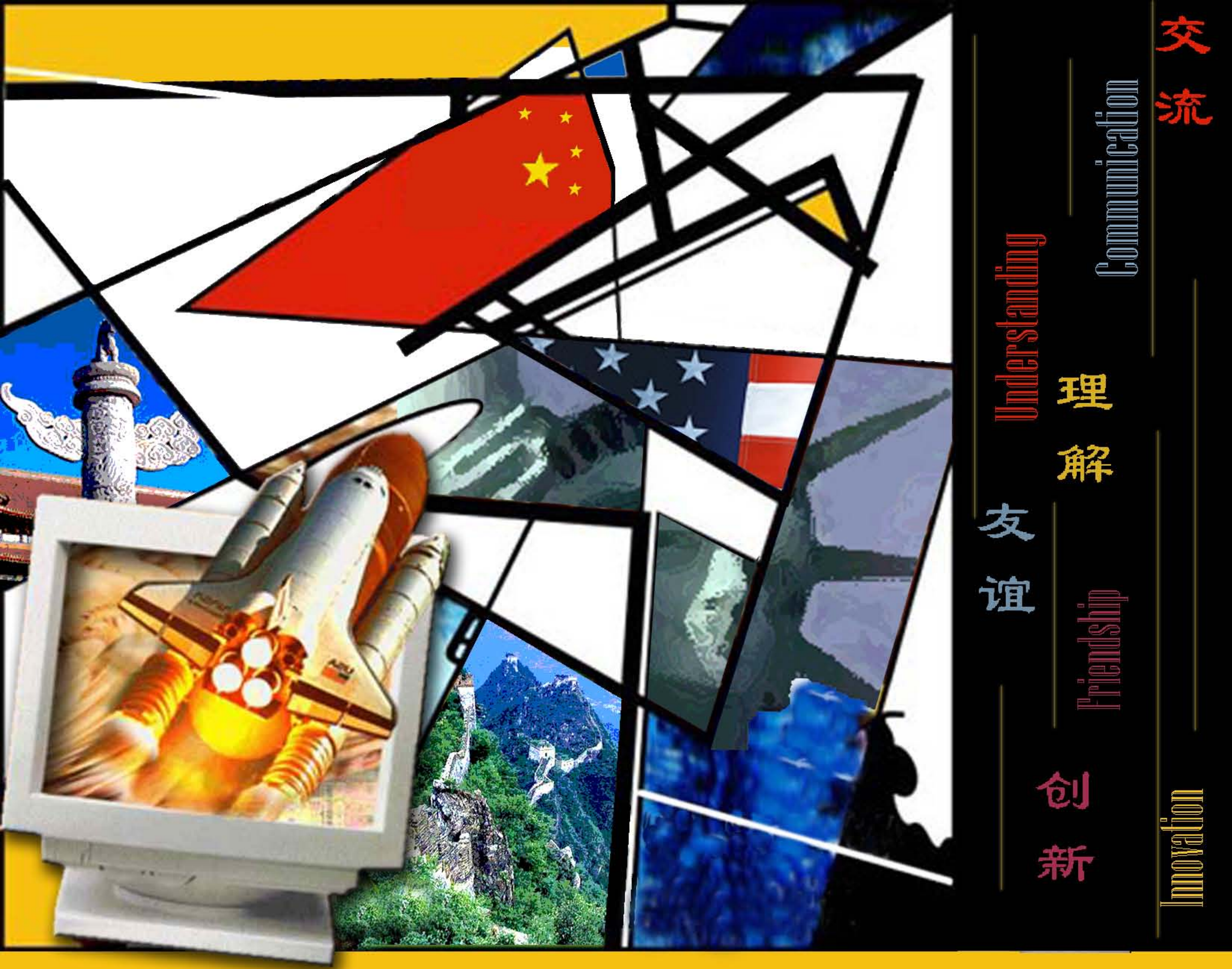

REPORT TO NATIONAL SCIENCE FOUNDATION:

INSIGHTFUL UNDERSTANDING OF CHINA'S HIGHER EDUCATION AND RESEARCH IN COMPUTER SCIENCE AND INFORMATION TECHNOLOGY

U.S. Senior Computer Scientists Delegation Visit to China

May 20, 2006 - June 3, 2006

Report to National Science Foundation: Insightful Understanding of China's Higher Education and Research in Computer Science and Information Technology

U.S. Senior Computer Scientists Delegation Visit to China, May-June 2006

Randal Bryant, Carnegie Mellon University
Jason Cong, University of California, Los Angeles
Keith Marzullo, University of California, San Diego
Martha Pollack, University of Michigan
Debra Richardson, University of California, Irvine
Fred S. Roberts, Rutgers University
Marc Snir, University of Illinois, Urbana Champaign
Mary Lou Soffa, University of Virginia
Gurindar Sohi, University of Wisconsin
Valerie Taylor, Texas A&M University
Bryant W. York, Portland State University
Xiaodong Zhang, Ohio State University

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Introduction and Purpose of Trip

After continuous and dramatic economic reform for more than 25 years, China is now playing a critical role in the global economy and information technology is a key driver of modern Chinese economic development. China has rapidly developed its college and graduate education and research programs in thousands of existing and newly-established universities and research institutions. In the last 10 years, the number of colleges and universities with degree programs in computer science and technology has grown to over 700, with more than half of these less than 10 years old. In addition, many major and leading U.S. and other international computer software and hardware companies have quickly established research labs in China

Faculty and researchers in U.S. academic research institutions still seriously lack insightful understanding of the rapidly changing trends in Chinese universities and research laboratories, and of the corresponding strong implications for U.S. science, technology, and the economy. Under NSF sponsorship, a delegation of leaders of major U.S. computer science (CS) academic institutions (mostly deans and department chairs) visited China from May 20 to June 3, 2006. The goals of the trip were to establish a dialogue between leaders of major U.S. and Chinese computer science departments, to enable the U.S. leaders to gain insight into current and future trends in information technology (IT) research in China, and lay the groundwork for potential future interactions. A report to NSF summarizes the delegation's observations and recommendations and discusses the next steps that the delegation plans to pursue. Here we summarize the report. A full copy can be read or downloaded from the trip website at http://dimacs.rutgers.edu/Workshops/China/.

Itinerary

The delegation began its visit in Beijing, where it held a one-day U.S.-China Computer Science Leadership Summit with Chinese colleagues to discuss issues of common interest and participated in the opening ceremony for the new NSF Beijing office. The Leadership Summit was held at Beihang University, which also coordinated our local arrangements in Beijing and hosted us for an introductory banquet. In Beijing, we also visited IBM China Research Lab, Microsoft Research Asia, the Institute for Computing Technology (an institute of the Chinese Academy of Sciences), Peking University, and Tsinghua University. A subgroup visited Southeast University and Nanjing University in Nanjing, another visited Northwestern Polytechnical University and Xi'an Jiaotong University in Xi'an, and a third participated in the International Conference on Software Engineering in Shanghai. The entire group visited Shanghai Jiaotong University and took a side trip to Suzhou to Suzhou University.

The Chinese Academic System in Computer Science and Research in Chinese Higher Education

Chinese higher education is changing rapidly, so what we observed may not be the case even in the near future. The People's Republic of China (founded in 1949) did not officially establish academic degrees until 1981, when it began to offer bachelor's, master's, and doctoral degrees to students after their graduation. It has had a short history of graduate studies. In the summer of 1978, for the first time in its history, China started its national entrance exams to recruit graduate students in several established universities. The first accepted graduate students entered graduate programs, including M.S. programs in CS, in the fall of 1978. Entrance into Chinese universities is very competitive and only a small percentage of Chinese young people are admitted to universities. Admission to bachelor's degree programs is based on a national entrance examination. There are complicated quota systems that give priorities at different universities depending on field of interest, minority status, or geographical home. Admission into graduate programs depends on examinations, records, interviews, and student fields of interest. Matching up students to advisors and programs sometimes gives more weight to university and national priorities than to student interest. Once the match between student and advisor is made in a Ph.D. program, it is rare for a student to leave the program prior to completion.

According to the Ministry of Education, China had over one million graduate students in universities and research institutions in 2005 and now has the second highest graduate student population in the world after the U.S. Since graduate programs started very late, and since many older faculty members started research during the Cultural Revolution when research was seriously hampered, many senior faculty members do not have Ph.D. degrees. This, however, is changing rapidly. Chinese professors hold three ranks: associate professor, full professor, and Ph.D. advisor; the fast growth of Chinese universities has created a situation where only a small set of full professors are given this final rank and are thus eligible to supervise Ph.D. students. Our Chinese hosts expressed concern about ensuring and increasing the quality of research by faculty and students. For example, concern with quality of dissertations has led to new procedures at some universities involving anonymous review of M.S. and Ph.D. theses (except in cases where a student has had a paper accepted in an international journal).

Funding sources for Chinese IT researchers include:

- the National Natural Science Foundation of China (NSFC), which supports basic research and some applied basic research in the natural sciences;
- the Hi-Tech Research and Development Program (863 Program), aimed at enhancing China's international competitiveness and improving China's overall capacity of R&D in high tech areas;
- the National Basic Research Priorities Program (973 Program), the national keystone basic research program; and
- the Key Technologies R&D Program**,** which embodies the principle of orienting science and technology towards the main fields of economic development.

Funding from these sources has been dramatically increasing. NSFC’s annual budget, for example, has gone from 80 million RMB in 1986 to over 2 billion RMB in 2004. (RMB, or yuan, is the Chinese currency. At present, $1 is approximately 8 RMB.)

The development of high-performance grid computing is very important to academic computer science in China, and there are three national grid projects, China National Grid (CNGrid), ChinaGrid (China Education and Research Grid), and CROWN, all providing applications portals to launch an application.

It is reasonable to say that the Chinese central government plays a much stronger role in setting science and technology research directions than in the U.S., as most research funding is provided by the central government.

Overall Impressions and Observations

We were impressed with what is happening at Chinese universities and research labs, and we hope our observations will help NSF-CISE and the U.S. research community understand what is happening in China and succeed with new collaborations. These observations, however, are based on discussions we had at a limited number of universities and laboratories.

Research at Chinese Universities: Much of CS research in China focuses on systems – the underlying hardware, software, and networking required to support computation and communications. We also saw a number of projects focusing on practical applications of information technology, such as urban traffic management. We saw much less evidence of research in more "fundamental" aspects of computer science, such as algorithms, formal methods, programming languages, architecture, or AI methods. The emphasis in the presentations we saw was on topics involving hardware, grids, and networking. That said, we were not able to observe any of the work in detail. Much of the faculty’s research work is strongly mission-oriented, as universities play a key role in the development of technologies of strategic importance to China and, as noted above, in general economic development.

Faculty: Because of the rapid growth in number of Ph.D. students and low number of Ph.D. supervisors, many Ph.D. advisors are supervising more than a dozen Ph.D. students and many more M.S. students through a research group involving other faculty as well. There is no explicit tenure system, though termination of faculty seems rare. Many institutions seem to have a tradition of hiring their own Ph.D. graduates.

Performance Evaluation: Faculty and Universities: China puts great emphasis on ranking universities. Most universities we visited aspire to be in the top tier of international universities. Universities put a lot of weight on statistical measures derived from the Science Citation Index (SCI) and the Engineering Index (EI) in evaluating performance. The universities aspire to have their faculty succeed in publishing in leading international conferences and journals, and there was considerable discussion during our visit about how to increase the number of papers that Chinese faculty and students author in international journals. While emphasis on how to get papers published dominated discussion about research, a number of the faculty we talked to said they were interested in learning about research practices that would make them more internationally competitive.

Students and Academic Programs: We were unable to judge the quality of Ph.D. and M.S. dissertations. However, Chinese universities are paying significant attention to the question of how to enhance academic quality. There is an effort at some universities to modify curricula, inspired by U.S. curricula such as ACM Curriculum 2001.

Diversity: We heard conflicting information about the percentage of women faculty members and students at universities and women researchers at research labs. As in the U.S., the level of participation by women seems low. However, there does not seem to be a priority for achieving gender diversity. At several visits, our hosts said there is a national priority to increase the number of ethnic minorities through faculty hiring and student acceptance.

Job Market for Chinese Graduates: We heard contradictory comments about the job market for Chinese students with bachelor's degrees. At some schools we heard that it was difficult for all their students to get jobs, and in particular for women with a bachelor's degree. However, the administrators and professors at one teaching-oriented university told us that a high percentage (as high as 95%) of their students with B.S. or M.S. degrees find jobs in local industries after graduation. The M.S. and Ph.D. graduates at the top schools we visited do not seem to have difficulties finding jobs. Although we did not hear it often, our hosts at several universities said they aspire to reaching the point where they can train their Ph.D. students to compete for positions at good foreign universities, including in the U.S.

Foreign Students and Chinese Students Abroad: The Chinese government is encouraging its universities to set up joint research and education programs with foreign universities. Also, U.S. and other foreign universities are setting up campuses in China. At least one university we visited is setting up a "park" for foreign universities. The universities are aspiring to have more foreign students and to provide international experiences for an increasing number of their own students.

Infrastructure: The physical facilities we saw were modern and impressive, including a brand new campus, new buildings everywhere, well-equipped laboratories, and modern student work areas.

Industrial Research Labs and University-Industrial Connections: A growing number of Chinese universities have established "science parks" nearby. The universities and companies located in the science parks often have close relationships and the companies may be owned in part by universities. Industrial laboratories in China have a variety of different arrangements for collaborating with universities, including lab members teaching courses at universities, jointly organized research labs, curriculum development, Ph.D. Fellowships, and support of junior faculty. In some case, the companies are contracting with the universities to do what could be considered advanced development rather than research, e.g., porting a software package to a different platform. Some of the industry-sponsored projects we heard about would not be considered desirable by U.S. research universities.

Obstacles to Future Collaborations: The need for strong English communication skills, both oral and written, among Chinese graduate students is paramount. Many of the graduate students we met spoke reasonably fluent English, many CS textbooks used in classes are in English and some courses are now taught in English. This suggests that communication will be less of a problem as time goes on. Chinese emphasis on publication in journals rather than in conferences – a result of the emphasis on SCI and EI indexing and differences between SCI/EI publication driven research and impact driven research more common in the U.S. – may pose obstacles to collaboration with U.S. researchers working in the major/core computer science fields where publication in highly competitive conferences leads to greater visibility and attention from the community. Many funded projects in Chinese universities are now closely related to the economic development of the country. These would not be defined as basic research projects in the U.S., and that may pose another obstacle to collaboration with U.S. academic researchers.

Recommendations to NSF

Infrastructure for Collaborations: NSF should hold a follow-up Leadership Summit in the U.S. in 2007 and a follow-up activity in China in 2008, set up a joint U.S./China steering committee to develop ideas for future collaborations, and encourage China to put together a delegation similar to ours that would visit U.S. universities.

Multiple Kinds of Collaborations: International experiences are important for U.S. students and faculty. Possible models include internships, summers abroad, semesters abroad, short-term visits, faculty sabbaticals, international REU programs, and joint U.S.-China projects – including capstone projects for undergraduates and research projects. We should consider short courses in China taught by U.S. faculty and develop specialized U.S.-China symposia to deal with issues in CS education. Writing tutorials by successful writers from U.S. faculty, offered in China or prepared for use in China, could help.

Supporting Collaborations: Many scientific exchanges between the U.S. and China are already taking place independent of NSF assistance. However, modest NSF support could help to jump-start many more such exchanges. Availability of such support should be widely publicized. Chinese faculty can often raise the funds to come to the U.S. for visits. Ways to take advantage of this should be explored.

Obstacles to Collaborations: There are a variety of obstacles to collaboration between the U.S. and China. Attention should be paid to ways to break down barriers such as cultural differences, language, the Chinese system of priorities, visa issues, and limitation on availability of travel funding. We need to find ways to overcome obstacles to success of

U.S. student visits to China, including language, longer Chinese semesters, limited course offerings in English, no tradition of summer courses in China, and inconsistent alignment of course content between U.S. and China.

Concluding Comments

The delegation was very impressed with the exciting things that are happening in Chinese universities and international research laboratories based in China, and with the fast pace of progress. There are increasingly many opportunities for interactions with Chinese colleagues and these are to be encouraged.

To facilitate future collaborations, U.S. researchers need more information. NSF should develop ways to gather this. In particular, based on a short visit, we were unable to understand the relative strengths of different research programs. Achieving this understanding will require a more in-depth analysis. Some follow-up, including more in-depth visits, is a good idea. Our trip was limited (with one exception) to top-ranked universities, so we are not able to make an analysis of the situation in and status of CS in the vast majority of Chinese universities. With so many new universities being created in China, future monitoring of the status of newer and up-and-coming universities is necessary. Moreover, with rapid changes in higher education's status, priorities, resources, and its relationships to government and private industry, the situation is fluid. Regular monitoring of the situation is called for and the results of such monitoring should be given widespread dissemination to the U.S. CS community.

The Delegation:

Randal E. Bryant, Carnegie Mellon University, Professor of Computer Science, Dean of School of Computer Science

Jingsheng Jason Cong, University of California, Los Angeles, Professor of Computer Science, Chair of Department of Computer Science

Peter Freeman, National Science Foundation, Assistant Director for the Computer and Information Science and Engineering Directorate

Keith Ansel Marzullo, University of California, San Diego, Professor of Computer Science and Engineering, Chair of Department of Computer Science and Engineering

Martha E. Pollack, University of Michigan, Professor of Computer Science and Engineering, Associate Chair for Computer Science and Engineering (Department of Electrical Engineering and Computer Science)

Debra J. Richardson, University of California, Irvine, Professor of Informatics, Dean of Donald Bren School of Information and Computer Science

Fred S. Roberts, Rutgers University, Professor of Mathematics, Director of Center for Discrete Mathematics and Theoretical Computer Science

Marc Snir, University of Illinois, Urbana Champaign, Professor of Computer Science, Head of Department of Computer Science

Mary Louise Soffa, University of Virginia, Professor of Computer Science, Chair of Department of Computer Science

Gurindar Singh Sohi,, University of Wisconsin, Madison, Professor of Computer Science, Chair of Department of Computer Science

Valerie Elaine Taylor, Texas A&M University, Professor of Computer Science, Head of Department of Computer Science

Bryant W. York, Portland State University, Professor of Computer Science

Xiaodong Zhang, Ohio State University, Professor of Computer Science, Chair of Department of Computer Science and Engineering

Wei Zhao, Texas A&M University, Senior Associate Vice President for Research, on assignment to National Science Foundation as Director of Division of Computer and Network Systems

For biographies of the delegation members, see http://dimacs.rutgers.edu/Workshops/China/member.html.

U.S. Senior Computer Scientists Delegation

ORGANIZING COMMITTEE

Peter Freeman, National Science Foundation

Fred Roberts, Rutgers University

Xiaodong Zhang , Ohio State University

Wei Zhao, National Science Foundation

DELEGATION MEMBERS

Randal Bryant, Carnegie Mellon University

Jason Cong, Univ. of California, Los Angeles

Keith Marzullo, Univ. of California, San Diego

Martha Pollack, University of Michigan

Debra Richardson, Univ. of California, Irvine

Marc Snir, Univ. of Illinois, Urbana Champaign

Mary Lou Soffa, University of Virginia

Gurindar Sohi, Univ. of Wisconsin, Madison

Valerie Taylor, Texas A&M University

Bryant York , Portland State University

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