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AIR UNIVERSITY

ADVANCING SINO-U.S. SPACE COOPERATION

By

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Contents

Disclaimer	ii
Abstract	iv
PART I: The Problem at Hand.....	1
Introduction	1
China's Counterspace Programs	1
Motivations	3
U.S.-China Space Cooperation	4
PART II: China and U.S. Space Programs	5
China's Space Program	5
U.S. Space Program	8
PART III: Space Cooperation	10
China's Space Cooperation	10
U.S. Space Cooperation	12
U.S.-China Space Cooperation	14
Conclusion	17
Appendix A – Other Motivations for Chinese Counterspace Activities	19
Appendix B - Aims and Principles of Development – China's Space Activities in 2006.....	20
Appendix C - NSP Space Policy Goals	21
Notes	21
Bibliography	26

Abstract

On January 11, 2007, China successfully executed a direct-ascent anti-satellite (ASAT) test/demonstration by destroying one of its aging weather satellites. This event captured the attention of the world, especially the U.S. It is believed that China is pursuing a host of counterspace capabilities but the question remains as to why. There are many possible reasons for China's pursuit of counterspace capabilities, with one of the more likely being a means to gain an advantage when facing a dominant conventional military force. Whatever China's motivation is, it is important for the U.S. to take action to deter China from further ASAT operations that could possibly harm satellite systems on orbit. It is the intent of this research to propose the idea of U.S.-China space cooperation in order to deter the PRC from potentially harmful ASAT operations. This is especially important given the current lack of dialogue between these two nations with regard to space issues. The respective space policies of the U.S. and China show that each nation is open to space cooperation, and both currently engage in international space cooperative efforts. U.S.-China space cooperation can provide benefits to both nations and ultimately provide greater transparency and trust with regard to each nation's space activities. Acquiring this transparency and trust through cooperation could be an ideal solution in deterring China from further harmful ASAT operations.

PART I: The Problem at Hand

Introduction

On January 11, 2007, China demonstrated the successful use of a direct-ascent anti-satellite weapon (ASAT). This particular test was proof to major world powers that China has established itself as a contender in the space arena. The target was a Chinese weather satellite at an altitude of 864 kilometers.¹ The kinetic kill vehicle was launched on a DongFeng-21 Intermediate Range Ballistic Missile (IRBM) from the Xichang space facility and impacted the weather satellite head on. It was technically remarkable, to say the least, in that, “the satellite was destroyed by a unitary hit-to-kill payload—a bullet hitting a bullet.”²

This test, however, brought criticism: “The deliberate destruction of a satellite in a highly used orbit—creating mass quantities of space debris that will remain a global danger for decades—has deservedly been met with U.S. and international opprobrium.”³ Given the vulnerabilities of U.S. satellite systems, the U.S. must take actions to make ASAT operations less attractive for China. It is the intent of this research to suggest the idea of cooperation between China and the U.S with regard to space in order to deter Chinese ASAT operations. Before discussing space cooperation between these two nations, I will first discuss China’s counterspace programs, its motivations for developing and using these capabilities, and the respective space programs of China and the U.S.

China’s Counterspace Programs

In addition to the direct-ascent ASAT capability demonstrated in January 2007, China has invested in the research of a range of counterspace technologies.⁴ Again, the January 2007 test was a demonstration of a direct-ascent ASAT. “Direct-ascent weapons are particularly effective against satellites flying in Low Earth Orbits (LEO), where most of America’s remote

sensing, meteorological, and imaging intelligence satellites, and their associated relays, currently operate.”⁵ While China does have the spacelift capability to launch objects into Medium Earth Orbits (MEO) and geostationary orbits, using larger rockets would “alter the dynamics for an effective hit-to-kill kinetic kill vehicle, making their current ASAT design unusable for such purposes.”⁶ This is not to suggest the People’s Republic of China (PRC) will never obtain this capability in the future.

Another counterspace capability that China is suspected of pursuing is the development of microsatellites (microsats).⁷ Like the direct-ascent ASAT, a microsat could be used to collide with another satellite to damage or degrade it. What makes microsats a challenging counterspace weapon is that they can “be difficult to detect both at launch and while on orbit.”⁸

“China has devoted substantial resources to directed energy systems, particularly ground-based high- and low power lasers.”⁹ In fact, reports in 2006 speculated that “China had for several years successfully used ground-based lasers to blind U.S. reconnaissance satellites.”¹⁰ Laser attacks could temporarily or even permanently damage satellite sensors (depending on beam power, and vulnerability of targeted sensor).¹¹ Other directed energy technologies being researched in China include microwave technology, electromagnetic rail guns, and particle beam weapons.¹²

To affect satellites located in the higher orbits such as MEO and geostationary, “Chinese tacticians have focused on electronic rather than physical means of attack.”¹³ “Sophisticated jamming technologies” could be used on communications and navigation systems that orbit earth at these higher altitude orbital planes.¹⁴

With a host of counterspace technologies available at different levels of maturity, it appears China is prepared to execute counterspace activities. “China’s counterspace efforts are

diverse, comprehensive, rapidly improving and deadly serious—exceeding even those of the Soviet Union at its peak.”¹⁵ So that brings up the next question. What motivates China to pursue these counterspace technologies?

Motivations

Since Chinese officials have provided little explanation concerning their ASAT demonstration, their principal motivation in the development of counterspace capabilities isn’t entirely clear.¹⁶ There is much speculation, however, about what drives China to develop counterspace capabilities.

A White Paper issued by China’s State Council in October 2006 states: “China is unflinching in taking the road of peaceful development, and always maintains that outer space is the common wealth of mankind.”¹⁷ Initially following the direct-ascent ASAT test, “the Chinese Defense Ministry claimed to be unaware of the test” after being confronted by the U.S. government.¹⁸ Very soon thereafter, a senior Chinese military academic described the event as “ordinary” in a Chinese newspaper.¹⁹ To complicate the issue a little more, “two months after the test, Prime Minister Wen Jiabao stated that China’s position on peaceful utilization of space remains unchanged and endorsed negotiation of a treaty on the peaceful use of outer space.”²⁰ It was also during this same time period after the test that “the Chinese Foreign Ministry wanly acknowledged the event, claiming that it was not directed at any country and does not constitute a threat.”²¹

As shown above, China is not going to come out and tell the world why it continues to pursue counterspace capabilities and why it conducted an ASAT test and/or demonstration. Was the ASAT test/demonstration perhaps an act of deterrence? A likely reason for the development of ASAT and other counterspace capabilities is the possibility of having to counter America’s

superior conventional power over an issue such as Taiwan.²² China has witnessed America's unsurpassed conventional capabilities in the Balkans, the 1991 Gulf War, and the most recent operations in Afghanistan and Iraq. Analysts in China know that "the advanced military might of the United States depends inordinately on a complex, exposed network of command, control, and computer-based systems that provided intelligence, surveillance, and reconnaissance; and these systems operate synergistically in and through the medium of space."²³ So rather than having to counter a dominant U.S. conventional force directly, China seeks capabilities it can utilize to exploit America's dependence on its space-based assets. Other possible motivations are listed in **Appendix A**.

U.S.-China Space Cooperation

After reviewing Chinese counterspace capabilities and possible motivations, the question at hand, again, is how can the U.S. make ASAT operations less attractive for China? To not do anything is an option since China broke no laws or treaties.²⁴ But what if China were to pursue continued and even more aggressive ASAT testing? Then there is always the option of multilateral treaties that could be designed to prevent or limit the weaponization of space. While this may appear to be an attractive option, a treaty of this sort could go against the 2006 U.S. National Space Policy which states that the U.S. intends to maintain its freedom to act in space.²⁵ U.S.-China space cooperation could be the ideal answer to deter Chinese counterspace testing and operations without significantly tying the hands of the U.S. with regard to maintaining freedom of action in space.

The idea here is gaining a partner versus a competitor. Despite improvement in diplomatic and economic relationships between the U.S. and China, there has been very little initiative from the U.S. in entering into cooperative efforts with China in space activities. In fact,

it was reported by Michael Griffin, the National Aeronautics and Space Administration's (NASA) current administrator, that the Bush administration failed to approve an "overture to China for a cooperative U.S.-China space mission" in late 2008.²⁶

Opening the doors toward increased cooperation with China in the space endeavor could present some attractive benefits. First and foremost, communication would improve between the two countries on space matters which would be essential in ultimately preventing further uncoordinated direct-ascent ASAT type activities. Currently, there is essentially no dialogue between the U.S. and China regarding military space issues.²⁷ Another advantage of space cooperation is cost. The U.S. and China share similar goals, like returning to the Moon and eventually pursuing a manned mission to Mars. Space is expensive, so why not share resources and capabilities in the pursuit of such activities?

PART II: China and U.S. Space Programs

Before addressing international space cooperation, I will briefly discuss the space programs of the U.S. and China. With cooperation, both sides will seek to benefit from what the other has to offer. Examining the space programs of both China and the U.S. will show the similar motivations of both countries in the pursuit of space.

China's Space Program

Following Russia and the U.S., China became "the world's third most prominent spacefaring nation" on 15 October 2003 by successfully launching its first successful manned spaceflight.²⁸ Origins of the Chinese space program date back to its inception of October 8, 1956, when its foundation was established by the Chinese political leadership of that era.²⁹

Currently, "the main agency involved with China's space program is the Commission on Science, Technology, and Industry for National Defense (COSTIND)."³⁰ Within this agency is

the China National Space Administration (CNSA) which plays a role similar to NASA. As listed on the CNSA website, some of the main CNSA responsibilities are: “signing governmental agreements in the space area on behalf of organizations, intergovernmental scientific and technical exchanges; and also being in charge of the enforcement of national space policies and managing the national space science, technology and industry.”³¹ The People’s Liberation Army (PLA) is a key player in China’s space activities by “managing both manned civilian and military efforts.”³² How much control the PLA has over the civilian aspects of China’s space program is currently unknown.³³

The backbone of China’s lift capability is based on its Long March series of rockets which are capable of placing payloads from LEO all the way up to geosynchronous orbit.³⁴ China’s three launch facilities are the Jiuquan, Xichang, and Taiyuan launch sites with a fourth one under construction in Hainan Province.³⁵ For manned missions, China uses the Shenzhou spacecraft, which has proved successful for all of China’s manned missions to date.

An interesting note on China’s space program is that it did not develop in a similar fashion as that of the former Soviet Union or the U.S. While the Soviet and U.S. programs were developed and based on military intelligence (space race), “the Chinese space program has decidedly more twenty-first-century motivations.”³⁶ Since 1970, China has launched over 100 orbital missions and has sent men into space in 2003, 2005 and 2008.³⁷ The Chinese also successfully deployed a lunar orbiter (fourth country to do so) which is “paving the way for additional moon exploration.”³⁸ In order to make many of these advances in space possible, China has used, and intends to further use “leapfrogging” techniques, essentially skipping generations in technological development.³⁹

What are China's motivations in pursuing such a space program? There are several different theories, with a recurring theme of national prestige that is often mentioned. A Congressional Research Service report mentioned that, "China has apparently chosen the more expensive route of sending humans into space, over machines, for the wider attention it attracts both domestically and internationally."⁴⁰ Another theory that appears plausible is that the space program helps in the unification and cohesion of the PRC.⁴¹ Similar to the Apollo program of the U.S., China's "space program provides a mechanism for research and scientific exploration that will undoubtedly advance China's education and high-tech industrial base."⁴²

China captured the aims of its space activities and principles of development in a White Paper that was issued by China's State Council in October 2006. (To see all of the aims and principles of development listed in this White Paper, reference **Appendix B**.) The intent here is to cover only the basic motivations for its space program from the PRC perspective.

In reviewing the 2006 White Paper, national prestige does appear to be an evident theme along with the aims listed in **Appendix B**. Under "the principles of development for China's space industry," the paper mentions "upholding independence and self-reliance policy," describing how China to date has built "its space industry from scratch" and will continue to do so.⁴³ The White Paper also mentions development of China's space industry "as a cohesive force for the unity of the Chinese people."⁴⁴ This relates to the PRC unification theory mentioned earlier.

Prestige is an important aspect of China's program, as it is for other spacefaring nations like the U.S. and Russia. Advancements in the areas of economy, science, technology and national security are also evident as important themes. And then, of course, there is that first aim mentioned in China's 2006 White Paper on exploration. Isn't exploration a significant part of

any manned space program? One key take away is that it appears China did not develop its program based on a “space race” like the former Soviet Union (FSU) and the U.S where each country was concerned about maintaining the military advantage.

It appears the PRC is likely are developing their program based on 21st century motivations as space is an opportunity to not only build national prestige, but move forward in the global economy as a supplier and global player in the benefits of space development. They are highly interested in the commercial satellite industry, with plans to launch 100 satellites from 2006 to 2010.⁴⁵ The construction of its fourth launch site will also greatly expand China’s capability of launching payloads into GEO orbit.⁴⁶ Future manned and unmanned missions spanning the next 15 years include plans for orbital docking, moon voyages, and the beginnings of a Mars program.⁴⁷ China’s resounding success and planned upgrades to its Long March series boosters will help in this endeavor. China’s commitment to space is evident with its possession of “the facilities, satellite technology, mission control centers, and launchers required of a space power.”⁴⁸

U.S. Space Program

With regard to the U.S space program, the intent with this paper is to review the program’s foundation and motivations briefly since there is so much information readily available. By doing so, this writer intends to show similarities and differences that will hopefully support the idea of space cooperation as an adequate and desirable solution to deter China from pursuing ASAT operations.

The birth of the U.S. space program took place following the Soviet launch of Sputnik on October 4, 1957. It was this first satellite launch that dealt a decisive blow against the prestige of the U.S., resulting in the National Aeronautics and Space Act of 1958. This bill called for the

creation of the National Aeronautics and Space Agency (agency later became Administration), which was to be headed by a single civilian director.⁴⁹ Also inherent in this bill was the concept of a dual space program, which was the desire of President Eisenhower. With this dual program, the Department of Defense (DoD) would retain control of military space while NASA ran the civilian side.⁵⁰

The U.S. space program today remains similar in organization. While NASA is often viewed as *the* U.S. space program, one needs to still consider the DoD side, which is comprised of a significant amount of military space activities. The DoD program spent “about \$22 billion in fiscal year 2008, almost a third more than NASA’s budget.”⁵¹

The U.S. was engaged heavily in a space race with the Soviet Union, beginning in the late 1950s. The dual space program was not only seeking to preserve national security, but was also trying to maintain the edge with regard to national prestige. Obviously, with the end of the Cold War, today’s motivations are a bit different than what existed during the early years of the U.S. space program. The motivations of the U.S. space program are captured in the U.S. National Space Policy (NSP), released August 31, 2006.

Two themes guide the policy. The first theme is the importance of freedom of action in space to the U.S. (national security).⁵² The second theme is the importance of the U.S. possessing “robust, effective, and efficient space capabilities” “in order to increase knowledge, discovery, economic prosperity, and to enhance national security.”⁵³ Much like the aims in China’s 2006 White Paper, the NSP establishes U.S. space policy goals, listed in **Appendix C**.

National security appears much more prominent in the U.S. NSP when compared to China’s White Paper, which should be of no surprise. As stated under section five of the NSP (National Security Space Guidelines), “United States national security is critically dependent

upon space capabilities, and this dependence will grow.”⁵⁴ For this reason, national policy makes it clear that the U.S. will maintain its freedom to act in space, and deter or dissuade those who impede these rights or pursue capabilities with the intent to do so.⁵⁵

Like China, the U.S. seeks the exploration and use of space for peaceful purposes. There is still evidence of national prestige in the U.S. program, although not likely to the extent that existed during the space race with the U.S.S.R. Advancement in the areas of science and economic security are also similar themes in both the China and U.S. space programs. As mentioned previously, national security is a dominant theme in the U.S. NSP. The U.S. is open in the NSP in stating that it will take actions to defend its space capabilities.⁵⁶ While China doesn’t address national security to this extent in its White Paper, one can assume the Chinese “ASAT test was a clear message that China also has deep and growing interests in space that require defending.”⁵⁷

PART III: Space Cooperation

The idea of international space cooperation is nothing new. Some of the earliest space cooperation efforts go back to the Cold War with the U.S. and the U.S.S.R. Today, many nations participate in cooperative efforts in space, including both the U.S. and China. International cooperation in space can provide many benefits, including more resources for exploration, an elimination of duplicated efforts, and improved international relationships, to name a few.⁵⁸

China’s Space Cooperation

It is evident in China’s 2006 White Paper on space activities that international cooperation in space is nothing new to the PRC and important with regard to its space ambitions.

Listed as one of their principles of development (**Appendix B**), China seeks cooperation “on the basis of the principles of equality, mutual benefit, peaceful utilization of outer space, and common development.”⁵⁹ Since 2001, China has “signed 16 international space cooperation agreements and memorandums with 13 countries, space agencies and international organizations.”⁶⁰ Below are some examples of Chinese space cooperative efforts with international partners.

China’s earliest space cooperation efforts go as far back as the late 1950s with the Soviet Union and early missile technology. It was during this time that China received some Soviet R-2 rockets along with the help of Soviet scientists and specialists.⁶¹ While this wasn’t the best example of space cooperation, due to political fallout with the Soviets, it did provide China the basics for the beginning of its space program.

Today, China and Russia have a thriving cooperation that has produced “marked results”.⁶² The two countries have regular meetings, discussing future cooperation areas such as manned spaceflight to include astronaut training.⁶³ It was reported in 2005 by the head of Russia’s Federal Space Agency that China and Russia added 29 new projects to their cooperation program.⁶⁴ Even more ambitious programs between these countries include a robotic Mars mission as early as 2009 involving assets from both countries.⁶⁵

China and the European Space Agency (ESA) also have a growing history of space cooperation with some recent successes. China’s Geospace Double Star Program, which was “the first collaborative scientific mission between CNSA and ESA”, is a successful program studying the Earth’s magnetic environment through the use of two small satellites.⁶⁶ Double Star marks a significant event in China’s cooperative efforts with the West.⁶⁷ China has also cooperated with the ESA on programs such as the Dragon Program, an earth observation system

studying projects in the fields of “agriculture, forestry, water conservancy, meteorology, oceanography and disasters.”⁶⁸ China currently has limited cooperation with ESA and other European companies with regard to satellite navigation, including the Galileo program.⁶⁹

China is also engaged in the Asia Pacific Space Cooperation Organization (APSCO), established in 2005. This organization, headquartered in Beijing, is represented by the following nine countries: China, Bangladesh, Indonesia, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey.⁷⁰ Like the ESA, APSCO is an “inter-governmental organization to promote regional space cooperation”.⁷¹

U.S. Space Cooperation

The 2006 U.S. NSP specifies in two sections that the U.S. Government seeks “international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foreign policy objectives.”⁷² Since NASA’s inception, it has “concluded thousands of agreements” with more than 100 nations and international organizations.⁷³ International cooperation has been regarded as a “cornerstone of NASA’s activities,” with current partners being: ESA, Japan, Canada, France, Germany, Italy, the UK, Russia and Brazil.⁷⁴ In the following paragraphs, I will review some successful U.S. international space cooperative efforts.

While NASA has a diverse history in the realm of international space cooperation, perhaps the most significant is the cooperation with Russia. It is interesting how two countries that were adversaries developed a successful relationship with regard to space cooperation at the peak of the Cold War. In fact, it was these early cooperative efforts between these two countries that paved the way to the modern day success of U.S.-Russia space cooperation. The Cold War

cooperative effort that captured the most attention was the Apollo-Soyuz docking in July 1975. Preparation for this event was very challenging, to say the least. Here you had two significantly incompatible space programs and political systems that had to work together in various forums and meetings in order to make this cooperation possible.⁷⁵ Results of this cooperative effort were much more than just a demonstration to the world that these two Cold War rivals could shake hands in space. The successful docking of the U.S. Apollo and Soviet Soyuz spacecraft demonstrated a common rendezvous and docking mechanism which would allow for possible space rescues, still in use today with the International Space Station (ISS).⁷⁶

The ISS is a key example of how space cooperation with Russia has been beneficial to the U.S. In February 2003, Russian Soyuz spacecraft were the only means available to travel to and from the ISS for U.S. astronauts following the Columbia space shuttle accident. This reliance on the Russian Soyuz spacecraft to ferry supplies and U.S. astronauts to and from the ISS lasted until NASA shuttle missions resumed in 2005. The U.S. will again be dependent on Russian Soyuz spacecraft when the shuttle program is retired (as currently scheduled) in 2010 until the new Crew Exploration Vehicle (CEV) is available for NASA to use.⁷⁷

Russian involvement with the ISS began in 1993, when President Clinton added Russia to the international endeavor that already consisted of the U.S., Europe, Japan and Canada.⁷⁸ Although originally brought onboard partly to encourage compliance with non-proliferation of ballistic missile technology, the Russians proved valuable and quite significant in the international team. In addition to providing a means for spacelift to and from the ISS, the Russians were important during Phase 1 of the ISS development with U.S. involvement on the Mir space station. During Phase 1, Russians flew onboard the space shuttle seven times and on nine occasions the space shuttle docked with Mir.⁷⁹

The ISS has proven to be the most successful space cooperation program to date for NASA. International cooperation for this venture includes the U.S. (NASA), the Russian Federal Space Agency, the Canadian Space Agency, Japan Aerospace Exploration Agency and the ESA which includes the following countries: Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the UK.⁸⁰ Hosting 19 research facilities, the ISS gives international partners the ability to conduct research and scientific experiments in the low gravity environments of Earth's orbit. This research, along with men and women living in and adapting to the space environment, will provide the foundation for future missions to the Moon and Mars.⁸¹

U.S.-China Space Cooperation

Both China and the U.S. are open to international space cooperation, as noted in their respective policy documents on space and current cooperative programs. History has shown that both China and U.S. have gained from space cooperation, which could be an ideal solution in seeking to deter China from exercising ASAT operations.

Benefits. While possibly deterring Chinese ASAT operations, this deterrence would be a secondary effect (or benefit for that matter) of successful U.S.-China space cooperation. In order for this cooperation to take place, the benefits will have to outweigh the challenges (some which will likely be viewed as risks) for both nations.

The first benefit of cooperation would be improved transparency.⁸² Secrecy of China's space program has led to a suspicious outlook by many critics of this program. Space cooperation between the two countries could be based on regular meetings which "could help the two nations understand each other's intentions more clearly."⁸³ With China as a partner, the U.S. would have better visibility and communication with the CNSA concerning China's space

activities, and the same would hold true for China. Reviewing China's White Paper on its space policy and trying to make sense of its counterspace capabilities after the fact is the wrong approach. "If NASA signed an agreement with CNSA and began joint space projects, they would more easily and directly understand China's space activities and directions."⁸⁴

Another benefit mentioned earlier is cost savings, which would be attractive for both nations. For most countries, budgets for space are insufficient or limited to the point where they depend on international space cooperation to meet their goals.⁸⁵ Exceptions to this in some degree are Russia, the U.S. and China, as all have achieved their own manned space programs. President Bush's "Vision for Space Exploration" announcement in 2004 called for "redirecting NASA's human exploration program from low Earth orbit to the Moon, Mars, and worlds beyond."⁸⁶ The timeframe specified in this announcement for the return to the moon was between 2015-2020, carrying a price tag of \$104 billion.⁸⁷ China too has ambitions for manned missions to moon, so spreading the cost could prove beneficial to both nations.

Increasing U.S. options with regard to manned spacelift could be a benefit in U.S. cooperation with China and is something the U.S. should consider for increased safety and logistics. History has shown that the U.S. was fortunate to have the cooperative programs it had with Russia when the shuttle fleet was grounded following the Columbia accident of 2003. If China were to become both a U.S. and ISS partner, the U.S. would eventually (assuming continued Shenzhou success) have another option besides Russia as a backup to deliver astronauts and supplies to the ISS.⁸⁸

Global stability is another possible benefit stemming from U.S.-China space cooperation.⁸⁹ "Both China and the USA are important countries in global politics, economics,

and space activity.”⁹⁰ Maintaining a healthy relationship between these two countries has positive global impacts.

Challenges. Space cooperation between the U.S. and China would not be an easy process to initiate and there would certainly be challenges. While space cooperation is not new, the 2007 Chinese ASAT test has made the idea of working with the PRC even more controversial.⁹¹

One area of increased concern is technology transfer. This is especially true of civil space technology being applied for military use (dual-use technology).⁹² For this specific reason, the International Traffic in Arms Regulations (ITAR) limits space cooperation with China.⁹³ With the intention of preventing the transfer of “sensitive technologies” to other governments, ITAR even makes “normal science exchanges and visits” challenging.⁹⁴ If there were to be increased space cooperative efforts between the U.S. and China, ITAR restraints would need to be reexamined and changed.

In a Congressional Research Service (CRS) Report for Congress dated September 29, 2008, the author, Jeffrey Logan, mentions a possible challenge of ineffectiveness.⁹⁵ He further states that some “argue that increased collaboration will not produce tangible benefits for the United States.”⁹⁶ It is mentioned in the 2006 U.S. NSP that international cooperation is encouraged along the lines of “mutual benefit.”⁹⁷ It is also mentioned in NASA Policy Directive (NPD) 1360.2A that “each cooperative project must demonstrate a specific benefit to NASA or the United States.”⁹⁸ With regard to the problem at hand (deterring Chinese ASAT operations), both NASA and the U.S. would benefit if the threat of unannounced Chinese ASAT tests were reduced in addition to the benefits mentioned above. It is a given that China is not technologically where the U.S. is with regard to space, but as mentioned before, space

cooperation with the PRC would still be beneficial with regard to increased transparency, backup capabilities, cost sharing and global stability.

Another significant challenge is the different political systems between the two countries, resulting in “difficulty building trust with each other.”⁹⁹ This issue has been tackled before between the U.S. and Russia, so while challenging, space cooperation is feasible between China and the U.S. despite different political systems.

Where We Currently Stand. In September 2006, NASA Administrator Mike Griffin visited China for a tour of some PRC space sites as well as discussions on possible future cooperative efforts in space.¹⁰⁰ Following a silent two years, NASA’s Assistant Administrator, Michael O’Brien, met with the CNSA administrator and deputy administrator in Beijing in 2008. Discussions included the establishing of “joint working groups on space science and Earth science in addition to addressing a framework for broader cooperation.”¹⁰¹

Later in 2008, NASA proposed to the Bush administration “an overture to China for a cooperative U.S.-China space mission” that “was largely devoted to space science, but also involved flight operations on the space shuttle and International Space Station.”¹⁰² NASA, however, failed to get the administration’s approval due to “human rights and arms-trafficking violations of international law” with regard to China.¹⁰³

With a new presidential administration as of January 2009, there are likely to be some changes with regard to space cooperation with China. At this time, however, there is little information to show which direction that is going to go.

Conclusion

Given the challenges presented, the U.S. and China will require significant growth with regard to any long-term cooperative efforts in space such as a joint venture to the moon.

Political differences and barriers such as ITAR need to be examined more closely before any major space cooperation efforts take place between these nations. Initial steps could be based on periodic meetings, limited scientific exchanges, and opening up ISS membership to China.

Both nations have voiced their openness to international space cooperation in their respective policies and both nations would likely benefit. Benefits such as cost savings, a redundant lift capability, and increased capabilities have proven beneficial with current and past partnerships, as demonstrated in U.S-Russia efforts.

Gaining a partner versus a competitor in space will help develop communication, transparency and understanding between the U.S. and China with regard to their space programs and intentions which could ultimately deter China from exercising destructive counterspace activities. While China's motivation in the pursuit of counterspace technology is not entirely clear, it has already demonstrated the destructive capability of these weapons. Doing nothing will continue to widen the gap between U.S. and China space programs, increasing space cooperation will help bring them together.

Appendix A

Other Motivations for Chinese Counterspace Activities

- 1) To prove their ASAT capability works. At some point in developing this technology, one needs to eventually ensure the system works for advancement to the next level.¹⁰⁴
- 2) A warning to Taiwan in their attempt for seeking independence.¹⁰⁵
- 3) “The Chinese ASAT test (and possibly ongoing program) was conceived largely as a deterrent to U.S. space-based missile defenses, which China views as a threat to its nuclear deterrent, rather than an offensive program.”¹⁰⁶
- 4) “China sees space weaponization as inevitable”¹⁰⁷
- 5) A hard power display to “bring the United States to the negotiating table over space-based missile defense and space weapons.”¹⁰⁸
- 6) Chinese perception that U.S. refuses to discuss military space intentions as indicated in October 2006 U.S. National Space Policy.¹⁰⁹ This in turn leads China to believe the U.S. intends to “dominate and control space.”¹¹⁰
- 7) A means of protecting its nuclear deterrent which is threatened by U.S. theater and national missile defense systems.¹¹¹
- 8) China takes extreme pride and prestige in its space program. The ASAT demonstration display a monumental achievement while showing China too intends to protect its interests in Space.¹¹²

Appendix B

Aims and Principles of Development – China’s Space Activities in 2006

Aims

- 1) “To explore outer space and enhance understanding of the Earth and the cosmos”
- 2) “To utilize outer space for peaceful purposes”
- 3) “Promote human civilization and social progress, and benefit the whole of mankind”
- 4) “To meet the demands of economic construction, scientific and technological development, national security and social progress”
- 5) “To raise the scientific quality of the Chinese people”
- 6) “Protect China’s national interests and rights”
- 7) “Build up the comprehensive national strength”¹¹³

Principles of Development

- 1) “Maintaining and serving the country’s overall development strategy, and meeting the needs of the state and reflecting its will”
- 2) “Upholding independence and self-reliance policy, making innovations independently and realizing leapfrogging development”
- 3) “Maintaining comprehensive, coordinated and sustainable development, and bringing into full play the functions of space science and technology in promoting and sustaining the country’s science and technology sector, as well as economic and social development”
- 4) “Adhering to the policy of opening up to the outside world, and actively engaging in international space exchanges and cooperation.”¹¹⁴

Appendix C

NSP Space Policy Goals

- 1) “Strengthen the nation’s space leadership and ensure that space capabilities are available in time to further U.S. national security, homeland security, and foreign policy objectives”
- 2) “Enable unhindered U.S. operations in and through space to defend our interests there”
- 3) “Implement and sustain an innovative human and robotic exploration program with the objective of extending human presence across the solar system”
- 4) “Increase the benefits of civil exploration, scientific discovery, and environmental activities”
- 5) “Enable a dynamic, globally competitive domestic commercial space sector in order to promote innovation, strengthen U.S. leadership, and protect national, homeland and economic security”
- 6) “Enable a robust science and technology base supporting national security, homeland security, and civil space activities”
- 7) “Encourage international cooperation with foreign nations and/or consortia on space activities that are of mutual benefit and that further the peaceful exploration and use of space, as well as to advance national security, homeland security, and foreign policy objectives”¹¹⁵

Notes

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- ¹ Ashley J. Tellis, "Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 1.
http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf
- ² Ibid.
- ³ Theresa Hitchens, "U.S.-Sino Relations in Space: From "War of Words" to Cold War in Space," *China Security*, no. 1 (Winter 2007), 13.
- ⁴ Ashley J. Tellis, "Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 4.
http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf
- ⁵ Ibid.
- ⁶ Phillip C. Saunders and Charles D. Lutes, "China's ASAT Test: Motivations and Implications," *INSS Special Report*, June 2007, 2. <http://www.ndu.edu/inss/Research/SRjun07.pdf>
- ⁷ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 8.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ⁸ Ashley J. Tellis, "Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 4.
http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf
- ⁹ Ibid.
- ¹⁰ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 8.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ¹¹ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 8.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ¹² Ashley J. Tellis, "Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 4.
http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf
- ¹³ Ibid., 5.
- ¹⁴ Ibid.
- ¹⁵ Ibid., 6.
- ¹⁶ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 31.
http://www.wsichina.org/cs5_all.pdf
- ¹⁷ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ¹⁸ James Mulvenon, "Rogue Warriors? A Puzzled Look at the Chinese ASAT Test," *China Leadership Monitor*, no. 20 (Winter 2007), 1. <http://www.hoover.org/publications/clm/issues/6301112.html>
- ¹⁹ Ibid., 2.
- ²⁰ Phillip C. Saunders and Charles D. Lutes, "China's ASAT Test: Motivations and Implications," *INSS Special Report*, June 2007, 2. <http://www.ndu.edu/inss/Research/SRjun07.pdf>
- ²¹ Ashley J. Tellis, "Punching the U.S. Military's "Soft Ribs": China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 1.
http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf
- ²² Ibid., 2.
- ²³ Ibid., 3.
- ²⁴ The Outer Space Treaty of 1967 only prohibits placing weapons of mass destruction in space.
- ²⁵ National Security Presidential Directive 49, *U.S. National Space Policy*, 31 August 2006, 1-2.
- ²⁶ Craig Covault, "Bush Administration Nixed NASA's U.S.-China Cooperation Idea," *Aviation Week*, 21 December 2008. http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/aw122208p2.xml (accessed 1 February 2009).

-
- ²⁷ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 41.
http://www.wsichina.org/cs5_all.pdf
- ²⁸ Brian Harvey, *China's Space Program: From Conception to Manned Spaceflight* (Chichester, UK: Praxis Publishing, 2004), 291.
- ²⁹ Ibid., 22.
- ³⁰ Stacey Solomone, "China's Space Program: Tang And Tea Together At Last," *Future Research Quarterly*, Spring 2005: 27.
- ³¹ China National Space Administration. <http://www.cnsa.gov.cn/n615709/n620681/n771918/index.html> (accessed January 9, 2009).
- ³² Jeffrey Logan, *China's Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 2.
- ³³ Stacey Solomone, "China's Space Program: Tang And Tea Together At Last," *Future Research Quarterly*, Spring 2005: 31.
- ³⁴ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 9.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ³⁵ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 42.
http://www.wsichina.org/cs5_all.pdf
- ³⁶ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 10.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ³⁷ Jeffrey Logan, *China's Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 1.
- ³⁸ Ibid.
- ³⁹ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁴⁰ Jeffrey Logan, *China's Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 3.
- ⁴¹ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 10.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ⁴² Gregory P. Metzler, "China in Space: Implications for U.S. Military Strategy," *Joint Force Quarterly*, no. 47, 4th quarter 2007, 97. http://www.ndu.edu/inss/Press/jfq_pages/editions/i47/22.pdf (accessed 1 February 2009).
- ⁴³ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁴⁴ Ibid.
- ⁴⁵ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 41.
http://www.wsichina.org/cs5_all.pdf
- ⁴⁶ Ibid., 42.
- ⁴⁷ Ibid., 41.
- ⁴⁸ Jeff. Kueter, "China's Space Ambitions—And Ours," *The New Atlantis*, no. 16 (Spring 2007), 9.
<http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours>
- ⁴⁹ Walter A. McDougall, ...*The Heavens and the Earth*, Baltimore, MD: The John Hopkins University Press, 1997, 172.
- ⁵⁰ Patricia Figliola, Carl E. Behrens, and Daniel Morgan, *U.S. Space Programs: Civilian, Military, and Commercial*, CRS Report for Congress IB92011, The Library of Congress, June 2006, 1.
- ⁵¹ Demian McLean, "Obama Moves to Counter China with Pentagon-NASA Link (Update1)," *Bloomberg.com*, 2 January 2009, 1. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aGMy_XFWN_VY (accessed 1 February 2009).

-
- ⁵² National Security Presidential Directive 49, *U.S. National Space Policy*, 31 August 2006, 1.
- ⁵³ Ibid.
- ⁵⁴ Ibid., 3.
- ⁵⁵ Ibid., 2.
- ⁵⁶ Ibid.
- ⁵⁷ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 42.
http://www.wsichina.org/cs5_all.pdf
- ⁵⁸ Audrey M. Schaffer, "What do nations want from international collaboration for space exploration?" *Space Policy* 24, no. 2 (May 2008): 95.
- ⁵⁹ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁶⁰ Ibid.
- ⁶¹ Brian Harvey, *China's Space Program: From Conception to Manned Spaceflight* (Chichester, UK: Praxis Publishing, 2004), 24.
- ⁶² China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁶³ Ibid.
- ⁶⁴ Kevin Pollpeter, "Building For the Future: China's Progress in Space Technology During the Tenth 5-Year Plan and the U.S. Response," *Strategic Studies Institute*, March 2008, 15.
<http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=852> (accessed 1 February 2009).
- ⁶⁵ "China plans first Mars probe in 2009 in joint mission with Russia," *People's Daily Online*, 22 May 2007.
http://english.peopledaily.com.cn/200705/22/eng20070522_376659.html (accessed 1 February 2009).
- ⁶⁶ Masson, "The First Sino-European Satellite Completes Its Mission," *European Space Agency Science and Technology*, 16 October 2007. <http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=41400>
- ⁶⁷ Yi Zhou, "Perspectives on Sino-U.S. Cooperation in Civil Space Programs," *Space Policy* 24, no. 3 (August 2008): 137.
- ⁶⁸ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁶⁹ Kevin Pollpeter, "Building For the Future: China's Progress in Space Technology During the Tenth 5-Year Plan and the U.S. Response," *Strategic Studies Institute*, March 2008, 15.
- ⁷⁰ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>
- ⁷¹ "Asia-Pacific Space Cooperation Organization starts operation." *CRIENGLISH.com*.
<http://english.cri.cn/4026/2008/12/17/1481s433684.htm> (accessed 2 April 2009).
- ⁷² National Security Presidential Directive 49, *U.S. National Space Policy*, 31 August 2006, 7.
- ⁷³ National Aeronautics and Space Administration, "2006 NASA Strategic Plan", 33.
- ⁷⁴ Yi Zhou, "Perspectives on Sino-U.S. Cooperation in Civil Space Programs," *Space Policy* 24, no. 3 (August 2008): 133.
- ⁷⁵ Roald Sagdeev and Susan Eisenhower, "United States-Soviet Space Cooperation during the Cold War," NASA.
http://www.nasa.gov/50th/50th_magazine/coldWarCoOp.html (accessed 1 February 2009).
- ⁷⁶ Ibid.
- ⁷⁷ Patricia Figliola, Carl E. Behrens, and Daniel Morgan, *U.S. Space Programs: Civilian, Military, and Commercial*, CRS Report for Congress IB92011, The Library of Congress, June 2006, 11.
- ⁷⁸ Carl E. Behrens, *The International Space Station and the Space Shuttle*, CRS Report for Congress RL33568, The Library of Congress, May 2008, 2.

⁷⁹ Ibid.

⁸⁰ “Nations Around the World Mark 10th Anniversary of International Space Station,” NASA.
http://www.nasa.gov/mission_pages/station/main/10th_anniversary.html (accessed 1 February 2009).

⁸¹ Ibid.

⁸² Jeffrey Logan, *China’s Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 6.

⁸³ Ibid.

⁸⁴ Yi Zhou, “Perspectives on Sino-U.S. Cooperation in Civil Space Programs,” *Space Policy* 24, no. 3 (August 2008): 134.

⁸⁵ D G Broniatowski, Ryan Faith, and Vincent G. Sabathier, “The Case for Managed International Cooperation in Space Exploration,” Center for Strategic and International Studies, 18 September 2006, 2.
http://www.csis.org/index.php?option=com_csis_pubs&task=view&id=3500 (accessed 4 February 2009).

⁸⁶ Patricia Figliola, Carl E. Behrens, and Daniel Morgan, *U.S. Space Programs: Civilian, Military, and Commercial.*, CRS Report for Congress IB92011, The Library of Congress, June 2006, 10,11.

⁸⁷ Ibid., 11.

⁸⁸ Yi Zhou, “Perspectives on Sino-U.S. Cooperation in Civil Space Programs,” *Space Policy* 24, no. 3 (August 2008): 134.

⁸⁹ Ibid., 133.

⁹⁰ Ibid.

⁹¹ Jeffrey Logan, *China’s Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 1.

⁹² Ibid., 5.

⁹³ Yi Zhou, “Perspectives on Sino-U.S. Cooperation in Civil Space Programs,” *Space Policy* 24, no. 3 (August 2008): 135.

⁹⁴ Ibid.

⁹⁵ Jeffrey Logan, *China’s Space Program: Options for U.S.-China Cooperation*, CRS Report for Congress RS22777, The Library of Congress, September 2008, 6.

⁹⁶ Ibid.

⁹⁷ National Security Presidential Directive 49, *U.S. National Space Policy*, 31 August 2006, 7.

⁹⁸ NASA Policy Directive (NPD) 1360.2A, *Initiation and Development of International Cooperation in Space and Aeronautics Programs*, 29 March 2004.

⁹⁹ Yi Zhou, “Perspectives on Sino-U.S. Cooperation in Civil Space Programs,” *Space Policy* 24, no. 3 (August 2008): 135.

¹⁰⁰ Warren Leary, “Chief of NASA explores space cooperation in visit to China” *International Herald Tribune*, 24 September 2006. <http://www.iht.com/articles/2006/09/24/news/nasa.php> (accessed 1 February 2009).

¹⁰¹ Craig Covault, “U.S. and China Talk Space Cooperation,” *Aerospace Daily & Defense Report* 227, no. 48 (September 2008): 3.

¹⁰² Craig Covault, “Bush Administration Nixed NASA’s U.S.-China Cooperation Idea,” *Aviation Week*, 21 December 2008.

http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/aw122208p2.xml (accessed 1 February 2009).

¹⁰³ Ibid.

¹⁰⁴ Phillip C. Saunders and Charles D. Lutes, “China’s ASAT Test: Motivations and Implications,” *INSS Special Report*, June 2007, 2. <http://www.ndu.edu/inss/Research/SRjun07.pdf>

¹⁰⁵ Ibid.

¹⁰⁶ Theresa Hitchens, “U.S.-Sino Relations in Space: From “War of Words” to Cold War in Space,” *China Security*, no. 1 (Winter 2007), 15.

¹⁰⁷ Ibid.

¹⁰⁸ Ibid.

¹⁰⁹ Ibid., 16.

¹¹⁰ Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 32.

http://www.chinasecurity.us/News_View.asp?NewsID=96

¹¹¹ Ashley J. Tellis, "Punching the U.S. Military's 'Soft Ribs': China's Antisatellite Weapon Test in Strategic Perspective," *Carnegie Endowment For International Peace*, no. 51, June 2007, 2.

http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf

¹¹² Eric Hagt, "China's ASAT Test: Strategic Response," *China Security*, no. 1 (Winter 2007), 42.

http://www.chinasecurity.us/News_View.asp?NewsID=96

¹¹³ China National Space Administration, "China's Space Activities in 2006," *Information Office of the State Council of the People's Republic of China*, 12 October 2006.

<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html>

¹¹⁴ Ibid.

¹¹⁵ National Security Presidential Directive 49, *U.S. National Space Policy*, 31 August 2006, 2.

Bibliography

- “Asia-Pacific Space Cooperation Organization starts operation.” *CRIENGLISH.com*, 17 December 2008. <http://english.cri.cn/4026/2008/12/17/1481s433684.htm> (accessed 2 April 2009.)
- Behrens, Carl E. *The International Space Station and the Space Shuttle*. CRS Report for Congress RL33568. The Library of Congress, May 2008.
- Broniatowski, D, G. Ryan Faith, and Vincent G. Sabathier. “The Case for Managed International Cooperation in Space Exploration.” Center for Strategic and International Studies, 18 September 2006.
http://www.csis.org/index.php?option=com_csis_pubs&task=view&id=3500 (accessed 4 February 2009).
- China National Space Administration, “China’s Space Activities in 2006.” *Information Office of the State Council of the People's Republic of China*, 12 October 2006.
<http://www.cnsa.gov.cn/n615709/n620682/n639462/79381.html> (accessed 7 February 2009).
- China National Space Administration*.
<http://www.cnsa.gov.cn/n615709/n620681/n771918/index.html> (accessed January 9, 2009).
- “China plans first Mars probe in 2009 in joint mission with Russia.” *People’s Daily Online*, 22 May 2007. http://english.peopledaily.com.cn/200705/22/eng20070522_376659.html (accessed 1 February 2009).
- Covault, Craig. “Bush Administration Nixed NASA’s U.S.-China Cooperation Idea.” *Aviation Week*, 21 December 2008.
http://www.aviationweek.com/aw/generic/story_generic.jsp?channel=awst&id=news/aw122208p2.xml (accessed 1 February 2009).
- Covault, Craig. “U.S. and China Talk Space Cooperation.” *Aerospace Daily & Defense Report* 227, no. 48 (September 2008): 3.
- Figliola, Patricia, Carl E. Behrens, and Daniel Morgan. *U.S. Space Programs: Civilian, Military, and Commercial*. CRS Report for Congress IB92011. The Library of Congress, June 2006.
- Hagt, Eric. “China’s ASAT Test: Strategic Response.” *China Security*, no. 1 (Winter 2007), 31-51. http://www.wsichina.org/cs5_all.pdf (accessed 2 April 2009).

Harvey, Brian. *China's Space Program: From Conception to Manned Spaceflight*. Chichester, UK: Praxis Publishing, 2004.

Hitchens, Theresa. "U.S.-Sino Relations in Space: From "War of Words" to Cold War in Space?" *China Security*, no. 1 (Winter 2007), 12-30.

Kueter, Jeff. "China's Space Ambitions—And Ours." *The New Atlantis*, no. 16 (Spring 2007): 8-22. <http://www.thenewatlantis.com/publications/chinas-space-ambitions-and-ours> (accessed 7 February 2009).

Leary, Warren. "Chief of NASA explores space cooperation in visit to China." *International Herald Tribune*, 24 September 2006. <http://www.iht.com/articles/2006/09/24/news/nasa.php> (accessed 1 February 2009).

Logan, Jeffrey. *China's Space Program: Options for U.S.-China Cooperation*. CRS Report for Congress RS22777. The Library of Congress, September 2008.

Masson, Arnaud. "The First Sino-European Satellite Completes Its Mission." *European Space Agency Science and Technology*, 16 October 2007. <http://sci.esa.int/science-e/www/object/index.cfm?fobjectid=41400> (accessed 1 February 2009).

McDougall, Walter, A. ...*The Heavens and the Earth*. Baltimore, MD: The John Hopkins University Press, 1997.

McLean, Demian. "Obama Moves to Counter China with Pentagon-NASA Link (Update1)." *Bloomberg.com*, 2 January 2009. http://www.bloomberg.com/apps/news?pid=newsarchive&sid=aGMy_XFWN_VY (accessed 1 February 2009).

Metzler, P, Gregory. "China in Space: Implications for U.S. Military Strategy." *Joint Force Quarterly*, no. 47, 4th quarter 2007. http://www.ndu.edu/inss/Press/jfq_pages/editions/i47/22.pdf (accessed 1 February 2009).

Mulvenon, James. "Rogue Warriors? A Puzzled Look at the Chinese ASAT Test." *China Leadership Monitor*, no. 20 (Winter 2007). <http://www.hoover.org/publications/clm/issues/6301112.html> (accessed 7 February 2009).

National Security Presidential Directive 49. *U.S. National Space Policy*, 31 August 2006.

NASA Policy Directive (NPD) 1360.2A. *Initiation and Development of International Cooperation in Space and Aeronautics Programs*, 29 March 2004.

National Aeronautics and Space Administration. *2006 NASA Strategic Plan*.

<http://www.nasa.gov/news/budget/index.html> (accessed 1 February 2009).

“Nations Around the World Mark 10th Anniversary of International Space Station.” NASA.

http://www.nasa.gov/mission_pages/station/main/10th_anniversary.html (accessed 1 February 2009).

Pollpeter, Kevin. “Building For the Future: China’s Progress in Space Technology During the Tenth 5-Year Plan and the U.S. Response.” *Strategic Studies Institute*, March 2008.

<http://www.strategicstudiesinstitute.army.mil/pubs/display.cfm?pubID=852> (accessed 1 February 2009).

Sagdeev, Roald., and Susan Eisenhower. “United States-Soviet Space Cooperation during the Cold War.” NASA.

http://www.nasa.gov/50th/50th_magazine/coldWarCoOp.html (accessed 1 February 2009).

Saunders, Phillip C., and Lutes, Charles D. “China’s ASAT Test: Motivations and Implications.” *INSS Special Report*, June 2007.

<http://www.ndu.edu/inss/Research/SRjun07.pdf> (accessed 7 February 2009).

Schaffer, Audrey M. "What do nations want fro international collaboration for space exploration?" *Space Policy* 24, no. 2 (May 2008): 95-103.

Solomone, Stacey. "China's Space Program: Tang And Tea Together At Last." *Future Research Quarterly*, Spring 2005: 25-45.

Tellis, Ashley J. “Punching the U.S. Military’s “Soft Ribs”: China’s Antisatellite Weapon Test in Strategic Perspective.” *Carnegie Endowment For International Peace*, no. 51, June 2007.

http://www.carnegieendowment.org/files/pb_51_tellis_final.pdf (accessed 7 February 2009).

Zhou, Yi. "Perspectives on sino-U.S. Cooperation in Civil Space Programs." *Space Policy* 24, no. 3 (August 2008): 132-139.