Testimony Before the U.S.-China Economic and Security Review Commission

"China's Growing Space Capabilities: Implications for the United States"

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Thank you, Mr. Chairman, for providing an opportunity to discuss this important topic. Earlier presentations today have covered Administration and Congressional views along with perspectives on China's military space programs and their implications. I am honored to provide some thoughts on China's civil space program and what implications it might have for the United States.

China launched its first satellite in 1970 – the same year as the first satellite launch for Japan. It began offering commercial launch services in 1985, launched its first astronaut in 2003, and sent its first probe to the Moon in 2006. China conducted its first space walk in 2008 and is actively developing a space laboratory and an even more ambitious space station.

The first point that should be made is that China does not have a fully separate civil space program in the model of NASA and U.S. civil space activities. China's development of space capabilities began in the mid-1950s at the direction of the Central Military Commission, less than a decade after the founding of the People's Republic. The development of space launch vehicles were part of the same development of diverse aerospace capabilities such as rockets, guided missiles, and aviation. China's human space flight efforts are managed by the elements of the People's Liberation Army (PLA) and require industrial capabilities that are the same as those used for military programs. Thus it might be more accurate to say that China has civil space activities, such as science and exploration, but does not have a civil space program.

An important second point is that China sees its space activities as part of what it sees as "comprehensive national power." That is, the development of space capabilities contributes to China's overall economic, military, foreign policy, and even social and cultural objectives. Space launch capabilities represent a dual-use capacity that can be used for long-range ballistic missiles. Requirements for human space flight are used to improve the quality control of Chinese industries. Offers of space technology to developing countries are used to secure access to needed raw materials for the Chinese economy. Chinese astronauts are helpful to promoting the China "brand" in promotional videos and international conferences. Interestingly, China has also recognized the achievements of persons of Chinese descent, such as Taylor Wang – an American scientist who flew on the Space Shuttle in 1985. While an American citizen, Dr. Wang's achievement as the first person born in China to fly in space has been included in lists of Chinese achievements in space.

China's first steps toward a manned space program began in 1967 during the height of the U.S.-Soviet space race with Project 714. This was an ambitious effort to place two astronauts in orbit by 1973. It was cancelled in 1972 due to economic constraints and the domestic turmoil of the Cultural Revolution. In 1986, a new manned space program was proposed by the Chinese Academy of Sciences that sought to create a manned spacecraft and associated space station. This effort became Project 921 that was formally authorized and funded in 1992. Today's Shenzhou spacecraft and the soon to be deployed Tiangong space station module were developed by Project 921.

The history of Chinese manned space activities leads to a third important point. China has engaged in a steady, long standing effort to build and strengthen its space capabilities. Current programs are not the results of "crash" efforts but have spanned almost the entire period of the modern Chinese state. Table 1 shows the dates of major space milestones for China, Russia, and the United States.

China has achieved progressively more ambitious space capabilities over a longer period of time and with fewer missions than those of the United States or the Soviet Union. They have proceeded cautiously but steadily without any sense of racing an adversary. While recognizing the experience gap with the partners on the International Space Station, there is a risk of underestimating how soon China will have comparable space capabilities to those same partners. It is not a question of whether China will have a full range of human space flight capabilities, but a question of when and what they intend to do with those capabilities.

One possible use for Chinese human space flight would be to advance Chinese foreign policy objectives. The Soviet Union and the United States both used flights of foreign astronauts as symbolic means of aiding allies and creating good will. China could do the same as well as using such flights to support economic growth by securing supplies of raw materials and access to markets. Chinese space cooperation agreements in Africa (e.g., Nigeria) and Latin America (e.g., Brazil, Venezuela) have reportedly included offers of technology, training, loan guarantees, and other inducements to trade.

As its space capabilities increase, China is becoming more active in international organizations such as the International Astronautical Federation and is hosting more space conferences. China leads an inter-governmental space cooperation organization, the Asia-Pacific Space Cooperation Organization (APSCO) that is similar in some respects to the European Space Agency. APSCO is based in Beijing with member space agencies from Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey. China is also a member of a less formal association of space agencies, the Asia-Pacific Regional Space Agency Forum, led by Japan. The forum includes space agencies, governmental bodies, and international organizations, as well as non-government organizations such as companies, universities, and research institutes. Japan is among the many Asian countries with its own space ambitions that are paying attention to China.

At recent international conferences, China has given clear indications of what its next steps are in human space flight as shown in Figure 1. It plans to place an unmanned module in space, demonstrate docking using another unmanned module and then send a crew to visit a modest space laboratory, Tiangong. In some respects, this would be similar to what the Soviet Union did in the Salyut space station program. Following the Tiangong would be a more ambitious space station akin to the Soviet and Russian Mir space station. It would consist of multiple modules with an overall mass of about 60 metric tons to which a single Shenzhou ship could dock along with an unmanned cargo resupply vehicle. Interestingly, on current schedules, this station would be deployed about the same time as the International Space Station may be preparing to close down.

China does not publicly have a formal program for sending humans to the Moon. However, the Chinese are making progress toward acquiring the capabilities necessary to conduct such missions. For example, the Chinese EVA suit derived from the Russian Orlan design has boots with heels – and other features for walking on a surface as well as floating outside a spacecraft. While I was at NASA, we did a notional analysis of how Chinese might be able to send a manned mission to the Moon. We concluded that they could use four Long March 5 vehicles, capable of lifting 25 metric tons each, to place a little under 15 metric tons on the lunar surface. This is about the same mass as the U.S. lunar modules that were launched by a single Saturn V. Figure 2 shows the notional concept developed in 2008. As said earlier, it is not a question of whether China will have a full range of manned space flight capabilities, but what the nation intends to do with those capabilities.

Growing Chinese space capabilities have naturally created speculation about future international space cooperation. A recent issue of *Aviation Week and Space Technology* (April 22, 2011) covered the wide and diverse range of international aerospace cooperation with China, notably in commercial aircraft. Such cooperation includes a full range of U.S. and European suppliers as well as traditional rivals, Boeing and Airbus. The amount and depth of cooperation is even more striking when compared to the minimal level of cooperation in space, even including space and Earth science.

The two most recent U.S.-China summit meetings include brief joint statements on space (emphasis added):

"The United States and China look forward to expanding discussions on space science cooperation and starting a dialogue on human space flight and space exploration, based on the principles of transparency, reciprocity and mutual benefit. Both sides welcome reciprocal visits of the NASA Administrator and *the appropriate Chinese counterpart* in 2010." - Beijing, China – November 17, 2009

"The United States and China agreed to take specific actions to deepen dialogue and exchanges in the field of space. The United States invited a Chinese delegation to visit NASA headquarters and other appropriate NASA facilities in 2011 to reciprocate for the productive visit of the U.S. NASA Administrator to China in (October) 2010. The two sides agreed to continue discussions on opportunities for practical future cooperation in the space arena, based on *principles of transparency, reciprocity, and mutual benefit*." - Washington, DC – January 19, 2011

The 2009 statement was vague regarding who the Chinese counterpart to the NASA Administrator would be as that seems to be unclear even to the Chinese. The China National Space Administration (CNSA) had previously been used as the "civil" interlocutor for space cooperation and it was initially assumed this might hold true for discussions of human space flight. However, the technical capabilities and management of human space missions resides with the PLA and it has not be clear that the CNSA would "add value" to discussions. For the United States, however, it would also seem odd to have a former Marine Corps General (Administrator Bolden) meeting with senior PLA officers if the future for U.S.-China military-to-military dialogue continues to be as uncertain as it has been.[1]

Nonetheless, the NASA Administrator did visit China in October 2010 and the 2011 summit statement said that discussions of practical cooperation would continue on the basis of transparency, reciprocity and mutual benefit. The latter two principles are unremarkable and have been a consideration for all U.S. space cooperation since the beginning of NASA. The principle of transparency is a different consideration and goes to one of the central concerns with all Chinese space activities – a lack of understanding on how decisions are made and what strategic intentions drive them. In large part, such opacity is intentional on the part of Chinese officials. In various discussions, they have expressed their discomfort with even the term "transparency" and preferring other formulations such as "clarity of outcomes" – thus shielding their internal decision-making processes.

Gaining a better understanding of China's decision-making process and strategic intentions remains a central objective and problem for the United States. This applies to civil space cooperation as well as other areas of the relationship. To oversimplify, in the case of the Soviet Union, we knew their intentions as well as their capabilities. China is not the Soviet Union, thankfully, but we may know more about their capabilities than their intentions. It is also possible they may not know themselves, but it is hard to tell even that.

In the aftermath of the Cold War, the demise of the Soviet Union and the emergence of Russia, there was a compelling case for human space flight cooperation with Russia. The Russians had extensive experience with long-duration manned space station just as the United States was building its Space Station with multiple foreign partners. There was a desire to symbolize a new "post-Soviet" relationship with the United States. Finally, there was a desire to engage the Russian space community internationally in a constructive project as opposed to engaging in missile proliferation and other destabilizing activities.

Unfortunately, there are no compelling political or technical reasons to engage in human space flight cooperation with China. The Chinese have space capabilities but nothing

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1 For the moment, the dialogue is moving forward as the PLA Chief of Staff Chen Bingde will visit the United States this month.

unique that the United States needs.[2] As the Chinese themselves said the NASA Administrator Bolden during his 2010 visit (to paraphrase): "we don't need you and you don't need us but we could do good things together."

The question of cooperation with NASA may be moot for the moment due to Congressional language barring bilateral cooperation with China in the House 2011 continuing resolutions appropriations bill:

> SEC. 1340. (a) None of the funds made available by this division may be used for the National Aeronautics and Space Administration or the Office of Science and Technology Policy to develop, design, plan, promulgate, implement, or execute a bilateral policy, program, order, or contract of any kind to participate, collaborate, or coordinate bilaterally in any way with China or any Chinese-owned company unless such activities are specifically authorized by a law enacted after the date of enactment of this division.

Even if this language were not in place, I would not recommend engaging with China on human space flight cooperation. The technical and political challenges are just too great – as are the political risks of not meeting raised expectations. However, I do believe that scientific space cooperation with China could be mutually beneficial and reciprocal while improving our understanding of Chinese decision-making and intentions.

Space cooperation with China could start small with scientific projects that have minimal to no technology transfer concerns or potential for dual-use exploitation. As an example, European and Chinese cooperation in space plasma physics has been successful. Two Chinese "Double Star" spacecraft carrying European and Chinese experiments joined four ESA spacecraft in high orbits around the Earth. The combination of six spacecraft had produced new insights into the magnetosphere and the solar wind. A similar U.S. project might extend work in plasma physics and heliophysics on traditional basis of no exchange of funds and open sharing of the scientific data produced. For example, a primary source of solar storm warnings is an aging NASA satellite, the Advanced Composition Explorer (ACE), which is almost 15 years old. Solar storms and coronal mass ejections can cause damage to electrical power grids and telecommunication networks. While plans are in work to replace ACE, it would be beneficial to have more robust sources of warnings.

Cooperation need not involve creating new spacecraft but could involve ensuring compatibility and interoperability with existing spacecraft. China and the United States already participate in international voluntary standards bodies such as the Consultative Committee on Space Data Standards (CCSDS) that develops open standards that enable cross-support for telecommunications and space navigation. The United States has been engaged in discussions with China for some years on its COMPASS satellite navigation

[2] There is an argument that sole reliance on Russian Soyuz vehicles for access to the International Space Station (ISS) after the last Shuttle mission is risky. Should potential U.S. commercial suppliers have delays and are unavailable and the Soyuz is also unavailable, then it might be desirable to employ Shenzhou to reach the ISS as a back up capability.

system to ensure compatibility and interoperability. While GPS and COMPASS are both dual-use systems, commercial competition and open markets are expected to foster sales for satellite navigation receivers that can use the civil or open signals from both systems. Joint ventures are another way to engage commercially with China and strengthen international use and acceptance of GPS while avoiding transfer of sensitive space technologies.[3]

Given the reliance of United States on space systems, it is unsurprising that it seeks to reduce and mitigate the creation of orbital debris. The 2007 Chinese ASAT test of course added greatly to the orbital debris population. This was a regrettable action for many reasons, among which was that fact that China had earlier participated constructively in technical discussions within the Science and Technology Subcommittee of the United Nations Committee on the Peaceful Uses of Outer Space (COPUOS) that developed a consensus set of orbital debris mitigation guidelines. Nonetheless, the United States continues to seek Chinese cooperation on reducing the creation of orbital debris and routinely provides "conjunction warnings" to countries – including China – at risk from being struck by debris. If China is successful in maintaining astronauts in orbit for extended periods of time, they might have increased incentives to cooperation with ISS partners in reducing potential hazards to those astronauts.

If asked about protecting the space environment today, the likely response from China would include the Russian-Chinese draft "Treaty on the Prevention of the Placement of Weapons in Outer Space, the Threat or Use of Force against Outer Space Objects" (PPWT). The PPWT is outside the scope of my presentation today save to note that the United States rightly remains opposed to its adoption. In contrast, the United States is considering a European Union draft proposal for an international, voluntary, non-binding "Code of Conduct for Outer Space Activities" that would promote a variety of transparency and confidence building measures of value to all space-faring states. Such a code would have little value as just an agreement between the United States, Europe, and Japan but would be more effective if space powers such as China and India, as well as emerging space-faring states such as Brazil, Korea, Nigeria, and South Africa, were to adopt it. Thus, the United States should pursue a diplomatic strategy that encourages countries with which China cooperates in space to adopt the Code of Conduct as well as engaging with China directly.

Chinese space capabilities could be of potential value in reducing tensions on the Korean peninsula. While the six-party talks (North Korea, South Korea, China, the United States, Japan and Russia) are currently suspended, future discussions will continue to deal with missile proliferation as well as denuclearization. If North Korea were to give up its long-range missile capabilities and suspend space launch activities, it is likely that North Korean leadership will require inducements or compensation of some sort. One such offset could be Chinese launch services for North Korea satellites as part of broader

[3] On the topic of U.S. export controls, the sentiment in the Congress is clear. There will be no change to the current treatment of space technologies (U.S. Munitions List Category XV) with respect to China even if broader legislative reforms are passed.

agreement that eliminated North Korean strategic missiles. While highly speculative, it is possible to imagine constructive outcomes if China chose to pursue them.

On balance, Chinese civil space capabilities can be expected to increase in the future. China will be able to undertake unilateral and international space projects of increasing complexity that will in turn increase commercial, military, and diplomatic opportunities at times and places of China's choosing. Today, U.S. human space flight capabilities remain considerably ahead of China by all measures or experience, technology, industrial base, and partnerships. Unfortunately, the continuation of the current balance is uncertain. The United States has failed to develop an assured means for U.S. Government human access to space, the International Space Station is reliant on the Russian Soyuz and unproven commercial providers with a consequent risk of loss of the Station should there be a major accident on-orbit, and finally, the United States has failed to engage its existing international partners in a program of exploration beyond low Earth orbit. Plans for a human return to the Moon are on hold and no other human exploration missions are in work. All of these factors increase the odds that the United States will not be a global leader in human spaceflight after the end of the International Space Station sometime in the next ten years or so.

The most important implication for the United States from Chinese civil space capabilities is not that the Chinese will be in space, but that we may not be. The United States appears to have forgotten the strategic value of a national human space flight program regardless of the existence of successful private endeavors. This may not have a near term economic impact on the United States as a robust range of unmanned programs will continue. However, the lack of visible U.S. leadership in human space flight may have serious foreign policy and international security impacts. It is a long-standing truism that the rules of international relations in new domains are created by those who show up and not by those who stay home.

Thank you for your attention. I would be happy to answer any questions you might have.

Milestones in Space Capability

	China	Russia	United States
Satellite Launch	1970	1957	1958
Human Launch	2003	1961	1962
2-man crew	2005	N/A	1965
3-man crew	2008	1964	1968
Space walk/EVA	2008 (14 min.)	1965 (24 min.)	1965 (20 min.)
Space Laboratory	2011-2020?	1971 (Salyut 1) 1986 (Mir)	1973 (Skylab)
Circum-lunar flight	?	?	1968 (Apollo 8)
Space Station	2020?	2000 (ISS)	2000 (ISS)

Table 1 – Space Milestones

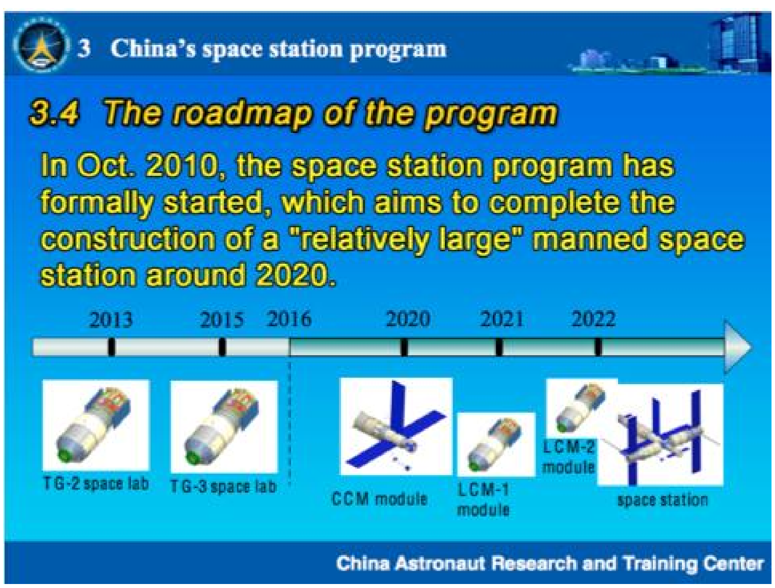

Figure 1 – Slide from Official Chinese Presentation, International Astronautical Conference, Prague, October 2010

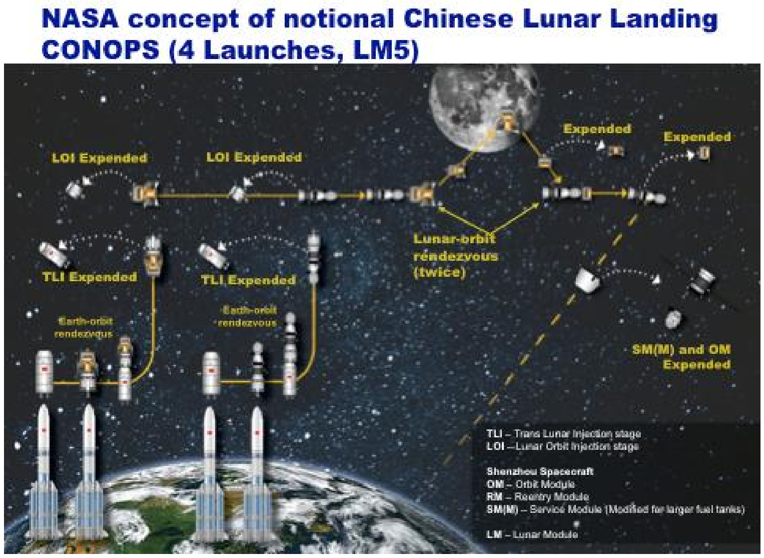

Figure 2 – NASA Concept for a Chinese Lunar Landing

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Prior to NASA, Dr. Pace was the Assistant Director for Space and Aeronautics in the White House Office of Science and Technology Policy (OSTP). From 1993-2000, Dr Pace worked for the RAND Corporation's Science and Technology Policy Institute (STPI). From 1990 to 1993, Dr. Pace served as the Deputy Director and Acting Director of the Office of Space Commerce, in the Office of the Deputy Secretary of the Department of Commerce. He received a Bachelor of Science degree in Physics from Harvey Mudd College in 1980; Masters degrees in Aeronautics & Astronautics and Technology & Policy from the Massachusetts Institute of Technology in 1982; and a Doctorate in Policy Analysis from the RAND Graduate School in 1989.

Dr. Pace received the NASA Outstanding Leadership Medal in 2008, the U.S. Department of State's Group Superior Honor Award, *GPS Interagency Team*, in 2005, and the NASA Group Achievement Award, *Columbia Accident Rapid Reaction Team*, in 2004. He has been a member of the U.S. Delegation to the World Radiocommunication Conferences in 1997, 2000, 2003, and 2007. He was also a member of the U.S. Delegation to the Asia-Pacific Economic Cooperation Telecommunications Working Group, 1997-2000. He is a past member of the Earth Studies Committee, Space Studies Board, National Research Council and the Commercial Activities Subcommittee, NASA Advisory Council. Dr. Pace is a currently a member of the Board of Trustees, Universities Space Research Association, a Corresponding Member of the International Academy of Astronautics, and a member of the Board of Governors of the National Space Society.