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Chairman D'Amato, Commissioner Mulloy, members of the commission, and distinguished guests, I appreciate the opportunity to appear before you today on behalf of the National Science Foundation (NSF) concerning China's science and technology trajectory.

First, I'd like to set the broad context for my presentation with a brief overview of the NSF and the mission we fulfill. Then, I'll speak briefly to two sets of indicators relevant to today's discussion—R&D and education.

For more than fifty years, the NSF has been a strong steward of America's science and engineering enterprise. NSF's $5.5 billion annual budget represents roughly 4 percent of the total federal budget for R&D. It's an important 4 percent, supporting half of the non-medical basic research conducted at U.S. academic institutions.

In the federal R&D structure, NSF is a unique agency. We do not have a mission-oriented-research-objective such as energy, health, agriculture, or space. Instead, we advance learning and discovery in all disciplines of science and engineering and foster connections among them. It is NSF's job to keep all fields of science and engineering focused on the furthest frontier, to recognize and nurture emerging fields, and to prepare coming generations with scientific talent.

NSF supports the best and brightest people, ideas, and tools in the nation through a peer-reviewed granting process. At present, NSF receives more than 40,000 proposals per year. NSF's merit review system is widely imitated around the world, and numerous governments, including China, have created their own science foundations based on the NSF model.

In addition to NSF's day job of guiding science and engineering to the latest frontier, the agency is Congressionally mandated to provide a central clearinghouse for the collection, interpretation, and analysis of data on scientific and engineering resources, and provides a biennial report to Congress titled, "Science and Engineering Indicators."

Hence, I'm here today to highlight some important data indicators to support your policy discussion.

It is important to note that not all of China's data are fully internationally comparable. Because there are often questions about individual data points, it is most useful to look at overall trends.

While China's science and technology enterprise lagged significantly behind other countries in the early 1990s, the last decade has seen phenomenal growth in a number of key indicators. The Chinese Government has instituted strategic policy initiatives intended to "revitalize the nation through science and education." These policies have been articulated through a number of formal channels, including the 1995 National Conference on Science and Technology and the tenth five-year (2001-2005) S&T plan. China's Ministry of Science and Technology reports that the policies have boosted China's overall high-tech development, R&D capacity, socio-economic development, and national security.

A few statistics will highlight the rapid growth of China's science and technology enterprise, including industrial advances and R&D investments, and education infrastructure and the workforce.

By 2001, China accounted for 9% of the world's high-tech exports. This is a reflection of the three-fold increase in production by high-tech industries in China between 1996 and 2001. It is notable that in-house production, characterized as "value added," also grew at the same rate as total production (Appendix Table 1).

Because the size and openness of the U.S. market provides incentives for foreign inventors to apply here for patent protection, trends in the number of U.S. patents issued to foreigners can indicate changes in patterns of inventiveness. The number of patents granted to U.S. inventors grew from 61,104 in 1996 to 86,973 in 2002, an increase of 42%. Over the same period, patents granted to Chinese inventors increased four-fold from 134 to 522. Because the review process leading up to the official granting of a U.S. patent takes approximately 2 years on average, trends in the number of U.S. patent applications provide a more up-to-date, albeit less certain, indicator. For the period 1996 to 2001, the number of U.S. patents applied for by Chinese inventors increased by three and one-half times.

Another indicator is the amount of funds U.S. parent companies invest in R&D in their majority-owned affiliates in China. In 1994, R&D expenditures at the 172 U.S. majority-owned affiliates in China totaled only $7 million. By 2000, the number of affiliates had increased to 454, and R&D expenditures reached $506 million, representing 2.6% of total overseas R&D by U.S. companies, and making China the eleventh largest host of U.S. R&D expenditures overseas. Moreover, U.S. affiliates in China invest relatively more in R&D compared with U.S. affiliates in other countries, as measured by the ratio of their R&D spending to their value-added gross product. In 2000, this ratio was 9.2% for U.S. affiliates in China, compared with 3.3% for the aggregate of U.S. affiliates in all host countries.

Gross expenditures for R&D (GERD) are an indicator of overall capacity for technological innovation. In 1996, China's R&D investment totaled $20 billion in Purchasing Power Parity dollars – only 10% of the U.S.'s investment. By 2002, China's investment reached $72 billion, representing 26% of U.S. expenditures and positioning China as the third largest investor in R&D, after the United States and Japan.

The ratio of Gross Expenditures for R&D (GERD) to Gross Domestic Product (GDP) is a measure of the share of the economy devoted to innovative activity and technological change. The U.S.'s GERD to GDP ratio has fluctuated between 2.4 and 2.7 for many years. China's GERD to GDP ratio more than doubled from 0.6 in 1996 to 1.29 in 2002. What makes this rapid rise in the GERD to GDP ratio more impressive is that it occurred against the backdrop of a very rapidly expanding economy, with an average GDP growth of almost 10% per annum. The Chinese Government has a stated goal of increasing R&D expenditures to 1.5% of GDP by 2005, and seems well positioned to do just that.

The human dimension of innovation, including knowledge creation, education, and workforce, offers another set of key indicators. Several prominent trends regarding education in the U.S. and China have emerged.

Higher education policy in China has resulted in a shift from an elite-based education system to a mass-oriented education system. During the 10-year period ending in 2001, China almost tripled its number of workers with associate degrees or higher, adding nearly 30 million college-educated workers to the labor pool. During the same period, the U.S increased its number of workers with associate degrees or higher by only one-third. The trend suggests that China's number of college-educated workers will soon surpass that of the United States.

With 10% of their 18-22 year olds enrolled in tertiary education in 1999, the Chinese Government set a goal to increase that ratio to 15% by the year 2010. The goal was nearly reached in just 3 years, with enrollments of 14.7% in 2002.

The number of Chinese students getting bachelor's degrees in science and engineering increased from 281,245 in 1996 to 337,352 in 2001, a 20% increase. Comparable data show a 4% increase for the United States, with 398,622 science and engineering bachelor's degrees in the year 2000. There has been even greater growth for doctoral degrees in science and engineering in China, nearly doubling from 1996 to reach 8,153 in 2001. During the same 5-year period, the number of science and engineering doctoral degrees in the United States remained essentially flat at 25-27,000, of which approximately 40% went to non-U.S. citizens. As a point of comparison, at over 8,000, China is now the largest producer of science and engineering doctoral degrees in the Asian region.

It is noteworthy that, while science and engineering account for about one-third of all bachelor's degrees in the United States, these fields account for nearly 60% of bachelor's degrees in China. The Ministry of Science and Technology reports that, as of 2003, there were 5 million students enrolled in science and engineering programs at Chinese universities. Data on China's science and engineering degrees over the next 5 years should be interesting indeed!

An indirect indicator of the development of a trained science and engineering labor pool is the number of individuals born in a country who are employed in science and engineering occupations within the United States. The number of individuals with college degrees who were born in China and employed in science and engineering occupations in the United States rose from 31,000 in 1990 to 124,000 in the year 2000, constituting an increase from 1.2 to 3.1% of all tertiary-degreed individuals working in S&E occupations in the United States. During the same period, the number of doctoral degree holders employed in U.S. science and engineering occupations who were born in China increased from 5,500 to 33,000, representing an increase from 2.6 to 8.7% of the total number of doctoral degree holders working in U.S. science and engineering occupations (Appendix Table 3).

In summary, I hope this snapshot of data provides useful context for your policy-making efforts. China faces many challenges in developing its science and technology enterprise, including social, political, organizational and bureaucratic constraints. However, data show significant growth in China's high-tech industries, and in their investments in R&D and education. Given their enormous reserve of human capital, and the increasingly global nature of science and technology in the 21st century, China appears poised for continued rapid growth in the future.

The National Science Foundation looks forward to tracking future trends and to continued participation in such timely discussions. Thank you again for the opportunity to appear before the commission.

Appendix Table 1.

China's S&T Trajectory
R&D Indicators

	United States			China				
	1996	2001	2002	1994	1996	2000	2001	2002
World High-Tech Exports (%)	20	17			7		9	
High-Tech Industries Production (billions of 1997 U.S. $)	597	941			93		266	
Value-Added Production (billions of 1997 U.S. $)	258	412			24		70	
Value Added/Production (%)	43	44			26		26	
U.S. Patents Granted to Inventors of U.S. and Chinese Origin	61,104		86,973		134			522
U.S. Patent Applications from Inventors of U.S. and Chinese Origin	106,892	177,511			364		1252	
R&D Expenditures of U.S. Majority-Owned Affiliates in China (millions of current U.S. $)				7		506		
Value Added/Gross Product of U.S. Majority-Owned Affiliates in China (millions of current U.S. $)				678		5,516		
Ratio of R&D to Value Added to Gross Product for U.S. Majority-Owned Affiliates in China (%)				1.0		9.2		
Number of U.S. Majority-Owned Affiliates in China				172		454		
Gross Expenditures on R&D (billions of U.S. $ in current PPP)	198		277		20			72
GERD/GDP (%)	2.6		2.7		0.6			1.3

Appendix Table 2.

China's S&T Trajectory: Education Indicators

	United States					China		
	1991	1995	1996	2000	2001	1991	1996	2001
Tertiary-educated Workers (thousands)	45,403				59,185	16,121		45,709
S&E Bachelor's Degrees		384,674		398,622			281,245	337,352
S&E Doctoral Degrees			27,243		25,509		4,428	8,153

Source: Science and Engineering Indicators 2004, National Science Board; and other

Appendix Table 3.

China's S&T Trajectory:
Workers in U.S. S&E Occupations

	Born in United States		Born in China	
	1990	2000	1990	2000
	(thousands)		(thousands)	
Bachelor's or Higher Degree	2,185	3,068 (77%)	31	124 (3.1%)
Doctoral Degree	159	240 (62%)	5.5	33 (8.7%)

Source: Science and Engineering Indicators 2004, National Science Board