, the **Chinese Academy of Sciences** (CAS), the **National Natural Science Foundation of China** (NSFC), the U.S. **National Science Foundation**, and the **Motorola Foundation**.

Final decisions regarding specific agenda items, topics and speakers were determined by a 16 member **Steering Committee** composed of U.S. members (appointed in consultation with the U.S. **Office of Science and Technology Policy** and the **Department of State**) and Chinese members (appointed in consultation with **MOST**)[1].

Background Papers. Three draft papers written by U.S. experts and reviewed by Chinese experts, and three written by Chinese experts and reviewed by U.S. experts were distributed, in their revised form, to all participants approximately 10 days before the opening of the Forum. Sets of these background papers were also made available in hard copy and electronic form (i.e., on CDs) for observers who attended the Forum. The titles of these papers and their authors are:

1. "Lessons Learned from the U.S.-China Scientific and Technical Relationship - 1970 to the Present," by **ALEXANDER DEANGELIS**, U.S. National Science Foundation (retired)

2. "Soaring Eagle, Flying Dragon: Industrial R&D and Innovation in the United States and China," by **KATHLEEN WALSH**, Professor of National Security Affairs, The Naval War College

3. "Basic Research: a Comparison of the United States and China," by **LIU YUN**, et al, Beijing Institute of Technology

4. "The Status and Effects of Technology on Economics and Foreign Relations between China and America since Normalization," by **ZHAO GANG**, Huazhong University of Science and Technology and National Research Center for Science and Technology for Development (NRCSTD), and NRCSTD colleagues

5. "U.S. Science and Technology and the Role of the Federal Government," by **NEAL LANE**, Rice University

6. "Comparative Analysis of Sino-U.S. Scientific and Technological Systems," by **ZHAO GANG**, et al, NRCSTD

1. A list of the Steering Committee members and their affiliations appears as Appendix A.

These papers appear in Section III.

Objectives. The overall objectives of the Forum were to:

- Explore issues important to the future China-U.S. bilateral relationship;
- Be useful to policy makers and decision makers in both countries, including the 2006 (12th) JCM;
- Generate a baseline of knowledge relating to the U.S.-China S&T policy relationship through commissioned background papers;
- Involve outstanding leaders in the Forum with knowledge, experience, and wisdom who will examine issues and synthesize useful ideas and conclusions for better dealing with bilateral S&T policy challenges;
- Provide a structure to participants to examine and discuss issues and ideas;
- Insure participation of outstanding individuals with relevant experience in academia, government, and industry;
- Enhance the understanding of relevant intellectual and practical information and data through careful selection of paper authors and speakers;
- Provide opportunities for young scholars to learn and to participate in dialogue with senior participants, with the possibility of attracting young talented scholars into areas related to some of the bilateral policy issues examined at the Forum;
- Document the background papers, presentations, discussions, and conclusions through print and electronic media; and
- Disseminate the printed and electronic record of the Forum to decision makers and the general public in both countries through a variety of means.

Participants and Observers. Approximately 120 Chinese and 50 U.S. leaders from government, industry, and academia were invited to attend the Forum. Among these 24 of the Chinese and 22 of the Americans played active roles as Forum participants[2]. Although officially designated as observers, the remaining Chinese and American attendees were invited to participate fully in open discussion periods.

Young Scholars. Six U.S. young scholars, ranging from a June 2006 bachelor's degree recipient to two post-doctoral scholars who had received their Ph.D. degrees within two years of the Forum, were among the participants. Four of the Young Scholars were supported by **NSF** and two by the **Motorola Foundation**. They were selected by means of a nationwide competition. These young scholars served as rapporteurs for the various sessions. On the two days immediately following the Forum the group visited **Tsinghua University**, the **National Natural Science Foundation of China** (NSFC), the **Institute for Policy and Management of the Chinese Academy of Sciences** (CAS/IPM), and the **National Center for Science and Technology for Development** (NRCSTD). During these visits they were briefed on various aspects of China's Science and Technology Policy, and had opportunities for open discussion with Chinese attendees.

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2. Lists of Chinese and U.S. participants and their affiliations appear as Appendices B and C.

In order to provide the six U.S. young scholars with opportunities to meet and become better acquainted with their Chinese peers, **MOST** and **NRCSTD** designated 10 Chinese young researchers from **Peking** and **Tsinghua Universities**, **Tianjin University of Science and Technology**, and **NRCSRD** as their counterparts. Several of these Chinese young researchers took part in an open discussion at **Tsinghua University** on October 18.

During their October 19 visit to **NRCSTD**, the six U.S. young scholars and their 10 Chinese counterparts participated in a Young Researchers' Symposium. On succeeding days, the U.S. young scholars made their own professional visits to research and relevant administrative organizations and individuals in Beijing and elsewhere in China. The six have prepared papers on various aspects of Chinese S&T policy and/or China-US bilateral S&T relations based, in part, on their experiences in China[3].

C. Structure

The core of the Forum consisted of two roundtables: the first of these, on **Lessons Learned during the Evolution of China-U.S. Relations Since Normalization**, was held during the afternoon of October 16; the second, on **U.S.-China Relations in the Globalized 21st Century**, was held on the morning of October 17. Each roundtable featured prepared remarks by three Chinese and three American speakers, followed by brief comments on those remarks by additional Chinese and American participants. Both roundtables were followed by open discussion periods.

The Forum opened with an **Inaugural Session** on the morning of October 16, featuring a Chinese and a U.S. keynote speaker. The final session of the Forum, held on the afternoon of October 17, was devoted to a general discussion and summary remarks by a U.S. and a Chinese speaker. This session served as the basis for two reports to the JCM on October 19 – one by **MA JUNRU**, Former General Director of the State Administration of Foreign Experts, the other by **J. THOMAS RATCHFORD**, Director of the Science, Technology and Trade Program of the George Mason University School of Law. Texts of these reports appear in Section V.

Five special presentations by distinguished participants were featured. During the inaugural session, **HUANG QITAO**, former Vice Minister of Science and Technology, and former Vice Minister of the State Science and Technology Commission, People's Republic of China; and **EDWARD DAVID JR.**, former Science Adviser to President Richard Nixon and former Director of the Office of Science and Technology (OST), provided keynote addresses.

During a working lunch on October 16, **RICHARD ATKINSON**, former director of NSF and President Emeritus of the University of California, presented an address entitled, "Research Universities and the Wealth of Nations." During the working dinner that evening, **ZHU ZUOYAN**, Vice President of NSFC, spoke on "The Roles of NSFC in Fostering International Collaboration in Science and Technology."

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3. A list of the six Young Scholars and their papers appear in Section IV.

During the working lunch on October 17, **DENG ZHONGHAN**, Chairman of the Vimicro Corporation, gave an address entitled, "Adding Value through Innovation." During the closing dinner session that evening, **JOHN GIBBONS**, former Assistant for Science and Technology to President Clinton and former Director of the Office of Science and Technology Policy (OSTP), spoke about "Lessons from the Past; Challenges of the Present; Opportunities for the Future."

D. Issues, Problems, and Challenges

The overall goals of the Forum were to explore the changing character and context of the bilateral science and technology relationship between China and the United States, and address the future directions of that relationship. Although a large number of themes and issues were raised in the course of the prepared presentations, by commentators on those presentations, and in general discussion periods, a number of issues, problems and challenges emerged as particularly salient.

While there were disagreements about specific matters, there was a strong consensus about the importance of China-U.S. cooperation in science and technology to both countries, as well as the diversity of that cooperation involving as it does the two governments, universities, industry, and individuals – all of whom have a stake in the continuation of a healthy relationship, even if their perspectives about what should constitute a "healthy" relationship may differ. Science and technology are important to both countries as an essential basis for their continuing respective cultural, economic, and social development. Cooperation between institutions and individuals in the two countries has enhanced the purely domestic aspects of science and technology in both countries. However, many participants believed that there are opportunities to broaden and deepen collaboration which should be seized.

There was also a consensus about the importance of the China-U.S. science and technology relationship to the broader relations between the two countries. In view of the increasing significance of these broader bilateral relations as China's global role becomes more pronounced, it is no exaggeration to state that the science and technology relations between China and the United States have global as well as purely domestic and bilateral significance.

The character of the science and technology relationship between China and the United States has changed considerably since normalization of relations between the two countries in 1978, and will no doubt continue to change. These changes are the result of several factors, including the rising capabilities of China in science and technology, and the rising contributions made by Chinese scientists, engineers and institutions to the pool of world scientific and engineering knowledge. Changes in the relationship have also occurred as a result of: changes in the character of science and engineering themselves, changes in how these activities are conducted, the institutions that support and conduct those activities, and the substantive character of the problems with which science and engineering are grappling. Changes in the substantive character of science and engineering are evident from the increasing importance of the biological sciences and of interdisciplinary research, for example.

How can changes in the diverse China-U.S. science and technology relationship best be monitored, adjusted, and managed so that new opportunities for collaboration can be identified and implemented, and negative factors that threaten the relationship be minimized? Despite impressive advances, the science and technology relationship between the two countries remains asymmetric in some aspects. To Chinese policy makers, science and technology – and thus the benefits obtainable from international collaboration with developed countries, most prominently the United States – remain an essential key to the future development of the country. In contrast, as one particularly knowledgeable U.S. participant observed, to policy level officials in the United States, bilateral science and technology relations are mainly "the frosting on the cake." One important question is what steps can be taken to make these policy makers as well as the informed public in the United States better informed about the significance of healthy bilateral science and technology cooperation with China?

Several problems and irritants affecting bilateral science and technology relations were identified during the two days of the Forum. Although China has made considerable progress in legislating and enforcing intellectual property rights (IPR) protection, several Chinese participants conceded that much more needs to be done before China meets world standards for IPR. Meanwhile, inadequate IPR protection in the country inhibits opportunities for productive cooperation in industrial research.

To the Chinese, the export controls of sensitive technologies enforced by the U.S. government remain a particular irritant. So do suspicions voiced by some members of the U.S. Congress and officials in several executive branch agencies that China has a well organized plan literally to "steal" sensitive dual-use technologies and divert them to military research and development.

To both the Chinese and U.S. Forum participants, there were concerns about the free flow of people and ideas. This is exemplified by the problems that Chinese students and scientists (and students and scientists from other countries) face in obtaining visas to enter and study or work in the United States. However, this situation appears to be improving.

Beyond these specific problems, there is a very real danger of a possible negative direction of science and technology relations between China and the United States. Therefore, perhaps the most pressing issue addressed by the Forum was how to assure a vibrant and strengthened policy framework in the future. Despite what a few participants may wish, science and technology relations between the two countries are conditioned to some extent by their broader political and economic relations. During the years since normalization, the character of those broader relations has oscillated; yet bilateral science and technology relations have continued to strengthen and broaden. There is little doubt that political and economic tensions between China and the United States will become more pronounced during the next 10 to 20 years. If that is the case, will our many faceted science and technology relationship be seriously diminished or even extinguished as a result?

The science and technology communities in both China and the United States face the challenge of seriously considering these problems and dangers and becoming more actively involved in helping to resolve them. Both the Chinese and U.S. communities should take more active steps to make the political leadership in their respective countries, as well as their informed publics, more fully aware of the importance of the bilateral science and technology relationship to broader relations.

The Chinese scientific community needs to recognize that irritants such as inadequate IPR legislation and enforcement and the alleged diversion of imported technologies to military purposes are of deep concern in the United States. In turn, these concerns inhibit a more expanded, productive science and technology relationship between the two countries.

The U.S. science and technology community needs to recognize and reward the rising capabilities and contributions of Chinese science and technology, and take steps to assure that the informed public is more fully aware of the benefits that the United States can derive from those rising capabilities.

Relying simply on trust in international affairs is a woefully inadequate strategy for firm relations of any sort, whether bilateral or multilateral. Yet trust remains important. The science and technology communities in both China and the United States should continue to take measures to build greater trust. And from the perspective of several participants, these communities need to be "imaginative" in framing a new model to replace the model for bilateral science and technology relations which has worked well for almost 30 years, but now need to be retooled.

E. Auspices and Continuity

SONG JIAN, former State Councilor; former Chairman of State Science and Technology Commission, former Vice Chairman, Chinese People's Political Consultative Conference, and former President, Chinese Academy of Engineering; and **EDWARD DAVID**, former Science Advisor to President Nixon, former Director of the Office of Science and Technology (OST) and former President of Exxon Research and Engineering, served as co-chairs of the Forum Steering Committee.

The October 2006 China-U.S. Science and Technology Policy Forum followed seven seminars, forums and workshops held on an approximately annual basis since 1999. These **Sino-U.S. Science Policy Dialogues**, which have been supported jointly by the **National Natural Science Foundation of China** and the U.S. **National Science Foundation**, have explored a number of specific bilateral science and technology policy issues.

The U.S. components of the Sino-U.S. Science Policy Dialogues, as well as the October 2006 Forum, have been supported in part by a grant from the U.S. **National Science Foundation** to **George Mason University's Science and Trade Policy Program,** a component of its **National Center for Technology and Law.** The **Motorola Foundation** provided support for two of the six Young Scholars who participated in the Forum. **J. THOMAS RATCHFORD**, Distinguished Visiting Professor and Director of the Science and Trade Policy Program, has served as Principal Investigator on all these NSF grants as well as principal U.S. organizer of all Sino-U.S. Science Policy Dialogues since October 1999. A detailed description of the George Mason U.S.-China program appears as Appendix F. Proceedings of all the Sino-U.S. Science Policy Dialogues, more information about the Young Scholars Program, and an extensive list of references and links to recent literature on Chinese science and technology, can be accessed at: www.law.gmu.edu/nctl/stpp/us_china.php.

F. Inaugural Session

JIN XIAOMING

JIN XIAOMING, Director of the Department of International Cooperation at **MOST** and former Science Counselor at the Embassy of the People's Republic of China in Washington, chaired the inaugural session of the Forum. **LING ZHU**, Graduate Student in Management Information Systems, University of Arizona, served as rapporteur.

JIN noted that he and his colleagues at **MOST** and elsewhere in the Chinese government regard the Forum as an important preparatory component of the JCM which would be held on October 18-19. More broadly, he hoped that the Forum would highlight and sharpen the opportunities and challenges which the China-U.S. science and technology relationship would confront during the first decades of the 21st Century. **JIN** then introduced **HUANG QITAO**, who also welcomed the participants and observers to the Forum, and proceeded to deliver the first of two keynote addresses entitled, "China's Development Strategy of Science and Technology Towards 2020."

HUANG QITAO

HUANG began by noting that President **HU JINTAO**'s official visit to Washington, DC, in April 2006 was purposely timed to coincide with the renewal of the umbrella agreement for science and technology cooperation between China and the United States. Since the first umbrella agreement between the two countries was signed in 1980, there has been a great deal of cooperation between government organizations in the two countries, as well as much more extensive cooperation between universities and individuals across a broad spectrum of science and technology fields.

Since the reform and opening of China initiated by **DENG XIAOPING** in 1978, China has made substantial progress in its economic development, spurred in part by its achievements in science and technology. But China, in common with many other countries, has paid a price for its development in terms of damage to its environment. If

China is to follow the path of sustainable development, technological innovation will be imperative.

The year 2006, according to **HUANG,** is significant as the first year in which China's Medium and Long Term Plan for Scientific and Technological Development, 2006-2020 (MLT), has been in effect. The MLT, developed in consultation with scientists, engineers, and government officials throughout the country under the leadership of Premier **WEN JIABAO**, has the overall goal of making China an innovative country by the year 2020.

First among the imperatives integral to the MLT, are recognition that the appropriate development of energy, water resources, and other environmental resources must underlie all aspects of China's economic development.

Second, the MLT lays particular emphasis on biotechnology.

Third, the MLT stresses the importance of innovation in high technology, including areas of technology that are only in their initial stages of development.

According to **HUANG**, the Chinese government pays a great deal of attention to the search for scientific knowledge, as well as to technology and institutional innovation as important factors in economic development. In the next 15 years, China will have to undergo extensive institutional innovation as a foundation of technology innovation.

The Chinese government emphasizes support for new enterprises, particularly small and medium size enterprises (SMEs). Specific steps it has taken or will take during the period of the MLT include:

- Providing financial and consultant assistance for enterprise innovation, with an emphasis on assistance to SMEs;
- Strengthening the ecosystem for entrepreneurial innovation;
- Strengthening cooperation between the industry and government;
- Strengthening cooperation between the industry, university, and research institutions; and
- Providing an effective legal environment for innovation, particularly in the intellectual property area, as an indispensable means for protecting innovation.

By 2020, China aims to invest 2.5 percent of its Gross Domestic Product (GDP) in research and development (R&D). By that year, it also aims to be among the top five countries in the world in terms of citations to its scientific publications in international, peer reviewed journals.

China can provide considerable experience to other developing countries in technology innovation and sustainable economic development. However, China must also strengthen and broaden its scientific cooperation with other countries, both developed and developing.

HUANG made several suggestions for enhancing science and technology (S&T) cooperation between China and the United States:

- Initiating strategic studies on China-U.S. cooperation in S&T;
- Elevating the consultation mechanism for S&T cooperation to the ministerial level;
- Promoting cooperation in key fields, such as nanotechnology, space technology, environmental technology, and biotechnology.

He called on the United States to:

- Give up export controls on high technology to China;
- Encourage broader participation in China-U.S. cooperation in S&T, by solving the visa problem for Chinese researchers and students who wish to enter the United States.

HUANG closed his address by noting that serious discussions are underway about the possibility of Chinese Science and Technology Year in the United States, which would promoting an understanding of China's science and technology development in the country. China would also welcome analogous activities in China undertaken by the United States.

DAVID SEDNEY, Deputy Chief of Mission, U.S. Embassy, Beijing, thanked **HUANG** for his interesting and provocative address. **SEDNEY** stated that as the son of a scientist, he has a deep appreciation of the importance of international scientific cooperation. Scientific cooperation between the United States and China, which has benefited both countries, also provides an essential foundation for the overall relationship between them. The role of the U.S. government is to enable scientific cooperation between companies, universities, and individuals in both countries. **SEDNEY** agreed with **HUANG** that there is considerable scope for greater science and technology cooperation between the United States and China. **SEDNEY** pointed out that to be most effective science cooperation should be as open as possible. The United States had become the world's leading scientific nation by bringing scientists and students from around the world into our leading institutes and universities. Some of these scientists stayed in the United States, others returned home or moved to other countries. But, the web of contacts and free flow of scientific thought benefited all. **SEDNEY** expressed the hope that China would embrace the same open model that its scientists and students benefit from in the United States. If the United States and China cooperate in this fashion, the results would be amazing.

EDWARD DAVID

DAVID opened his keynote address by reminding the audience that the origins of the U.S.-China science and technology relationship date from 1979, the year in which he first visited China. The Forum has been organized to examine science and technology policy. In his opinion, enlightened bilateral policies for science and technology relations are important not just for scientists and engineers. Additionally, science and technology policies affect many if not most of our fundamental relationships in trade, environmental protection, and security. Understanding the science and technology system of any country is a necessary but not sufficient condition for a successful research system. **DAVID** stated that a good deal of his address would be devoted to the complex question of what factors are necessary for a successful research system.

In the aftermath of World War II, the federal government emerged as the principal funder of research in the United States. However, times have changed and today private industry has become the principal funder for research and development in the country. The causes behind this transformation are diverse, but one major influence has been recognition that the research enterprise drives economic growth. Governments worldwide now recognize that research is a key to economic prosperity. China has been in the forefront with its outstanding academic institutions and traditional inventiveness and entrepreneurship.

DAVID noted that President **HU JINTAO**, has used the phrase "making China an innovation-driven nation." This phrase encompasses both fundamental research and economic-driven development. The distinction between science and engineering lies in the motivations behind activities in these very different areas of human endeavor. Science is driven often by curiosity and the desire for understanding. Engineering and technology are driven by the effort to commercialize new devices and systems benefiting publics and nations. He emphasized that the modern viewpoint is that both understanding and engineering are required to accomplish the goals of societies and nations. However, the complete innovation picture also includes such diverse activities as education, research and testing, intellectual property rights, the rule of law, and operating a world society that fosters innovation and attracts talent to research across many different countries and cultures including, for the purposes of the Forum, both China and the United States.

According to **DAVID**, a startling feature of the changing research scene is the increasing worldwide emphasis on biology and life sciences as somewhat distinct from the physical sciences. In the United States, the growth of life sciences has outpaced that of the physical sciences in recent years. Significantly, this distinction between the physical and life sciences does not translate into engineering. Engineering has a foot in both camps. It is true that engineering has been associated with physical science traditionally, but today bioengineering is outpacing other fields of engineering and promises to become *the* leading engineering field.

Returning to the subject of innovation, **DAVID** emphasized once again the growing recognition of the importance of innovation in improving humanity's lot. Innovation includes manufacturing and marketing newly invented devices and systems. Countries are exploring ways to commercialize and protect inventions. The United States and China are familiar with the pitfalls encountered when bringing new products forward to augment economic development. Both countries have learned well that attention must be given to subjects beyond the purely technical. Some of these are design, manufacturing, distribution, sales, and training of both users and technicians to make contributions to successful innovation. Manufacturing costs and natural resources availability also require attention for successful innovation.

DAVID pointed to the Internet as a critical aspect of the shared infrastructure which links China and the United States. Not only does it benefit scientific research and commercial development but also it increasingly supports education and cultural exchange. He noted that it is widely anticipated that universal broadband service, based upon fiber and wireless technologies, will become available for all people, businesses and public institutions in the not too distant future. Even as this expansion takes place it is vital that this shared communication infrastructure support the mutually agreed on interests of China and the United States.

DAVID suggested that the Forum should pay explicit attention to new discoveries and inventions animating today's science and engineering. He cited nanotechnology, information technology (IT), and synthetic biology, which enable researchers to create DNA from scratch, as three such animating research areas. Two of these three research areas did not emerge from traditional sources - that is, from physical science. This is not surprising, but it is suggestive that the future for societies and nations will be determined in unfamiliar ways and from unfamiliar sources. He suggested that this is a challenge for this Forum as well as the JCM.

DAVID concluded his address by referring to the similarities between science and technology policies in China and the United States. "These are driven by common desires of Chinese and U.S. scientists and engineers to do productive research in their specific fields and professions. This commonality is a major bridge between our cultures. It is a bridge we should use to overcome the often cited issues which divide our governments. Relations between them have had their ups and downs over the past 35 years. Science and technology policies have been largely agreeable. So as we bring forward our findings for the JCM, let us emphasize policies for collaboration between us. That will benefit us all."

Following **DAVID**'s address, the following six participants provided short comments on the two keynote speeches:

- **LI DAOYU**, former Ambassador of the People's Republic to the United States of America;
- **XU HEPING**, Director, Executive Office, Ministry of Science and Technology (MOST);
- **WANG CHUNFA**, Deputy Director-General, Investigation and Publicity Department, China Association for Science and Technology;
- **WILLIAM BLANPIED**, Senior Research Scholar, Science and Trade Policy Program, George Mason University School of Law;
- **JENNIFER MCCORMICK**, Postdoctoral Fellow, Stanford University Center for Biomedical Ethics; and
- **DENIS SIMON**, Provost and Vice President for Academic Affairs, Levin Graduate Institute, State University of New York.

Li praised **Huang**'s and **David**'s presentations, noting that both emphasized the vast common ground between China and the United States. There are clearly many common desires between the two countries, such as how to involve more young people in science and technology activities. For a large developing country like China, further expansion of international cooperation in science and technology is essential. **Li** closed by asserting that he hoped that the Forum would contribute to an increase in the mutual trust between China and the United States.

Xu particularly appreciated **David**'s observations on the various factors underlying innovation. In adopting its new Medium and Long-Term Plan, China has reached an important set of decisions about which road to take in developing its capabilities in science and technology. For that reason, the country needs to rely in part upon the experiences of other, more developed countries and to learn by collaborating with other countries. Doing so is in the fundamental interests of both China and the United States.

Ma emphasized that the fact that many Chinese students and scientists go to the United States to study and to work is beneficial to both countries, although there are some in China who disagree on the grounds that the country loses some of its most valuable human resources as a result. On the contrary, **Ma** and many others are proud or the contributions of Chinese scientists and engineers who work in the United States. For example, in 1996 there were 2,700 Chinese entrepreneurs working in Silicon Valley. Such examples demonstrate that China can compete internationally in science and technology. Many Chinese scientists who receive advanced degrees in the United States and remain to work there for several years ultimately return to their home country and bring with them the benefits of their working experience abroad. As **David** pointed out, human resources are perhaps the most essential component of successful technology innovation. Examples of the accomplishments of Chinese citizens working in the United States convincingly demonstrate this point, and also demonstrate that science and technology exchanges benefit both countries.

Blanpied praised the two keynote speakers for emphasizing the importance of science and technology cooperation for both China and the United States and, in view of the significance of the overall bilateral relationship between the two countries, the importance of cooperation between them for the entire world. He then stressed the importance over the years of the U.S. **National Science Foundation** (NSF) in fostering basic research cooperation between U.S. and Chinese scientists. As an NSF staff member for over 25 years, he is particularly proud that NSF had served as a model for the **National Natural Science Foundation of China** (NSFC), and also pleased with the important role that NSFC now plays in supporting outstanding research in China. The importance that the agency attaches to research cooperation with Chinese scientists is demonstrated by the fact that an **NSF** office was established in Beijing in 2005.

Blanpied asserted that finding ways to interest and involve more young people in the United States in understanding China's science and technology development is essential. To that end, the U.S. delegation to the Forum includes six young scholars selected by means of a national competition. Following the Forum, these young scholars will visit science and engineering organizations in Beijing and elsewhere in the country. They will each write papers about their experiences for publication in the proceedings of the Forum.

MCCORMICK, one of the six young scholars whom **BLANPIED** referred to, emphasized the importance of the exchange of science and technology information, while noting that many such exchanges cannot take place in the absence of effective intellectual property protection. Science and technology are clearly important to social and economic development. But the effectiveness of any country's science and technology system cannot simply be taken for granted. She stressed the need for effective evaluation both of scientific programs themselves and their broader social and economic impacts.

SIMON began by noting that he had first visited China 25 years ago and, like so many others who have returned repeatedly to the country, has been fascinated to observe its rapid economic development. There has been good collaboration between U.S. and Chinese universities over the years, and such cooperation is bound to increase as more Chinese universities become internationally recognized as centers of excellence. However, many people in the United States, including the U.S. Congress, fear that China's rise to the status of an important global power could be a threat to the United States. **SIMON** emphasized the need for scientists, engineers and policy makers in both countries to work together to educate members of Congress, official in government agencies, and the faculties and students in U.S. universities on the realities of China's science and technology developments. Because of the status that China now occupies as a major global power, and the threat that many in the United States see in China's rising importance, in his opinion we can no longer rely on the old model of cooperation in science and technology that has served both countries well during the past 25 years. Perhaps this Forum can contribute to the difficult thinking required to develop a new model which can continue to be mutually beneficial to both countries.

G. Luncheon and Dinner Presentations

October 16 – Luncheon

Chair: WANG Yuan, Director-General, National Research Center for Science and Technology for Development
Rappoteur: Jennifer McCormick, Postdoctoral Fellow, Stanford University Institute for Bioethics
Speaker: Richard Atkinson, Former Director of NSF and President Emeritus, University of California
Topic: "Research Universities and the Wealth of Nations"

RICHARD ATKINSON

The overarching theme of **ATKINSON**'s talk was the positive role of universities in a nation's economy. Fundamentally, universities contribute to the economy through their commitment to, and role in, conducting basic research. Additionally and importantly, they contribute by educating the future generations of scientists and engineers essential to the economy of any nation. In the United States, these functions are closely coupled, since an essential component of the education which candidates for advanced degrees in science and engineering receive is to conduct significant, original basic research under the guidance of senior mentors.

The success of the U.S. research and development (R&D) enterprise is grounded in a partnership between the federal government and research universities, with the government providing support for the conduct of basic research in universities. Private industry, which now funds almost 70 percent of the R&D performed in the United States, is obviously another essential component of the success of the U.S. system. One important function of private companies is their role in cooperative research agreements with universities which are intended to take the results of basic research to another level where their applicability to specific, tangible ends can be explored. Here, the federal role is also important since the government provides funds for university-sides of such cooperative research agreements, thus offering incentives for industrial participation.

ATKINSON provided some specific examples of the ways in which universities, industry, and government work together to benefit the economy – local, state, and national – by referring to what has happened in the State of California, particularly since the late 1980s. With the fall of the Berlin Wall in 1989, the defense contracting on which so much of the California economy had depended was drastically reduced. Subsequently, the state managed to reinvent itself as a center of the new knowledge-based economy. Universities in the state, including the **University of California**, **Stanford**, and **Caltech**, played a central role in that reinvention.

ATKINSON reminded the audience of the impacts on the U.S. research system of **Vannevar Bush**'s seminal July 1945 report entitled *Science – the Endless Frontier*. Bush served as President Franklin Roosevelt's science adviser during World War II. In November 1944, the president asked Bush to prepare and submit to him a report on how the lessons that had been learned about applying science and engineering to wartime purposes might serve as the basis for a peacetime federal science policy. **ATKINSON** stated that in his opinion, many of the points raised by the Bush report have relevance for the contemporary situation in China and can serve as a model for the country as it moves forward in assuming a leadership position in science and technology.

The question period following the talk generated further discussion on the roles of universities in the U.S. science and technology system, including:

- Implications of the dual role that many university researchers play as educators and innovators/entrepreneurs;
- Small Business Innovation Research (SBIR) grants awarded by all the major supporters of R&D in the federal government in stimulating research-based innovation;
- The roles of national laboratories in the university-industry-government partnership; and

- The role of the U.S. **National Science Foundation** (NSF) in facilitating the conduct of basic research in U.S. universities.

October 16 – Dinner

Chair: Xiangli Chen
Rapporteur: Aaron Levine, Graduate Student in Public Affairs, Princeton University
Speaker: ZHU Zuoyan, Vice President, National Natural Science Foundation of China (NSFC)
Topic: "The Role of NSFC in Fostering International Collaboration in Science and Technology"

CHEN introduced the speaker as a very famous expert in cell biology and mechanical engineering who initiated the research field of transgenic fish research and has contributed significantly in many other fields. In his long and varied career, **ZHU** has published more than 130 papers, three of which have become classical papers of transgenic fish research. For the past decade, he has engaged in the management of science and technology. From 1995 to 1999 he acted of Head of Institute of Hydrobiology of Chinese Academy of Sciences. From 2000 to the present, he has been the fourth Vice-President of the **National Natural Science Foundation of China**.

ZHU ZUOYAN

After thanking **CHEN** for his introduction, **ZHU** commented that the important role of science and technology is now widely acknowledged. This underlies the significance of the Forum because it is essential to establish policies that can optimize the role of science and technology in development.

In its development plans, China recognizes the importance of basic research as an important factor underlying innovation. **NSFC** works, along with the **Ministry of Science and Technology** and the **Ministry of Education** to support basic research in China.

NSFC has been committed to international collaboration since its founding in 1986. This commitment has led to over 60 formal cooperative science and technology agreements with 35 nations and regions. **ZHU** emphasized that these agreements stress international communication and coordination efforts. The **Sino-US Science Policy Dialogues** which **NSFC** has supported along with the U.S. **National Science Foundation** (NSF) since 1999 provide one example of the success of these efforts.

ZHU laid particular emphasis on the importance of the relationship between **NSFC** and **NSF**. His organization has learned a great deal from **NSF** in key areas including funding supervision and proposal submission. The two agencies have built a solid relationship allowing for continued cooperation and communication. **NSFC** is particularly pleased that **NSF** has chosen to open an office in Beijing as this indicates the agency's strong commitment to cooperation with China.

ZHU concluded by wishing the Forum participants good luck in their important task.

Following the presentation, **DENIS SIMON** asked **ZHU** to describe how relationships between **NSFC** and European funding agencies compare to its relationship with the U.S. National Science Foundation. **ZHU** responded by pointing to **NSFC**'s 20^{th} anniversary celebration in May 2006. Presidents of seven counterpart agencies made presentations at that time, including those from Germany, the UK, Japan, Korea, Australia, and New Zealand, in addition to **NSF**. Premier **WEN JIABAO** received all these guests. But during a subsequent reception, he met specifically with the U.S. and German representatives, highlighting the fact that both Europe and the United States are assigned high priorities by **NSFC**.

LING ZHU asked for details about how **NSFC** operates and, in particular, its financial resources. **ZHU ZUOYAN** responded by noting that total R&D investments in China now account for 1.3 percent of its GDP. Approximately 5 percent of those investments are for basic research, of which **NSFC**'s budget accounts for 20 to 25 percent. That budget has been increasing by about 20 percent per year for the past several years. For the current year, it is approximately 3.4 billion rmb. **NSFC** receives between 30,000 and 40,000 proposals each year, of which approximately 20 percent are successful.

ROBERT ROBERTS asked whether **NSFC** makes use of a peer review process. **ZHU** answered in the affirmative. All proposals are sent out to five experts for mail review. For proposals seeking support from **NSFC**'s key grants program, most of those peer reviewers are Chinese scientists and engineers working in Europe or the United States. After the mail reviews have been evaluated, **NSFC** convenes one or more panels of experts and invites a short-listed group of applicants to make reports and respond to questions. Then the panel makes final decisions about which proposals to support. According to **ZHU**, international scientists occasionally return to join these panel reviews and are very impressed. Even the **National Institutes of Health** (NIH) does not arrange such face-to-face discussions.

October 17 – Luncheon

Chair: Deborah Seligsohn, Environment, Science, Technology and Health Counselor, U.S. Embassy, Beijing
Rapporteur: Kathryn Miller-Jensen, Post-Doctoral Fellow, Massachusetts Institute of Technology
Speaker: DENG Zhonghan, Chairman, Vimicro Corporation
Topic: "Adding Value through Innovation"
In introducing the speaker, **SELIGSOHN** noted that **Vimicro Corporation** is often referred to as "fabless." For some time she had thought that was shorthand for "fabulous." Then she learned that "fabless" is shorthand for "fabrication-less." That is, the company designs, but does not fabricate.

DENG ZHONGHAN

DENG began by emphasizing the importance of China's Program for Medium-to Long-Term Scientific and Technological Development, 2006-2020 (MLT). The MLT suggests that China has learned from the United States that to be successful, innovation must be market-driven and based on the initiatives of enterprises, and that an adequately enforced intellectual property regime is essential.

Vimicro is the largest multimedia semiconductor technology company in China. It has filed almost 400 patents worldwide, with cutting-edge products to both PC and mobile markets. The company continues to demonstrate that it is possible move beyond "Manufactured in China" to "Designed in China."

How does innovation lead to value creation? Quoting **Clayton Christensen** of the Harvard Business School, **DENG** defined technology as "the processes by which an organization transforms labor, capital, materials, and information into products and services of greater value … the concept of technology extends beyond engineering and manufacturing to encompass a range of marketing, investment, and managerial processes." Innovation occurs when there is a change in one of these technologies.

According to **DENG**, value creation requires that due attention be given to both the supply and demand side implications of an innovation. On the supply side, a candidate innovation requires great technology, strong management, good capital and competitive cost. Market scale and market scope are critical factors on the demand side.

Using **Vimicro** as a case in point, on the supply side the company has developed cutting edge technologies, has experienced management, a world class board and directors, and savvy and resourceful investors. On the demand side, **DENG** noted the huge market scale in China. The country has the world's largest mobile population with over 350 million subscribers and wireless data market, as well as advanced network infrastructure. He also emphasized the government's commitment to promoting the multimedia industry. There also exists a well developed market scope on multimedia applications. Exploiting both these supply side and demand side factors, **Vimicro** provides value creation to global parties: global consumers, global customers, global suppliers, and global shareholders/investors. **Vimicro** is adding value by China through innovation. It has demonstrated that China is on the verge of a new era; from manufactured in China to designed in China.

Following his presentation, **DENG** was asked about the character of the **Ministry of Information**'s involvement with **Vimicro**. He responded that the investments made by the ministry in the company were the first venture investments made by any Chinese government organizations. Indeed government rules regarding investments were shaped in part as it explored the feasibility of investing in **Vimicro**. The co-founders own 65 percent of the company, the government the remaining 35 percent. However, the **Ministry of Information** is not represented on **Vimicro**'s board. **DENG** emphasized that government money is not enough; industry partnerships help far more.

DENG was asked whether he was concerned about the company's intellectual property and whether the government would help enforce its protection. He responded that it would be difficult to pirate **Vimicro**'s leading-edge technologies. Additionally, vendors who might be tempted to infringe on the company's intellectual property are invested in partnerships. He conceded that the intellectual property protection is considerably easier in the multimedia industries than in biotechnology, for example.

October 17 – Dinner

Chair: **LI Genxin**, Secretary-General, Institute of International Studies
Speaker: John Gibbons, Former Assistant for Science and Technology to President Clinton
Topic: "Lessons from the Past; Challenges of the Present; Opportunities for the Future"

JOHN GIBBONS

GIBBONS began his presentation with a chart providing data on the carbon dioxide concentration found in Antarctic ice cores over the past 400,000 years (and more recently by atmospheric sampling), and average temperature changes during that same period of time. While both fluctuate considerably, those fluctuations track closely. Until about 20 years ago, the peak level of carbon dioxide concentration of approximately 280 parts per million (ppm) occurred in 1800, at the beginning of the Industrial Revolution in Europe. That level has now been surpassed and is currently approximately 370 parts per million (ppm). It is projected to grow rapidly unless deliberate steps are taken to stabilize carbon emissions, mostly from combustion of fossil fuels.

He then turned to computer models of the earth's annual mean surface temperatures from 1850 to the present, showing that these models match observations only if natural forcings (e.g., volcanoes and solar fluctuations) and forcings due to human activities are taken into account. The latter account for most of the rapid warming since 1970. Climatologists sometimes speak in terms of three atmospheric stabilization emission paths: the first envisions a limit to the atmospheric concentration of carbon dioxide at 750 ppm, the second at 550 ppm or twice the pre-industrial level, and the third at 350 ppm. According to the first of these scenarios, the number of metric tons of carbon emitted into the atmosphere annually would continue to increase until about 2065 when it would be approximately 13 billion metric tons, after which it would slowly decline. The second and third scenario would result in more drastic reductions of atmospheric carbon. Following either scenario – particularly the third – could result in severe damage to the world's economy as a result of rapid changes in, for example, fossil fuel combustion and rapid abandonment of energy-intensive capital stocks such as automobiles and housing.

According to **GIBBONS**, one way to reduce atmospheric carbon emissions would be to increase the ratio of hydrogen to carbon in the principal fuels used throughout the world. The hydrogen to carbon ratio for coal is 1 and for petroleum is 2, while the ratio for methane is 4. It is possible to envision increased use of methane as a fuel during a transition to an economy in which non-fossil hydrogen would serve as the world's principal fuel. A hydrogen economy by the early years of the 22nd century is conceivable if action toward that end were undertaken soon.

GIBBONS noted, however, that it will be difficult to achieve sustainable growth absent a leveling of the world's population growth which increases the demand for energy. According to the current, exponential growth model of development, any change in the efficacy of energy use translates to only delaying for a few years the inevitable growth of demand. On the other hand, in an equilibrium growth model, the change in efficiency of energy use translates to a permanent lowering of demand, and therefore, pollution for a given level of economy.

GIBBONS concluded by listing three imperatives that will be essential if the world is to achieve sustainable growth by the 22nd century: first, stabilize human population growth; second, transform production from "open" to "closed" systems; third, make available the necessary resources to support research and development (R&D) aimed at achieving sustainable growth, such as making the transition to a hydrogen economy as rapidly as possible. All three imperatives, but particularly the third, would benefit from increased international cooperation.

Achieving sustainable development represents a related set of long-term challenges. Several successive new generations of well trained, highly motivated, and adequately equipped scientists and engineers in China, the United States, and in other countries will be called upon to continue to address those challenges for the balance of this century.

H. Roundtable 1: Lessons Learned During the Evolution of China-U.S. Relations Since Normalization

The first roundtable was chaired by **LI DAOYU**, former Ambassador of the People's Republic of China to the United States of America. **ELIZABETH MOREL**, B.S. Chemical Engineering, University of Kansas, 2006, served as rapporteur.

Many of the themes discussed at the session had to do with ***why*** China and the United States cooperate in science and technology, and ***how*** we might expand and deepen that cooperation in the future. Some commentators maintained that the relationship, at least its official, governmental aspect, is at a crossroads: can we strengthen and broaden cooperation in science and technology? Should the roles of the two governments working through the JCM be made more effective? Or should the mission of the JCM be recognized as limited and even restrictive?

Six participants delivered prepared presentations:

- **XIANGLI CHEN**, General Manager, Global Technology, GE Healthcare;
- **WU YIKANG**, Honorary president, China Association for Science and Technology Cooperation;
- **DENIS SIMON**, Provost and Vice President for Academic Affairs, Levin Graduate Institute, State University of New York;

- **DUAN RUICHUN**, former Vice Secretary General, **MOST**;
- **RICHARD SUTTMEIER**, Professor of Political Science, University of Oregon; and
- **ZHANG WEI**, Deputy Director, Department of Management Sciences, **National Natural Science Foundation of China.**

XIANGLI CHEN's presentation entitled, "Successes and Challenges of Industrial R&D in China," showcased the success of **GE Healthcare** in China as a case study of how a global company can develop an effective business strategy amidst globalization.

There are now about 750 multinational corporations with R&D centers in China. The approximately $2 billion they spend annually in the country amounts to 11 percent of total R&D spending in China. Thus, these centers are important in the country's innovation eco-system. GE has 12,000 employees in China, has invested more than $2 billion, and has annual revenues of approximately $5 billion.

CHEN emphasized that R&D lies at the core of **GE**'s business strategy in China, which is focused on capability and capacity building. This business strategy involves four related components: (1) manufacture – be a "local" company; (2) sell – obtain deep market knowledge and understand the customer's needs; (3) source – develop a competitive cost position regarding components, thus leveraging local capabilities; and (4) services - develop a service model to help ensure long-term competitiveness.

GE grows R&D competency one step at a time: starting with production transfer to localize and develop a supplier base. Then introduce value engineering and redesign, proceed to sub-system ownership and, finally, proceed to system-level new product introduction. At this stage, local capabilities can become internationally competitive. In short, start "local" develop into "global".

CHEN concluded that building an effective R&D organization requires that an organization plan strategically and stay the course. A central component of any strategic plan must be to invest in people. Hire only the best, and fully leverage returnees. Send organization leaders overseas, and bring technical experts to China. Provide training in "soft" skills, project management, design processes, and intellectual property protection. Finally, provide challenging opportunities that can build for long term success.

WU YIKANG's presentation entitled, "The Evolution and Experiences of Sino-American Scientific and Technological Cooperation," drew on his own long experience with bilateral cooperation to explore issues that need to be addressed for the future of the China-U.S. cooperative relationship in science and technology. He identified four distinct periods in the evolution of Sino-U.S. cooperation in science and technology: (1) the period of exchange at the non-governmental Level (1972 through 1978); (2) the period of vigorous development of governmental cooperation (1979 through the first half of 1989); (3) the period from depression to recovery (the second half of 1989 through 2001), and (4) the period of new development (2002 to the present).

WU noted that at present, Sino-American science and technology cooperation consists of four major components: (1) cooperation between the two governments, (2) enterprise-related cooperation, (3) cooperation at local and non-governmental levels; and (4) cooperation with returned scientists and visiting scientists in the United States. China and the United States have somewhat differing perspectives on their bilateral science and technology relations. China views it primarily in terms of benefits it brings to the country itself. However, a portion of the U.S. perspective on the relations is based on the somewhat negative review of the U.S.-China Science and Technology Cooperation made by the U.S.-China Economic and Security Commission in 2004.

Based on his own experience, **WU** stated that: (1) Sino-U.S. science and technology cooperation is of mutual benefit and can (and has) achieved "win-win" results; (2) although attention and support from the political leadership of both countries are required for the smooth implementation of science and technology cooperation, such cooperation should not necessarily coincide with diplomacy; and (3) the scientific and technological communities of both countries should be encouraged to promote a strengthening of bilateral cooperation in science and technology.

WU concluded by enumerating several problems he perceives in moving forward with China-U.S. science and technology cooperation, the principal ones being: (1) problems with agreeing on major cooperative projects in some areas, e.g., space; (2) the visa problem; and (3) export control issues.

DENIS SIMON's presentation on, "Sino-U.S. Technology Transfer Relations, 1981-2006: the Impact of Globalization," drew on his 25 years of experience in observing the science and technology-based economic development of China. He began by noting that the issue of technology transfer in Sino-US relations has been one of the most controversial and contentious in the recent history of the relationship. He proceeded to highlight three main salient features about the nature and thrust of these relations: 1) the steadily enhanced understanding and sophistication of China with respect to the operation and dynamics of the international market for advanced technology and equipment; 2) the growing divergence and lag between the strategic goals and objectives on the part of the American business community and the US government, and 3) the increasing impact of globalization on the bilateral relationship.

SIMON characterized the first attempts of U.S. companies to work in China during the 1980s as one of false starts and misunderstandings on both the U.S. and the Chinese sides. However, the policy environment and operating situation regarding technology transfer in the 1990s was one of steady normalization and improvement. In essence, Chinese participation in WTO has helped to lead to greater convergence between Chinese and U.S. commercial interests in the area of technology transfer.

SIMON emphasized that one of the most complex and least understood facets of U.S. technology transfer policy towards China has been the efforts by the U.S. government to balance its commercial interests with its national security concerns. On the one hand, the government has sought to restrict the export of sensitive technologies, while on the other it has sought to promote U.S. business interests in China and ensure the peaceful, economic development of the country.

He referred to the 1998 publication of what he characterized as "the now infamous Cox Report" as a key watershed event in the Sino-U.S. technology transfer relationship. What made the Cox Report so ominous were the rather explicit statements about alleged Chinese acquisition of U.S. classified and controlled know-how to support their advanced nuclear weapons and delivery programs, and the contention that the so-called "gap" between China and the United States in these strategic weapons areas had been closed by the concerted efforts of the China to access targeted technologies by legal and illegal means. Fortunately, according to **SIMON**, the weak analysis, mis-conceptualization, and innuendo contained in the document were not allowed to carry the day in terms of the long-term efficacy of the Cox Report. On the other hand, in view of the level of uneasiness in the U.S. Congress and several executive branch agencies regarding China's status as a global economic power and the more widespread concerns in the country about the impacts of outsourcing on U.S. employment, the appearance of another "Cox Report" could result in severe damage to the interests of the United States and China in developing mutually beneficial technology-transfer mechanisms.

According to **SIMON**, globalization has had a particularly major impact in the domains of technology, innovation, and competitiveness. Therefore, globalization will be an increasingly salient factor in Sino-U.S. technology relations. Globalization has had a huge impact on the perspective of U.S. firms regarding China and the potential role the Chinese economy will play in the years ahead. Whereas once China was a marginal player on the outskirts of the global innovation system, today it is steadily moving into the mainstream. Today, it is now increasingly the case, that to be a truly global firm, a company—whether it is GE, IBM, Intel, or Microsoft, must have an R&D and perhaps engineering presence in China. Moreover, American companies not only see China as a growing market, but also as a source for high end talent.

Chinese leaders have clearly embraced globalization, which means that some of the advantaged position held by US firms during the last twenty years may begin to evaporate as more technology transfer channels and options are available. Nonetheless, the fact that China is more closely integrated into the global innovation system and that US R&D operations in the country are a force for increasing this integration should be viewed in a positive light.

SIMON concluded his presentation by returning to an assertion made at the beginning of his presentation: namely, that technology transfer in the commercial realm will continue to be one of the most salient dimensions of the Sino-US bilateral relationship. Sensitivities regarding China already are high in the United States, and many American companies are extremely concerned about their domestic image at home with respect to out-sourcing of manufacturing and services, off-shoring of R&D, technology transfer and job loss, for example.

For the United States, it is time to recognize that the lag in perceptions and behavior around China technology issues between government and business must be bridged.

Debating whether China's growth is bad or good for the United States is simply counterproductive. Chinese growth and modernization is occurring and will continue to take place with or without U.S. participation.

"A vibrant Sino-US relationship in the area of technology transfer is critical for American competitiveness in the years ahead and also critical for the performance of the American innovation system. American and Chinese 'brainpower' and expertise joined together in the pursuit of common commercial as well as societal goals should be considered one of the fundamental building blocks for long-term, sustainable American prosperity as well as the continuous overall improvement in the quality of life for the Chinese people during the 21st century and beyond."

DUAN RUICHUN's presentation entitled, "Who is the Winner? Competition and Cooperation on IPR," examined the importance of adequate intellectual property protection both for international cooperation in science and technology and for effective domestic innovation. He began with a brief history. The first Sino-U.S. science and technology agreement negotiated in 1979 after normalization of diplomatic relations between the two countries was meant to be mutually beneficial to the science and technology communities in the two countries. One important issue not clearly recognized in the original agreement was intellectual property rights (IPR) protection. The first serious conflicts between the Chinese and U.S. governments occurred in negotiating an annex to the original science and technology agreement, dealing with: (1) conditions of technology transfer, (2) ownership and sharing of IPR under joint R&D projects; and (3) the treatment for the differences in IPR legislation in the two countries.

According to **DUAN**, progress was made in China in the IPR area during the 1990s. A good deal of this progress was related to China's negotiations for becoming a member of the **World Trade Organization** (WTO). These required the country to: (1) legislate international standards of intellectual property protection for the country; (2) develop an action plan for IPR enforcement; and (3) permit marketing access of foreign IPR products. 12 separate pieces of IPR-legislation were adopted by China between October 1997 and October 2001. The principles on which China's IPR legislation and action plan for enforcement are based are intended to: (1) insure equality and mutual benefit; and (2) be based on national conditions, while being close to international norms. Not only did the IPR legislation and action plan for enforcement satisfied the conditions for China's entry into the WTO, which occurred in 2001. They have also been incorporated into 98 official international agreements for science and technology cooperation negotiated successfully by the Chinese government. In short, they have been instrumental in shaping a better platform for cooperative relations.

DUAN asserted that considerable progress related to IPR has been made in China during the five years since its entry into the WTO: (1) the significance of innovation coupled with adequate IPR have been elevated to the status of a national strategy; (2) substantial IPR-related legislation has been adopted; and (3) many more IPR institutes and enterprises have been established. Still, there remain what **DUAN** referred to as "many blank pages" still to be filled in regarding IPR enforcement in the country. These include:

(1) changing social conceptions of IPR, (2) designing implementation rules, (3) incorporating IPR considerations into science and technology policies, (4) training enforcement teams, (5) learning about adequate judicial procedures, (6) establishing an adequate legal environment, and (7) supporting IPR-based enterprises.

In **DUAN**'s personal opinion (which he believes is also mainstream opinion), IPR infringements and piracies result in more damage to domestic industry than to foreign investment. They also have negative impacts in the long-term that far outweigh any putative short-term advantages.

At any rate, an IPR protection action plan for 2006-07 has been issued by the National Leading Group, and a National IPR strategy for 2006-2020 will soon be issued and implemented by the State Council.

RICHARD SUTTMEIER's presentation (prepared in collaboration with **CAO CONG** of the University of Oregon and the Levin Institute of the State University of New York) entitled, "China-U.S. Science and Technology Cooperation: Past Achievements and Future Challenges," focused primarily on research collaboration. He began by listing several of the achievements of such collaboration over the years, primarily: (1) establishment of what he referred to as a "web of relationships," (2) reinforcement of bilateral economic relationships, (3) contributions to technological development, and (4) indirect support of political relations. **SUTTMEIER**'s web of relationships consist of (1) activities under the U.S. and Chinese governments' umbrella science and technology agreement, (2) inter-institutional agreements, (3) non-governmental organization (NGO) activities, (4) scientist-to-scientist relations, and (5) corporate R&D activities.

SUTTMEIER then examined changing patterns of U.S.-China research collaboration in detail by means of bibliometric data. The number of Science Citation Index (SCI) papers with authors from Chinese research institutions rose from less than 15,000 in 1996 to almost 68,000 in 2005. The number of internationally co-authored papers with at least one Chinese author has also grown since 1996, but at a slower rate than the number of SCI papers. Therefore, the percentage of all internationally co-authored Chinese SCI papers fell from a high of 24 percent in 2002 to less than 22 percent in 2005. Between 1996 and 2005, China became an increasingly favored source of co-authors in the four scientific fields which he and **CAO** examined: cell biology, genetics, chemistry and nanotechnology. While the United States remains a favored source of co-authors in these fields for Chinese scientists, patterns of co-authorship have become more diversified for Chinese scientists since 1996.

SUTTMEIER observed that in the 1996-2005 period relations between China and the United States were often tense, that Chinese policy favored diversification, and that analysis of co-authorship data shows clear evidence of diversification. Yet China-U.S. research ties have strengthened. Why? He hypothesized that these strengthened relations depend in large measure to the fact that as of 2005, there were over 62,000 China PhD's in science and engineering working in the United States, excluding those born in Taiwan. Among them, almost half are U.S. citizens. The ages of 74 percent are between 30 and

49, that is, in the high scientific productivity age range. Analysis of co-authorship patterns between scientists working at U.S. and Chinese institutions indicate that in several fields, a majority of the U.S. authors are China-born PhDs'. It appears, then, that China-born PhDs' working in the United States have incentives to maintain their working relations with China. Likewise, China-based researchers have incentives to maintain ties with China-born scientists working in the United States.

These high levels of what **SUTTMEIER** referred to as "co-ethnic" research collaboration are one of five factors which he believes will influence the future of U.S.-China relations in science and technology. He stressed the impacts which China's Medium and Long-Term Plan (MLP), 2006-2020 for Scientific Development, are likely to have on those relations. Scientists are clearly in the lead in the basic research components of the MLP. There will be an increasing competition for scientific talent between China and the United States. If the strength of China-U.S. research relations is to persist during the period of the MLP, easy travel and communication will be essential, as will be the need for attention to scientific integrity. It is important that the United States recognize the strategic importance of science and technology for China's future, as well as the complexity of the overall science and technology relationship between the two countries. For China, it will be important to continue reforms of its science and technology system, to continue to work on intellectual property protection, to clarify the concept of *zizhu chuangxin* (most often translated as indigenous innovation), to make dual-use and military-related science and technology more transparent, and to tackle the problem of scientific misconduct.

SUTTMEIER concluded by emphasizing the imperative for both the United States and China to "build trust" on both sides of the relationship.

ZHANG WEI's presentation, entitled "Sino-U.S. Cooperation in Management Sciences: A Perspective from NSFC for the Past 25 Years," used the area of management science to illustrate possibilities for bilateral cooperation in the social sciences.

ZHANG began with a history of the evolution of management science in China. In the early 1980s following the Cultural Revolution, China began to send scholars to the United States to study management. Most of them were system scientists with prior experience in the United States, who began to direct their research objectives to the social-economic systems of China. During those years, mathematical programming models and optimal dynamic control theory were applied to macro-level systems for the needs of a centrally-planned economy. When it became clear by 1990 that establishing a market-economy would be the ultimate objective of China's economic reform, Master of Business Administration (MBA) education was introduced into the country based on the U.S. model. A new area of management study emerged to focus on the behavior of enterprises, the micro entities, and the basic elements of a market economy. During the 1990s, Chinese scholars of management began to develop academic cooperation in education and research with U.S. university faculty. But their studies were fundamentally "imitative" in the sense that U.S. management problems were analyzed using Chinese data.

ZHANG then described the progress that has been made in management science in China since the turn of the century. The Chinese leadership is now paying more attention to social and public affairs than exclusively to the issue of economic growth. This has stimulated the development of research in social system management and public administration in the context of China's developing economy. According to the **National Natural Science Foundation of China** (NSFC), the building blocks of what NSFC defines as Management Science and Engineering are business administration and public administration.

According to **ZHANG**, management sciences are more "context related" as compared with basic science disciplines. As a result, problem-driven and China-specific studies are gaining increasing attention. New phenomena are being discovered and new theories are being developed. With the increasing impact of China on the world's economy, internationally-recognized experts in management science are beginning to show their interest in studying China-related issues. As a result, Chinese scholars are becoming genuine academic partners rather than simply "data collectors" for U.S. – and other – foreign experts.

ZHANG concluded by suggesting that Sino-U.S. cooperation in science and technology has laid a firm foundation for the development of management science in China. The new level of cooperation by Chinese and foreign experts in management science is already leading the discipline to a "regime shift." From following others to making original contributions, Chinese scholars are now making original contributions to global knowledge of management.

The following three Chinese and three U.S. participants then provided brief reactions to these six prepared presentations:

- **LUO HUI**, Executive Office, **MOST**;
- **SUN XIANGDONG**, Associate Professor, Chinese Central Party School;
- **KONG DEYONG**, Executive Deputy Director General, Association for Soft Science in China;
- **EDWARD DAVID**;
- **KATHRYN MILLER-JENSEN**, post-doctoral associate, Massachusetts Institute of Technology; and
- **ROBERT ROBERTS**, Director, Science and Technology Policy Institute, Institute for Defense Analysis.

LUO found **SUTTMEIER**'s data on co-ethnic publishing intriguing. Although he had been aware for some time that China-born PhDs working in the United States maintain close connections with their compatriots in China, these were the first data he had seen that stressed those connections. **LUO** agreed that such connections are likely to be an increasingly positive factor in science and technology relations between the United States and China.

SUN agreed with **SIMON** that overall relations between China and the United States have changed considerably since normalization in 1978. Indeed, a closer look at history indicates that there have been several oscillations in the political and economic relations between the two countries since that time. What had started in large measure as an anti-Soviet alliance had to identify one or more different reasons for its existence after the collapse of the Soviet Union following the opening of the Berlin Wall in 1989. **SUN** also commented that **DENG XIAOPING** policy of openness has been followed consistently by the Chinese leadership since 1978.

KONG agreed with **ZHANG**'s description of the evolution of management sciences in China to its current mature status of being recognized internationally. He also noted that the fact that there is now a Department of Management Sciences at the **NSFC** illustrates how the scope of that organization has broadened since it was created 20 years ago.

DAVID questioned the notion that "trust" by itself could or should provide a sound basis for relationships between any two countries. Certainly that should be almost self-evident for relations between two such large and complex countries as the United States and China. Indeed, he found the notion "seductive" and counterproductive to the Forum's goal of exploring both positive and negative aspects of the science and technology relationship between the two countries. **DAVID** also took issue with **WU**'s assertion that bilateral science and technology relations between the United States can be pursued independent of "diplomacy" – that is, of the political aspects of our overall relations.

MILLER-JENSEN hoped that **SUTTMEIER** (and **CAO**) could broaden their analysis of international co-authorship to incorporate interdisciplinary areas since, as a biological engineer, she was firmly convinced that interdisciplinary collaboration would be an increasingly important component of future international collaboration between China and the United States. As one of the six young scholars who are among the U.S. Forum participants **MILLER-JENSEN** arrived in China approximately six weeks prior to the event and had been a guest researcher at **CAS's Institute of Biology** in Beijing since her arrival. A recent PhD recipient, she admitted that her perspective on science and technology cooperation was somewhat limited and no doubt a bit naïve. However, based on her experience at the **Institute of Biology**, she felt she had every reason to be optimistic about the future relations between the science and engineering communities of the United States and China.

ROBERTS stated that he was generally in agreement with the historical analyses of the evolution of U.S.-China relations since 1978 as explored by most of the prepared presentations. However, he thought it worth noting that scientific relations between the two countries predated normalization by many years. In particular, starting early in the 20^{th} century, many Chinese students had been enrolling in U.S. graduate school programs in science, engineering, and medicine. Likewise, up to the outbreak of hostilities between Japan and China in 1937, many Americans, including teachers and physicians, had spent several years working in China. So by the time the United States and the People's Republic of China normalized their relationship, there were many scientists and engineers in both countries with prior experience in collaborative activities (including

China-born PhDs working in the United States) who were eager to resume those activities and introduce new generations of scientists and engineers in both countries to the mutual benefits that could be derived from bilateral cooperation.

I. Roundtable 2: U.S.-China Relations in the Globalized 21st Century

The second roundtable was chaired by **JOHN GIBBONS**, former Assistant for Science and Technology to President Clinton and former Director, Office of Science and Technology Policy (OSTP). **EVAN MICHELSON**, Research Associate, Woodrow Wilson Center for International Scholars, served as rapporteur.

Key Summary Points:

- Many participants expressed the idea that U.S.-China relations, both in general and specifically related to science and technology, are moving toward a turning point. S&T issues will therefore affect and be affected by this change.
- The complexity of the S&T relationship involves numerous actors — particularly government agencies, universities, and firms — with multiple points of view.
- The changing nature of the U.S.-China S&T relationship raises the question of how the two sides adjust to this change in a manner that is beneficial for both countries.
- A number of potential solutions to this challenge were expressed, including:
    - Development of new institutions: This includes cooperation and collaboration between NGOs, public private partnerships, and advisory functions/councils to the JCM.
    - New Methods: Development of new theoretical methods of measuring the relationship and new practical methods (case studies, historical perspective, etc) as well.
    - Locus points of cooperation: There may be particular fields of S&T — such as energy and space — that are natural areas for cooperation.

Six participants delivered prepared presentations:

- **MU RONGPING**, Director-General, **Institute of Policy and Management, Chinese Academy of Sciences**;
- **J. THOMAS RATCHFORD**, Director, Program on Science and Trade Policy, George Mason University School of Law (speaking for **NEAL LANE**, former NSF Director, former Assistant for Science and Technology to President Clinton, and former Director of the Office of Science and Technology Policy);
- **FAN HONGFU**, Director of Beijing Office, ZTE Corporation;
- **SADEG FARIS**, Chairman and CEO, REVEO;
- **GONG KE**, President, Tianjin University; and
- **ALLEN SESSOMS**, President, Delaware State University.

MU RONGPING began his presentation entitled, “The Science and Technology of the United States and China – Change and its Impact,” by addressing the gap in science and technology between the two countries. During the past 10 years, the ratio of Science Citation Index (SCI) papers by U.S. authors has remained between 30 and 35 percent, whereas the ratio of papers by Chinese authors has increased from less than one percent to somewhat more than five percent. Thus, although there is still a large gap between SCI papers by U.S. and Chinese authors, that gap is decreasing. Likewise, in 2004, 80,000 patents were awarded to U.S. inventors, with 20,000 to Chinese inventors. However, in 1994 Chinese patenting was negligible, whereas U.S. patenting has leveled off since 1997. China is also closing the gap for patent applications.

The United States has dominated Nobel Prizes for more than 10 years. Also, the United States remains the world's leading country in information and communications technology (ICT), energy, materials, biology and medicine, resources and the environment, manufacturing, space, and chemistry and chemical technology.

MU then addressed possibilities for cooperation between U.S. and Chinese scientists. Citing data for the past 10 years, he demonstrated that the United States is favored over all other countries by Chinese scientists as a source of co-authors of research papers. In his opinion, there is considerable scope for expanded Sino-U.S. cooperation. Globalization is one imperative for such expanded cooperation. Others are China's abundant and increasingly capable pool of human resources for science and technology, and the huge market opportunities in the country. Increased scientific cooperation would be beneficial to both countries.

J. THOMAS RATCHFORD read a prepared presentation by **NEAL LANE** entitled, "A Time of Unprecedented Opportunity for U.S.-China Cooperation in Science and Technology."

LANE's paper admitted at the outset that he takes an optimistic perspective on U.S.-China cooperation based on four assertions, which he proceeded to justify:

First, there is little question that our two countries will emerge as world leaders in our respective hemispheres; and each of us face enormous challenges that will require the knowledge and tools of science and technology.

Second, the past century has shown that progress, as a nation, requires significant government investments in R&D, freedom on the part of the researchers to pursue the most interesting and important questions, and open sharing of ideas and results.

Third, the United States and China have had a long history of informal collaboration between their researchers and formal cooperation in selected areas of science and technology. But the scale of cooperation has not matched the opportunities, especially in recent years.

Fourth, we are now entering a time of unprecedented opportunity for scientific cooperation between our two countries on a much larger scale than in the past. And it is in both countries' best interests to take advantage of that opportunity.

Among the challenges that both countries face, the need for clean, efficient energy may well be the most important. **Richard Smalley**, the late Nobel Prize winner, often spoke about the need for revolutionary new energy technologies, which he felt nanotechnology would offer. **LANE** asserted that one reason he had worked hard to help put together President Clinton's National Nanotechnology Initiative is because he agreed with Smalley. The promise of nanotechnology is enormous; and the research community is making good progress, e.g. in areas like catalysis.

The United States consumes energy at five times the world average and over twice that of Europe, per capita. Correspondingly, it is one of the greatest emitters of CO_2 on the planet. Our challenge is to use energy more efficiently, aggressively pursue renewable energy sources for significant portions of our energy needs, and cut back emissions substantially. This can be done with innovative technologies and sound policy. China's energy consumption, per capita will increase along with economic growth. With sufficient investments in energy R&D and in the demonstration and deployment of new energy technologies, China can improve on the Western experience by using technologies that did not exist when the United States and other Western nations were building up their energy infrastructure. Some of those technologies still don't exist or are not yet ready for deployment. So, considerable R&D is necessary.

But, much energy research, particularly basic research, is inseparable from other important areas of research in the earth and life sciences, as well as the physical and mathematical sciences and engineering. In **LANE**'s opinion, several U.S. federal agencies, including the **National Science Foundation**, the **National Aeronautics and Space Administration**, and the **National Institutes of Health**, should expand their international cooperative efforts with China.

LANE concluded by reemphasizing his view that this is a time of unprecedented opportunity for cooperative research between the United States and China in a broad range of research areas. That fact, coupled with the large number of gifted Chinese science and engineering researchers, many of whom have studied in America and either remained there or returned to China, suggests that the time is right to launch a new era in U.S. – China cooperation in science and technology.

FAN HONGFU presentation entitled, "ZTE-Qualcomm Cooperation on CDMA," used his company's expanding relations with **Qualcomm** as a case study in mutually beneficial industrial research cooperation.

FAN explained that **ZTE** is the largest telecommunications equipment manufacturer in China. Founded in 1985, it was selected among Global Top 100 companies by Business Week. It has a total staff of more than 30,000, whose average age is about 30. As China's key high-tech enterprise, its products and services cover wireless, networks, terminals, data four fields, cooperating with 500 operators in more than 100 countries. **ZTE** has 14 research institutes in China and abroad.

The company has created a strategic cooperative technology department to launch extensive technical cooperation. Currently, **ZTE** has strategic cooperative relationships with **IBM**, **Intel**, **ADI**, **Ericsson**, **Alcatel, Lucent**, **Cisco**, **Qualcomm**, **Microsoft**, and **Texas Instruments**. **ZTE**'s CDMA2000 products are delivered to 70 countries, serving nearly 100 operators, with wireless capacity of over 40 million lines, mobile phone sales reached 10 million. **ZTE** is among the top three in the world in this area.

FAN noted that in 1995, **ZTE** started cooperation with **Qualcomm** for CDMA technology development. Since 2001, **ZTE** and **Qualcomm** established a special strategic partnership for the promotion of CDMA2000 both in China and worldwide. Currently, **ZTE** is marketing CDMA in the 20 countries where it has established a physical presence.

Promoting CDMA2000 technology around the world is in the common interest of both **ZTE** and **Qualcomm**. **Qualcomm** has authorized its IPR to **ZTE**, and has provided technical and services support. **ZTE** can therefore achieve development and industrialization, and as well as market advances.

FAN concluded by emphasizing the significance of cooperation between **ZTE** and **Qualcomm**. It is upgrading the status of the domestic telecommunications enterprises in the global market; boosting the development of CDMA technology in a global context, and promoting cooperation and exchanges between China and U.S. hi-technology enterprises.

SADEG FARIS opened his presentation entitled, "How Pioneering Innovations Close the Technology Gap and Achieve Technology Sovereignty," by defining innovation as "indigenous problem solving leading to an exclusive differentiation with anything that has occurred before." He went on to remark that, a country can close the innovation gap with more advanced countries only by means of pioneering, indigenous innovation. If it does so, then it achieves technological sovereignty. Otherwise, it will be subject to technological colonization.

The essence of **FARIS**'s presentation was an attempt to demonstrate how pioneering innovations close the technology gap, leading to technological sovereignty and harmonious relationships between people. He asserted that trading is the world's oldest profession and is deeply rooted in our DNA, and then noted that there are two kinds of trading: harmonious trading, which is natural, stable, and satisfying to both partners, and acrimonious trading which is unstable and unnatural. Large trade gaps can lead to significant problems; for example, with 4.6 percent of the world's population, the United States has 40 percent of the world's economy, with per capita earnings of $42,000 and a GDP of $13,500 billion. The trade gap between the United States and the European Union has grown in ICT, PCs, and biotechnology, for example, primarily because the United States has made pioneering innovations in all these fields, whereas Europe has not. When a trade gap is too wide, the result can be invasion, war, piracy, and counterfeiting.

According to **FARIS**, the rise and fall of civilizations for the past 5,000 years is directly correlated with technology gaps. Currently, the GDP of Japan and the European Union countries are declining, whereas those of the United States, China, and India are rising. Can we predict which of the latter two countries will close the technology/trade gap and achieve technological sovereignty?

GONG KE's presentation entitled, "Scientific Research and Social Development – The Role of Research Universities and their Industrial Cooperation," dealt with linkages between scientific research and social development. Chinese universities are currently educating approximately five million students. According to the Ministry of Education, there are 209,000 researchers working in Chinese universities. During the past five years, 50 percent of the national awards for scientific research were obtained by universities; 70 percent of China's science citation index (SCI) papers are from universities. In 2004, Chinese universities owned 12,000 patents.

Chinese universities not only educate students, but are also important centers for research and development (R&D). According to **GONG**, industrial cooperation is a very important characteristic of Chinese universities. About 50 percent of the research funds obtained by Chinese research universities come from industry. Many results of university R&D are directly transferred to industry. A large number of companies have joint labs with universities. For example, at Tsinghua University, there are 63 such joint research labs involving approximately about 60 companies, about 20 of them foreign. Moreover, university spin-off companies are becoming significant components of China's high-tech industries. Finally, cooperation between Chinese research universities and multinational corporations is growing rapidly.

GONG concluded by emphasizing that Chinese research universities, like their counterparts in other countries, are paying key roles in R&D. However, in his opinion they are more actively involved with applied research and cooperation with industry. He believes that Chinese research universities should increase their international cooperation and become more active on the global stage.

ALLEN SESSOMS began his presentation entitled, "The Role of U.S. Universities in Economic Development," by describing how the Bayh-Dole Act of 1980 resulted in a significant enhancement of university-industry research cooperation in the United States. The Act allows for the transfer of exclusive control over many government funded inventions to universities and businesses operating with federal contracts for the purpose of further development and commercialization. The contracting universities and businesses are then permitted to license their inventions exclusively to other parties.

SESSOMS continued with a quotation from **Henry Samueli**, Chairman of the Broadcom Corporation. "Who knows what my company's going to be doing in 20 Years? Probably something that was discovered at a university." A graduate of UCLA, Samueli went on to suggest that, "multidisciplinary centers like UCLA are replacing industry-sponsored research labs. That's the future."

SESSOMS noted that virtually all basic research today is university based, with a 10- to 20-year time horizon to possible commercialization. As that basic research work finds its way into applied research, the engineering schools pick it up and drive it to real-world applications. The vast majority of applied research is in the three to five to 10-year time horizon. Much of this applied research deals with high-priority, high-yield concepts that have been identified by industry or government. That's where universities have taken command. High priority research topics include avian flu, biotechnology, energy, homeland security, nanotechnology, and pharmaceuticals.

SESSOMS went on to provide data illustrating the impact of approximately a dozen universities (or clusters of universities) in various pars of the country on their state and local economies. The universities he selected vary considerably in size and include both state and private institutions. Universities create jobs and their activities generate both direct expenditures and tax revenues. Additionally, for every dollar spent from funds appropriated by state governments or from the interest on endowments, more than a dollar is attracted in the form of grants, contracts and gifts. In all the cases he cited, a significant multiplier effect is evident, with the activities of universities generating considerably more revenue than the amounts spent from appropriated or endowment funds to conduct those activities.

Following these prepared presentations, the following Chinese and U.S. participants provided brief reactions to them:

- **LIU JIANFEI**, Director, Office of Foreign Affairs, Chinese Central Party School;
- **MA LIANJIE**, Professor, College of Public Administration, Huazhong University of Science and Technology;
- **YUAN PENG**, Deputy Director, Institute for America Studies, China Institute of Contemporary Relations;
- **ELIZABETH MOREL**, Engineer, B.S. Chemical Engineering, University of Kansas, 2006; and
- **KATHLEEN WALSH**, Professor of National Security Affairs, Naval War College

Referring to **MU**'s presentation, **LIU** emphasized that the science and technology gap between China and the United States has been closing since normalization of relations between the two countries. China has been learning from the G8 countries. Although friction exists between the Chinese and U.S. governments, he agreed with **LANE** that the two countries have unprecedented opportunities for cooperation in science and technology.

MA made use of a proverb whose moral is "harmonious but different" to describe the cooperative science and technology relationship between China and the United States, and emphasized the need for leadership and for differing perspectives than had been presented at the Forum: e.g., from NGOs and current policymakers.

YUAN suggested that China-U.S. cooperation is entering a "third period," moving from agriculture (pre-WTO) to institution-to-institution or individual-to-individual (WTO), to a new era of openness. He argued that whereas political obstacles are decreasing, social and economic obstacles are increasing. Future cooperation efforts are emerging from a new dialogue between the commercial sectors that is going from the technical side to strategic planning side. He predicted that the emerging dialogue will focus on space, energy, and balancing rogue states with diplomacy.

MOREL stressed opportunities and needs for interactions between industry, universities, and government. In particular, industry experience is important for undergraduates. For example, the Massachusetts Institute of Technology (MIT) has a $50,000 program that rewards young entrepreneurs and stimulates them to engage in independent thinking, skill sets, risk knowledge, and big dreams. Perhaps there might be a possibility for a high publicity, joint U.S.-China undergraduate training program with industry.

WALSH suggested that since many of the presentations had referred to gaps, there should be more discussion on how to address those gaps: by understanding historical patterns, expanding current bilateral agreements, and exploring possibilities for new frameworks that might lead to new bilateral agreements. Who can address these issues? Beyond money, what leadership and effective/politically palatable approaches can be taken? What new people should be involved?

J. Highlights of Open Discussions

The Forum featured three open discussion periods: one after each of the two roundtable sessions, and a final discussion session during the afternoon of October 17. The following were among the more significant ideas raised or re-emphasized during these periods:

- It was generally agreed that international cooperation in any area – including science and technology – starts by identifying common interests, then building on those interests to discover other areas of potential mutual benefit. Along these lines, one U.S. participant suggested that analysis ought to be carried out on the economic benefits of cooperation. Several comments were made regarding differences in the dynamics of high-tech cooperation in different fields: e.g., IT and biotechnology.

- Cooperation in small science fields is quite different than in big science fields, and often considerably less controversial. Moreover, the role of governments varies in the two cases. Since normalization of relations between China and the United States in 1978, the roles of the two governments in small science cooperation has decreased, whereas their roles in large science cooperation have increased.
- Suggestions were made that China should take a bold new step to invite international collaboration in a big science field that would demonstrate its commitment to playing a responsible global role. For example, the Chinese Academy of Sciences might undertake a serious study of the feasibility of the country cooperating in a mission to Mars.

- Regarding the matter of trust as a basis for international relations discussed during Roundtable 1, one U.S. participant noted that the United States tends to be unilateral in dealing with other countries, including dealing with them in science and technology. For this reason, the country has sometimes been called an unreliable foreign partner in cooperative science ventures, particularly in big science projects. Such an approach certainly does not inspire trust.

- There was some discussion about the theme raised by **SIMON** in his Roundtable 1 presentation, on the need for a new way to understand the complexity of the current U.S.-China science and technology relationship that is multi-disciplinary, team-based, project-oriented, integrated, multinational, collaborative, inter-generational, and problem-directed.

- One participant noted that U.S.-China cooperation goes well beyond issues discussed at the Forum or the institutions (i.e., government, university, and industry) represented. For example, professional science and engineering societies in both countries have been cooperating for many years, as have NGOs in certain fields, most notably the environment. Along these same lines, there is nothing particularly new about scientific and educational exchanges between China and the United States. In 1854, Rong Pong graduated from Yale and thus became the first individual from China to graduate not only from a U.S. university, but from any university anywhere. Returning to China, he worked for many years to convince the Qing government, in 1870, to sponsor groups of young Chinese men to go to the United States to study. Tsinghua University owes its roots to Tsinghua Academy, established in 1911 to prepare young Chinese to study at U.S. universities. Thus, in a very real sense, educational links between the two countries may well be the oldest in the world.

There was considerable discussion about whether the biennial meetings of the JCM still provide an optimum mechanism for monitoring and enhancing China-U.S. S&T cooperation. U.S. participants tended to be more skeptical than the Chinese about the JCM's utility. It was pointed out that for a very few months preceding a JCM meeting, science and technology cooperation receives significant attention at the highest levels of the two governments. Relevant government organizations in both countries prepare position papers and reviews on their immediate past cooperative activities and future prospects for cooperation. However, the JCM rarely takes the broad, analytic view of science and technology cooperation whose desirability was advocated by several participants at the Forum. (As a case in point, relatively few JCM members from either country attended appreciable portions of the Forum, even though the Forum had been endorsed by the JCM and deliberately scheduled for the two days immediately preceding the JCM meeting.)

There seemed to be a strong feeling among the Chinese participants in the Forum that the JCM mechanism for promoting and strengthening bilateral science and technology cooperation between the United States and China could be improved. The importance of a high level bi-lateral mechanism of some description, they believed, is essential to the continued vigor and health of that relationship. Individual government science and technology-related organizations in both countries communicate on a continuing basis between the biennial meetings of the JCM. One option for restoring the vitality of the JCM might be for relevant interagency groups in both countries to invite representatives of appropriate non-government organizations to join them in monitoring the broader, non-governmental aspects of the science and technology relationship on a continuing basis, and to explore options for new approaches. Representatives from the expanded U.S. and Chinese groups could meet periodically to compare notes and coordinate their activities.

The concept of strong non-governmental organizations dedicated to bilateral (and multilateral) S&T cooperation was proposed and discussed. Such organizations could be national or bilateral, and might be modeled in some respects on the China Association for International Science and Technology Cooperation (CAISTC). Such "bottom up" non-governmental groups would supplement and not compete with the governmental JCM process. They would be consistent with suggestions from CAISTC leaders such as **WU YIKANG** and **LIU ZHAODONG**, and by **NEAL LANE** (in his prepared remarks) and **ALLEN SESSOMS**. There was agreement to pursue these suggestions further following the Forum.