

Per aspera ad astra: Identifying
Opportunities for International Cooperation
with China in Space Exploration

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Abstract

Space exploration is an area of growing international interest and activity. China is an emerging space power, has become increasingly active in space exploration, and has advocated for further international cooperation in various space activities. To identify opportunities for international cooperation proposed frameworks have used technical and policy parameters to locate suitable partners for specific projects. With the goal of more accurately informing these frameworks this paper will explore China's policy parameters by measuring the degree to which the international environment enables and constrains China's space exploration ambitions. Specifically, this study analyzes two Chinese civilian space exploration programs and three cooperative space projects with international partners as case studies to identify domestic and foreign policy considerations informing China's position in. It is found that in addition to national prestige economic development and progress in science and technology development are major motivations for China's selection of space exploration activities.

Key words: space exploration; international cooperation; science and technology; China; Chinese foreign policy

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Table of Contents

List of Abbreviations	4
1. Introduction	5
1.1 Thesis overview	6
1.1.1 Case study method, design, and parameters	7
1.1.2 Data sources	8
1.2 Definition of key concepts.....	9
1.2.1 Space exploration	9
1.2.2 International cooperation and international collaboration	9
1.3 Background	10
1.3.1 Overview of the potential benefits of space exploration	10
1.3.2 Barriers to international cooperation in space exploration	15
1.4 Literature review.....	19
1.4.1 Liberal international relations theory and space activities.....	20
1.4.2 Evolution of cooperation: Space Exploration 3.0	22
1.4.3 Building coordination mechanisms	24
1.4.4 Critique of literature	29
2. China’s civilian space sector.....	35
2.1 Organization.....	35
2.1.1 Organizational structure	35
2.1.2 Policy-making processes.....	40
2.2 China and international cooperation in space exploration	41
2.2.1 China’s official position on international cooperation.....	41
2.2.2 Barriers to international cooperation for China.....	43
3. Case studies	47
3.1 Summary of analysis.....	47
3.2 RQ1: What domestic policy considerations influence how China sets its space exploration goals?	49
3.2.1 Project 921	49
3.2.2 Lunar Exploration Program.....	52
3.2.3 Discussion	54
3.3 RQ2: How does the international environment enable and constrain opportunities for international cooperation in space exploration available to China?	57
3.3.1 Kuafu	57
3.3.2 Yinghuo-1	59
3.3.3 International Space Station.....	60
3.3.4 Discussion	61
4. Conclusions	65
5. Bibliography	69
6. Appendix.....	78

List of Abbreviations

CAS	Chinese Academy of Sciences
CASC	China Aerospace Science and Technology Corporation
CASIC	China Aerospace Science and Industry Corporation
CCIC	Coordination Committee for International Cooperation
CCP	Chinese Communist Party
CGWIC	China Great Wall Industry Corporation
CMI	Civil-military integration
CNSA	China National Space Administration
CSA	Canadian Space Agency
ESA	European Space Agency
HCOG	Hague Code of Conduct
IAC	International Astronautical Congress
IAF	International Astronautical Federation
ISECG	International Space Exploration Coordination Group
ISS	International Space Station
ITAR	International Trafficking in Arms Regulation
JAXA	Japan Aerospace Exploration Agency
MIIT	Ministry of Industry and Information Technology
MLP	Medium- to Long-Term Plan for the Development of Science and Technology 2005-2020
NASA	National Aeronautics and Space Administration
NEO	Near-Earth object
NGO	Non-governmental organization
NSSC	National Space Science Center
PLA	People's Liberation Army
PLA GAD	People's Liberation Army General Armaments Department
R&D	Research and development
S&T	Science and technology
SASTIND	State Administration for Science, Technology and Industry for National Defense
SCAR	Scientific Committee on Antarctic Research
SOE	State-owned enterprise
SSA	Space situational awareness
UN COPUOS	United Nations Committee on the Peaceful Uses of Outer Space

1. Introduction

Human presence in space is expanding. Space exploration requires a significant allocation of human and financial resources, and therefore offers great potential for countries to collaborate in a meaningful domain. Specifically, international cooperation in space exploration can be used as a proxy to solve global challenges and to strengthen peaceful relations between countries.

China has invested significant resources into their space program and is quickly becoming a space superpower. Among their achievements are establishing a space laboratory, developing advanced space launch capabilities, and a human spaceflight program whose success made China the third country to successfully launch a human into space.

Although cooperation in space exploration is recognized as a means to create significant benefits for all partners various barriers including ineffective communication, dual-use technologies and technology transfer, and practical impediments prevent the international community from more extensive cooperation. China faces additional challenges in expanding its partnerships stemming from the role of the People's Liberation Army (PLA) and from its civil-military integration (CMI) policy. Overcoming these barriers is key to deepening China's integration into the existing framework of international cooperation. Considering China's current status as an emerging space power, their participation in cooperative and collaborative projects is increasingly important to exploit the potential of international cooperation.

To adequately explore the issue of international cooperation in space exploration mechanisms for multilateral cooperation and specific proposals for cooperation will be discussed. The goal of this study will be to describe China's policy parameter considerations i.e. the political utility gained by China from participating in internationally coordinated projects. The contribution of this work will be to provide a more detailed account of how China calculates its political utility. These findings can be used to better inform analytical frameworks and collaboration architectures used to identify opportunities for international cooperation in space exploration.

Cooperation- and collaboration-enhancing initiatives for space exploration activities are difficult to facilitate. A plethora of highly sensitive issues that affect national security and economic development are intrinsically connected with space exploration. *Per aspera ad astra* – “*through hardship to the stars*” - captures the essence of the challenge this study aspires to help solve.

1.1 Thesis overview

This thesis aspires to examine how China can increase cooperation with existing spacefaring countries in space exploration missions. This examination is guided by two goals: first will be to better understand domestic factors affecting how China’s civilian space program sets and pursues it’s space exploration ambitions; second will be to identify opportunities for cooperation in a changing international environment.

This study will build upon literature regarding multilateral coordination mechanisms and collaboration architectures used to facilitate cooperation in space exploration. This work will draw upon liberal international relations theory, which considers complex domestic bargaining processes and the influence of the international environment as constituting national space policy. Specifically, the theory will inform the structure of this paper. Finally, there has been much literature on the benefits and barriers countries face in international cooperation. A selection of benefits and barriers is presented first to provide a background understanding.

The unique contribution of this thesis will be to present synthesized findings that elaborate on the political utility calculations that most strongly affect China’s attitude towards varying degrees of international cooperation. In this pursuit this study will look at two of China’s space programs and three space projects for which China cooperated with an international partner to answer the following research questions:

1. What domestic policy considerations influence how China sets its space exploration goals?
2. How does the international environment enable and constrain opportunities for international cooperation in space exploration available to China?

1.1.1 Case study method, design, and parameters

Case studies are a standard tool for investigation used by social science scholars. Cases can be designed in different ways as to appropriately capture information from the object of study. The case study method is applied for research that covers contextual or complex multivariate conditions, relies on multiple sources of evidence, and can accommodate causal complexity by analyzing condition in which outcomes occur.¹ Yin (2012) categorizes case study research strategies into exploratory, descriptive, and explanatory, where descriptive case studies “can offer rich and revealing insights into the social world of a particular case” whose insights can, when added to the stock of related case studies, achieved greater importance.²

A descriptive case study is an appropriate design given the scope of this paper. The benefit of investigating China’s space program and international collaboration mechanisms for space exploration using this method are related to the flexibility in addressing complex causality. Cooperation in space exploration is a multidimensional phenomenon that can provoke several explanations for a particular outcome and therefore requires this flexibility.

The aim of this study is to describe China’s policy parameters that can be used to better inform analytical frameworks and collaboration architectures that identify opportunities for cooperation. A descriptive case study can achieve this through a constitutive portrayal of decision- and policy-making processes in China’s civilian space program. As Simons states: “the aim is particularization – to present a rich portrayal of a single setting to inform practice, establish the value of the case and/or add to knowledge of a specific topic”.³ This case study will add to our understanding of China as an emerging space power and their position in the shifting ‘real-world’ context for space actors.

¹ Yin, Robert K. *Case Study Research: Design and Methods*. Sage Publications, 2003. Print. Pg xiii; 31.

² Yin (2012): 49

³ Simons (2009): 24

The parameters of this research will focus on state-led, multilateral international collaboration mechanisms and space exploration activities by China's civilian space program.

1.1.2 Data sources

The sources used to investigate the thesis topic are consistent with sources traditionally used by other academics and professionals in researching space policy. The primary source documents used in this paper include official government documents, specifically the *China's Space Activities in 2011* White Paper, statements from authoritative space sector participants made at public conferences and as quoted in the media, conference proceedings and presentations, and several publications from the International Astronautical Congress (IAC). Primary sources published by main actors in China's civilian space sector were also utilized.⁴ In addition contributions from secondary sources, including academic journals and think tank reports, were extensively consulted.

There are a few noteworthy comments to be made on sources used in this paper. First, academic journals published only in Chinese were not consulted due to the author's lack of proficiency in Mandarin. To partially offset this limitation an effort was made to include authoritative Chinese contributors who have published in English. Furthermore, articles whose author(s) conducted in-person interviews with Chinese space authorities were also consulted. It should be noted, however, that cross-cultural misinterpretations are frequent in strategic communications regarding space activities.⁵ This paper's bias towards English-published sources therefore renders it susceptible to this concern.

⁴ The author collected official handout materials from CASIC, CASC, NSSC, and the CNSA and the 64th International Astronautical Congress in Beijing.

⁵ Johnson-Freese, Joan. "Strategic communication with China: what message about space?" *China Security* 2 (2006): pp. 37-58; Kulacki, Gregory and Joan Johnson-Freese. "Factual Errors in May 20, 2008 Written Statement from Ashley Tellis". Email to United States – China Economic Security and Review Commission. 20 May 2008. Web. Accessed 20 September 2013.

<http://www.ucsusa.org/assets/documents/nwgs/memo-to-uscc.pdf>

1.2 Definition of key concepts

The following two key concepts are used throughout the study. To ensure a common interpretation the scope of the terms are defined below.

1.2.1 Space exploration

Space exploration is often conflated with various space activities, particularly the exploitation of space resources. This understanding is misleading as by definition exploration operates on the frontiers of human expansion into space. This study will therefore interpret space exploration as the discovery, exploration, and investigation of celestial objects and phenomena through human and robotic spacecraft.

Various supporting activities such as space sciences research, analogue training for astronauts, and space launch capabilities needed to conduct particular space exploration missions are captured in this definition. It is important to consider that supporting activities vary depending on project. For example human missions require extensive space life sciences preparations whereas robotic missions need only consider the effects of specific environments on its hardware.

Finally the scope of this paper is limited to government-led civilian space activities. These parameters are appropriate as government actors dominate space exploration activities. Military and private sector space activities are considered insofar that they pertain to civilian space exploration; detailed elaboration on military and private sector space activities are not within the scope of this study.

1.2.2 International cooperation and international collaboration

International cooperation in space exploration can take form through bilateral, multilateral, or industry-led cooperation. To accommodate the various forms of cooperation this paper adopts a broad interpretation. International cooperation will be understood as state-led, which can then enable linkages between principal domestic

actors in the space industry including public actors, higher education actors, large industrial groups, and small and medium enterprises.⁶

This paper will also distinguish between cooperation and collaboration. Whereas cooperation refers to agreements and linkages (horizontal) collaboration will refer to the degree to which each partner is assigned significant responsibilities (vertical). The responsibilities assigned to each partner include technical and policy considerations and often leads to an asymmetrical distribution. For example ‘lead partners’ may contribute a critical-path component, such as life-support systems on the International Space Station (ISS), while another partner may contribute a non-critical path component, such as a module for scientific experiments. Collaboration will be employed then to capture this difference in responsibility.

1.3 Background

1.3.1 Overview of the potential benefits of space exploration

International cooperation in space exploration is challenging yet is considered an integral principle guiding human expansion into space. This research emphasizes coordination mechanisms and collaboration architectures used to facilitate international cooperation in space exploration. The first step in this process is to discuss the potential benefits of cooperation. The following section outlines a number of benefits that collaboration in space exploration can offer. This is not an exhaustive list but demonstrates several potential benefits.

1.3.1.1 Sharing resources and risk

Space exploration projects demand a significant allocation of resources, however the total amount of resources needed is difficult to estimate. The risk of rising project costs comes from difficulties in cost estimation. Cost estimation for space programs and projects has been shown to be problematic due to growing project complexity, mission

⁶ For an elaboration on principal actors in the space economy industry see: OECD (2012), “Principal actors in the space economy”, in *OECD Handbook on Measuring the Space Economy*, OECD Publishing.

failures, managing growth, and controlling costs.⁷ Contracting mechanisms have also been found to have a downward bias on cost estimates.⁸ Furthermore methods used in cost estimation, parametric modeling being the most popular internationally, were also found to be inadequate due to an inability to predict the future and by having process replace judgment in decision making.⁹ These difficulties have led to cost overruns in the US space program to average over 45%, and is a problem most national space programs face.¹⁰

International cooperation allows partners to leverage investments by sharing the cost burden of a project thereby spreading the risk of rising project costs among partners. One concern is that in this arrangement total project cost may be higher than if a country were to manage the project independently due to increased overhead costs associated with cooperation such as translation, communication, transporting hardware, and regulatory issues.¹¹ However despite these increases it is mainly accepted that as per-partner cost burden decreases in cooperative projects, per-partner utility increases.¹² For example the ISS is a space laboratory that enables participating countries to conduct national space experiments. With the exception of the most technologically advanced and well-funded space programs, most countries do not have the technical ability or the monies required to fund equivalent projects.

Major spacefaring nations acknowledge that the financial and technical resources required to explore space are so great that no one state could competitively pursue these activities autonomously.¹³ Sharing resources and risk allow partners to undertake more ambitious missions - major benefit afforded by international cooperation.

⁷ Keller, S., P. Collopy, and P. Componation. "What is wrong with space system cost models? A survey and assessment of cost estimating approaches." *Acta Astronautica* 93 (2014); pp. 345-351

⁸ Macauley, Molly K. "The supply of space infrastructure: issues in the theory and practice of estimating costs." *Space Policy* 24 (2008); pp. 70-79.

⁹ Keller, Collopy, and Compination (2014)

¹⁰ Peeters, Walter and Bernd Madauss. "A proposed strategy against cost overruns in the space sector: The 5C approach." *Space Policy* 24 (2008): 80-89.

¹¹ Broniatowski, David et al. "A framework for evaluating international cooperation in space exploration." *Space Policy* 24 (2008): 187; American Institute of Aeronautics and Astronautics. George PJ, Pease GM, Tyburski TE. "A management model for international participation in space exploration missions." AIAA 1st space exploration conference, Orlando, FL, 2005.

¹² Center for Strategic and International Studies. Broniatowski, David, G. Ryan Faith, and Vincent G. Sabathier. "The Case for Managed International Cooperation in Space Exploration." Washington DC, 2006. Pg.2

¹³ This is recognized by all ISECG participating agencies.

1.3.1.2 Data and knowledge sharing

Data acquired from space science experiments and the increase in technological capacity that comes from developing space technologies to support space science investigations are two major motivations for exploring space. Data can be fetched in various ways including but not limited to remote-sensing satellites, robotic spacecraft, adding scientific experiment payloads to launch vehicles, and human exploration missions. Due to the significant technical and financial resources needed to support space exploration projects duplicative projects is a serious barrier to the cost effectiveness of global space activities. Duplication refers to a devotion of resources to a project whose objectives have already been achieved by another actor. This problem, and the solutions afforded by international cooperation, applies differently to space sciences and space technologies.

Two instances in which duplication occurs in space sciences are from a lack of data exchange agreements and from an inability to compare data already acquired. The problem therefore relates to sharing data already acquired as well as the methods used to gather the data. A case study on international cooperation in space life sciences research exemplifies this point.¹⁴ Data regarding the space environment's effect on human physiology during and after space mission is crucial, non-sensitive information that is needed to support future long-term exploration missions. However it is difficult to generate this data due to cost considerations and the limited capacity of existing space platforms¹⁵. Duplication was therefore found to be very costly and creates a substantial opportunity cost due to the bottleneck of requests for space experiments.

The main issue in regards to duplication for space technologies is interoperability. It is important that the hardware and software utilized by various space technologies be compatible with the space technologies developed by other international partners. Without this compatibility it would be impossible to have space assets work in synergy as each asset would be limited to their own system. The issue of interoperability has been

¹⁴ McPhee, Jancy C., and Ronald J. White. "Advantages of international cooperation in space life sciences research." *Acta Astronautica* 63 (2008): 776-782.

¹⁵ Space platforms in this context refer to space infrastructure that can accommodate experiments. Examples include the ISS and the Tiangong space laboratory.

recognized as one of the most important challenges to address to ensure a sustainable human presence in space.¹⁶

A case study on increasing the reliability of space solar arrays demonstrates that data exchange agreements and standardization of testing procedures also apply to space technologies.¹⁷ However it is important to consider that duplication in space technologies can also be seen as a positive in that it provides redundant systems. Redundant systems are a key factor in project sustainability because they can be used as a backup in case of failure.¹⁸ For example the Russian Soyuz capsule acted as a redundant space transportation system for US astronauts, which proved useful when the Shuttle program was decommissioned. Therefore within a certain degree redundant systems created (un)intentionally by duplicative efforts can be seen as a positive.

International cooperation can address issues of duplication in space sciences by encouraging a standardization of testing procedures. Standardization ensures that data, whether collected collaboratively or separately, can be compared with datasets generated from other investigations.¹⁹ In regards to space technologies international cooperation is critical in facilitating interoperability of hardware and software systems.²⁰ Interoperability of space technologies is needed for future exploration activities and can be achieved through early coordination between partners.²¹

Although cooperation in data and knowledge sharing can yield significant benefits, unwanted technology transfer and the potential of dual-use technologies must also be considered. The benefits of technology transfer and dual-usages are that they can

¹⁶ International Space Exploration Coordination Group. *The Global Exploration Roadmap*. ISECG, 2011. 38 pages. <http://www.globalspaceexploration.org/documents>

¹⁷ Brandhorst, Henry .W., and Julie A. Rodiek. "Space solar array reliability: A study and recommendations." *Acta Astronautica* 63 (2008): 1233-1238.

¹⁸ NASA "Redundancy and Backup in Services & Systems"
<http://media.ihmc.us/capturethefuture/video/video.php?video=WilliamGerstenmaier-HowHasTheCollaborationWithInternationalPartnersAtISSEvolved.mov&w=854&h=496&label=William%20Gerstenmaier%20comments%20on%20How%20the%20Dependency%20among%20International%20Partners%20on%20ISS%20has%20Evolved&source=NASA>

¹⁹ Brandhorst and Rodiek (2008); McPhee and White (2008)

²⁰ International Space Exploration Coordination Group. *The Global Exploration Strategy: The Framework for Coordination*. ISECG, 2007. 25 pages. Pg 13.
http://www.nasa.gov/pdf/296751main_GES_framework.pdf

²¹ Global Exploration Roadmap (2011): 22; The Global Exploration Strategy: Framework for Coordination (2007): 6; 13.

build the technological capability and can increase return on investment.²² However unwanted technology transfer and possible military applications of dual-use technologies are a significant concern to spacefaring countries.²³ Balancing these issues has proven difficult, as is evidenced by the US-China relationship.

1.3.1.3 Political sustainability

Space exploration missions operate on long-term time horizons. As such there is an importance placed on establishing a predictable and sufficient dedication of resources to fulfill a country's assumed responsibilities. The ability of a partner country to meet their obligations is susceptible to changes in domestic political support; this potential volatility in political support creates uncertainty in the ability of a partner to predictably contribute to long-term projects. Political sustainability refers to how susceptible a space exploration project is to cancellation due to a lack of political support to continue an investment of resources.

Changes in political support have been measured using domestic political stability and the position of space exploration on the political agenda.²⁴ These indicators gauge the ability of a country to participate in long-term projects. In measuring political stability a preference is given to countries with a low political rotation, as these types of political regimes can put forth a more stable space policy and commit the requisite amount of resources for long-term projects. The priority of space exploration on the political agenda can be estimated from official national space policy documents. These documents indicate the priorities and principles of national space policies and the role space exploration plays within the larger national space strategy. For example China, the United States, and Russia have strong ambitions for human exploration missions whereas Japan and Europe have a preference for science and technology-building focused projects.²⁵

²² The Global Exploration Strategy: Framework for Coordination (2007): 22.

²³ IFRI Security Studies Center. Johnson-Freese, Joan. "China's Space Ambitions." Prepared in collaboration with the Atomic Energy Commission (CEA), 2007. 26 pages. Pg.8; Stumbaum, May-Britt U. "Risky business? The EU, China and dual-use technology," *European Union Institute for Security Studies*, Occasional Paper. Conde-sue-Noireau, France, October 2008.

²⁴ Grimard, Max. "Will the US remain the real leader of human space exploration? A comparative assessment of space exploration policies." *Acta Astronautica* 75 (2012): pp. 1-14.

²⁵ *Ibid*, 6; 7-8

International cooperation enhances political sustainability by adding diplomatic utility to the calculation of political support. If deciding to withdraw from an international cooperative project diplomatic utility would be calculated as the loss of diplomatic benefits as well as the negative effects on reputation.²⁶ The degree to which the value of diplomatic utility can be used to justify the added costs of continued cooperation contributes to the project's political sustainability.

1.3.1.4 Diplomatic prestige

Diplomatic prestige presents an opportunity to demonstrate leadership and technical ability on the international stage. Diplomatic prestige differs from diplomatic utility in that prestige refers to a leadership role that can be used as a diplomatic tool for soft power. Cooperation creates diplomatic prestige by allowing other countries to benefit from the accomplishments of another's space program, thus demonstrating leadership.

One way in which diplomatic prestige from space exploration can be used as a soft power diplomatic tool is in the value is derived from the symbolism of cooperation that demonstrates good relations between partners. An important demonstration of this is the Apollo-Soyuz space link-up that helped ease tensions at the height of the Cold War by bringing two superpowers into cautious cooperation.²⁷ It was later revealed that diplomatic prestige played a key role in Moscow's approval of the joint-orbital mission as Russia could be seen as an equal partner to the US who had the most advanced space program in the world.²⁸ The effect of space exploration as a diplomatic tool for soft power can therefore be measured by the extent to which cooperation can be used as a proxy to implementing a policymaker's agenda.²⁹

1.3.2 Barriers to international cooperation in space exploration

International cooperation in civilian space exploration has the potential to accrue many benefits to participating actors. There are however challenges that impede progress

²⁶ Broniatowski, Faith and Sabathier (2006)

²⁷ Sheehan, Michael. *The International Politics of Space*. New York: Routledge, 2007. Print. Pg. 14.

²⁸ "The real lessons of international cooperation in space." Oberg, James. *The Space Review*. 18 July 2005. Web. Accessed 1 October 2013. <http://www.thespacereview.com/article/413/1>

²⁹ Broniatowski (2006): 2

in expanding international cooperation. This list is non-exhaustive and does not detail every challenge faced in regards to evaluating opportunities for international cooperation. It does however illustrate some of the major concerns the international community has about cooperating in space exploration.

1.3.2.1 Practical impediments

The idea that international cooperation necessarily leads to cost savings is false. The main reason for this are the number of practical impediments that increase the ‘layers of complexity’ within a cooperative project. These challenges can arise from unaligned funding and programmatic cycles and from practical, in-field challenges faced by international teams working on a cooperative project.

Unaligned funding and programmatic cycles occur due to the different ways countries manage their national space agencies. This misalignment is caused by different political systems, but can also be due to unique cultural dimensions, specifically in relation to time orientation, power distance, gender roles, social orientation and uncertainty avoidance.³⁰ An example of where these concerns have had tangible effect can be found in US National Research Council’s *Vision and Voyages for Planetary Science in the Decade 2013-2022* that noted an inherent risk of international cooperation is that: “different space agencies use different planning horizons, funding approaches, selection processes, and data dissemination policies”.³¹ Furthermore technical specification, management, and implementation were all found to have added a layer of programmatic complexity to international missions.

Practical, in-field impediments have also signaled problems with international cooperation. For example the integration of ISS electrical power systems is a case that highlight problems in, *inter alia*, engineering and design change and verification.³² In regards to the former it was found that design changes were required to undergo such a thorough review process by all international partners affected that the cost of even minor

³⁰ Ehrenfreund, Pascale, Nicolas Peter, Kai-Uwe Schrogl, and John M. Logsdon. “Cross-cultural management supporting global space exploration.” *Acta Astronautica* 66 (2010): 245-256.

³¹ United States National Research Council Committee on the Planetary Science Decadal Survey. *Vision and Voyages for Planetary Science in the Decade 2013-2022*. National Academies Press, 2011.

³² George and Tyburski (2005)

changes were significant. Verification was also problematic due differences in acceptable levels of risk and differences in methods used to demonstrate compliance.

Addressing practical impediments is needed to promote project efficiency and therefore has placed emphasis on developing collaboration architectures that can reduce coordination costs.³³

1.3.2.2 Ineffective communication

Miscommunications create misinformed perspectives on the ambitions of space actors. These communication problems have been noted at strategic and practical levels.

Strategic communication signifies the numerous methods by which governments understand, engage, advise, and influence through communication strategies.³⁴ When applied to space activities strategic communication is key in sending messages about the ambitions of one's space program. A clear example of a lack of strategic communication regarding a country's activities in space is seen in the US-China case. Johnson-Freese (2006; 2009) argues that space messages between the US and China have been distorted as a result of scholarly error and sensationalist spinning of Chinese actions.³⁵ The consequences of these errors are misinformation or analyses with preordained conclusions, poor report credibility consequent of misinterpreted information, and the influencing of policymakers towards misguided actions. Tensions can be furthered by ineffective strategic communication that distorts information on current and future national space activities, creating mistrust between space actors.³⁶

As a possible solution it is recommended that engineers and scientist make sound technical assessments that inform political analyses so as to minimize decisions made on bad information.³⁷ The problem of ineffective strategic communication however is an

³³ Rendleman, James D., and J. Walter Faulconer. "Improving International Space Cooperation: Consideration for the USA", *Space Policy*, vol. 24:3 (2010), p.143-151. Pg.18.

³⁴ This breakdown is taken from the 2004 Defense Science Board and used as a base definition in Johnson-Freese's works (2006; 2009). Specifically, strategic communication refers to: "*understand* global attitudes and cultures, *engage* in a dialogue of ideas between people and institutions, *advise* policymakers, and *influence* attitudes and behavior" *Defense Science Board, Report of the Defense Science Board Task Force on Strategic Communication (2004) pg.11*. In Johnson-Freese (2006): 39.

³⁵ Johnson-Freese (2009): 53-56.

³⁶ Johnson-Freese (2006)

³⁷ Johnson-Freese (2009): 60.

ongoing problem required effort from all parties to accurately present one's ambitions and to understand the ambitions of others.

Other issues regarding ineffective communication have also been raised. Cross-cultural management frameworks cite miscommunications in language, visions, negotiations, and management styles as reasons for failed collaborations.³⁸ Communication difficulties are also often cited as a significant practical challenge for cooperation at the sub-operation level, as George et al. (2005) noted from their experience working with the ISS: "Participants are on different continents, speak different languages and have culturally different expectations. These challenges must be overcome regardless of what notional management model is used".³⁹

1.3.2.3 Dual-use technologies and unwanted technology transfer

Space technologies have an intrinsic strategic quality that creates an ever-present possibility of dual-use application. Indeed some 95% of space technology is considered to have dual-use application.⁴⁰ The best example of this is how space launch rockets can be easily transformed into ballistic missiles.⁴¹ As was mentioned earlier in this work two benefits of cooperation are building technological capability through technology transfer and achieving a higher return on investment from dual-use technologies. The concern here is that of a proliferation of sensitive technologies from unwanted technology transfer and undesired applications, specifically military applications, of dual-use technologies.

Export control regimes are used to prevent the proliferation of sensitive items and technologies. Non-proliferation is recognized as an issue that must be solved at the international level. Space items are particularly sensitive within export control regimes as there is much overlap between space launch technologies and ballistic missile technology. With this overlap in mind the Missile Technology Control Regime and the Hague Code of Conduct against the Proliferation of Ballistic Missiles (HCOC) have been

³⁸ Ehrenfreund et al. (2010): 246

³⁹ George and Tyburski (2005)

⁴⁰ IFRI Security Studies Center. Johnson-Freese, Joan. "China's Space Ambitions." Prepared in collaboration with the Atomic Energy Commission (CEA), 2007. 26 p.5.

⁴¹ Project 2049. Stokes, Mark A. and Dean Cheng. "China's Evolving Space Capabilities: Implications for U.S. Interests." Prepared for the US-China Economic and Security Review Commission, 2012. 84 pp.

two international-level attempts to address proliferation. The difficulty in creating an effective export control regime is to balance a reduction of trade barriers to encourage commercial sector growth while maintaining a due diligence towards national non-proliferation commitments.⁴² The most evident example of this barrier are the International Trafficking in Arms Regulation (ITAR) export restrictions imposed by the US on China.

1.4 Literature review

Cooperation in space exploration is recognized as necessary; the financial and technical resources required to explore space are so great that it is understood that no one state can competitively pursue these activities autonomously. Given this acknowledgement, existing literature has expressed much interest in investigating opportunities for new partnerships and mechanisms for cooperation. The focus of these discussions has not concentrated on justifications of why countries should cooperate, but rather on how best to implement cooperation- and collaboration-enhancing initiatives.

The following literature review is divided into four major sections. First, a discussion of liberal international relations theory as an appropriate theoretical framework to evaluate international cooperation in space exploration will be presented. This framework will identify the importance of domestic-level bargaining processes and the influence of the international environment in forming national space policy. Second, an overview of the evolution of international cooperation in space exploration using the *Space Exploration 3.0* conceptual framework will be offered. It will be shown that the current conditions are unique in that there are many more actors involved in space exploration activities and that these activities are being pursued for scientific and non-scientific reasons. Third, literature regarding desired design criteria for a multilateral collaboration mechanism and proposals for international cooperation will be offered. These contributions will highlight criteria that must be met for a mechanism to successfully facilitate collaboration between spacefaring nations. This section will

⁴² Zhao, Yun and Yongmin Bian. "Export control regime for space items in China: Opportunities and challenges in the new era." *Space Policy* 27 (2011); pp. 107-112.

conclude with a critique of the literature and highlight its applicability to the Chinese case.

1.4.1 Liberal international relations theory and space activities

Liberal international relations theory interprets the international system as anarchic. The system is comprised of national and transnational actors who interact with each other. Cooperation in this environment is possible by using international institutions to mitigate behavior. Specifically, the role of international institutions is to encourage good governance by promoting liberal values of justice, liberty, and tolerance in international relations.⁴³ International regimes also have influence as: “the norms and rules of regimes can exert an effect on behavior even if they do not embody common ideals but are used by self-interested states and corporations engaging in a process of mutual adjustment”.⁴⁴

Liberalism interprets space activities as a complex set of political interactions between domestic and international actors. This interpretation therefore considers domestic and foreign policy concerns as informing national space policies. This perspective is relevant in providing explanations for cooperation as birthed from the relationship between national space policies and globalization, which is strongly influenced by the high cost of space ventures and required technological interdependence.⁴⁵

The distinction between harmonization and cooperation within liberal international relations theory has particular relevance to space policy. Intergovernmental cooperation occurs when “the policies actually followed by one government are regarded by its partners as facilitating realization of their own objectives, as the result of a process of policy coordination”.⁴⁶ An example of intergovernmental cooperation can be seen in the function of the United Nations Committee on the Peaceful Uses of Outer Space (UN COPUOS). UN COPUOS is used to promote good governance between states and

⁴³ Dunne, Tim and Brian Schmidt. “Realism.” *The Globalization of World Politics: An Introduction to International Relations*. 5th edition. Baylis, John: Oxford University Press, 2011. 88-95.

⁴⁴ Keohane, Robert. “Cooperation and International Regimes.” *Conflict and Cooperation: Evolving Theories of International Relations*. Genest, Marc: Oxford University Press, 2003. 199-211. Print

⁴⁵ Sheehan (2007): 16

⁴⁶ Keohane, p.211

involves all participants by instituting a ‘decision by consensus’ rule to encourage national delegations to spend time to explain an issue, to communicate background information that may not be obvious to emerging spacefaring nations, and to present a proposed work plan.⁴⁷ This process is meant to develop “new norms of behavior in outer space, either through internationally accepted guidelines or other forms of codification”.⁴⁸

Harmonization refers to a situation where one actor pursues a self-interested policy that happens to attain the goals of another actors.⁴⁹ The ESA provides an example of a harmonization of interests. Instead of integrating members within a supranational framework the ESA synthesizes overlap between national space policies to harmonize national interests into a defined European vision.⁵⁰

Although liberalism has explanatory value for cooperation in space activities the approach does not capture ideational or cultural influences on national space policy. Liberalism’s explanatory value in describing space activities is limited by its focus on international and transnational actors. The problem is a consequence of the level-of-analysis problem in international relations that “permits us to examine international relations in the whole, with a comprehensiveness that is of necessity lost when our focus is shifted to a lower, and more partial, level”.⁵¹

The value of liberalism as a theoretical grounding for this thesis then is that it informs the structure of this paper. Liberalism views national space policy as product of complex political bargaining processes that occur domestically as well as the influence of the international environment. Acknowledging the dialectic relationship between domestic and international factors in influencing national space policy, this work pursues research questions that accommodate both levels.

⁴⁷ Brachet, Gérard. “The origins of the ‘Long-term Sustainability of Outer Space Activities’ initiative at UN COPUOS.” *Space Policy* 28:3 (2012); pp. 1-5. Pg.5

⁴⁸ *ibid.*

⁴⁹ Keohane, p.210

⁵⁰ European Space Agency. “ESA’s Purpose.” Web. Accessed 20 Oct 2013.

http://www.esa.int/About_Us/Welcome_to_ESA/ESA_s_Purpose

⁵¹ Singer, David J. “The Level-Of-Analysis Problem in International Relations.” *Conflict and Cooperation: Evolving Theories of International Relations*. Genest, Marc: Oxford University Press, 2003. Pg.31.

1.4.2 Evolution of cooperation: Space Exploration 3.0

The history of space exploration has been significantly conditioned by geopolitical influences. To capture changes over time Nicolas Peter (2006) presented a conceptual model arguing that conditions for cooperation can be grouped into three phases (see Table 1). The model is based on the idea that the level of space technology achieved by a national space program dictated cooperation. States, according to capability from lowest to highest, could be placed on the following scale: 1) purchasing of satellites; 2) developing systems in cooperation with a more capable partner; 3) developing satellites independently; 4) disseminating satellite technology to others. Using this approach cooperation was found to occur between spacefaring countries located on the second and fourth position of the proposed development scale.

Table 1

Exploration era	Characteristics
Space Exploration 1.0 <i>Cold War</i>	<ul style="list-style-type: none"> • Drivers for cooperation: political, limited to 'intra-bloc' • Dominated by two actors: the United States and the U.S.S.R. enabled more options for cooperation
Space Exploration 2.0 <i>1990s-now</i>	<ul style="list-style-type: none"> • Drivers for cooperation: scientific and practical applications • Proliferation of new national space agencies
Space Exploration 3.0 <i>Currently transitioning towards</i>	<ul style="list-style-type: none"> • Drivers for cooperation: quest for knowledge in the hard sciences, social sciences, and humanities; economic potential • Defined by participatory space exploration including states, industries, universities, and non-governmental organizations.

Adapted from Nicolas Peter (2009: 108)

The Space Age was birthed primarily from military motivations as competition between the United States and the U.S.S.R heightened during the Cold War. During this

period space exploration was seen as a venue for peaceful competition between the United States and the U.S.S.R.; cooperation was mainly limited to intra-bloc alliances.⁵² The post-Cold war era defined the next phase of space exploration. The increase in technical capabilities of other states and a proliferation of new national space agencies reflected the globalization of space actors. The increase in cooperation between national space actors was mainly conducted through bilateral and multilateral agreements, and was often driven by scientific motivations.⁵³ It should be noted that cooperation was primarily found in space sciences and space applications agreements. During this period cooperation in space science often referred to an agreement where one partner agreed to launch a foreign instrument or experiment on a national spacecraft. Space applications mainly referred to Earth-observation satellites or space-based navigation projects where countries lacking the indigenous ability to build and launch these projects could be included in this type of partnership by purchasing the services from partners.⁵⁴

Cooperation in space sciences and space applications deepened connections between states and helped facilitate the internationalization of space activities. Although this type of cooperation – in space science and space applications – does not necessarily constitute a space exploration activity, it enabled first-time access to space activities for a number of states. This engagement in space activities would help build a foundation on which nascent national space programs could begin to develop indigenous capabilities.

The current international context for space exploration differs from previous eras as space exploration is becoming more participatory due to a proliferation of actors and because it is being driven by scientific and non-scientific motives. Non-scientific motives include the quest for knowledge, to discover whether life exists outside of Earth, the exploitation of space resources such as asteroid mining, and space tourism to name a few.⁵⁵ In this context, the proliferation of new actors creates new options for cooperation that did not exist in state-dominated, bipolar or weak multipolar systems.

⁵² Peter, Nicolas. “The changing geopolitics of space activities.” *Space Policy* 22 (2006): pp. 100-109. Pg. 108

⁵³ *ibid*

⁵⁴ *ibid*, pg. 103-104

⁵⁵ For further elaboration of non-scientific drivers see European Space Policy Institute. Schrogl, Kai-Uwe. “The political context for human space exploration.” *Studies in Space Policy: Humans in Outer Space- Interdisciplinary Perspectives* vol. 5 (2011); pp. 3-14; American Institute of Aeronautics and Astronautics SPACE 2011 Conference & Exposition (2011), Comstock, D. and Lockney, D.; Glass, C.; “A sustainable

1.4.3 Building coordination mechanisms

Space exploration is prohibitively demanding of financial and technical resources for any one state to pursue independently in a competitive way. The benefits accrued from cooperation are significant ranging from the creation of jobs, scientific gains, and spinoff applications to more comprehensive interpretations that capture cultural and emotional impacts. What needs to be added to this discussion then is what states want from international collaboration in space exploration. In other words, it is important to consider criteria a mechanism for multilateral collaboration must meet to encourage states to participate. This section will provide an overview of the literature related to the building of an international coordination mechanism in space exploration, with a focus on state-centered multilateral mechanisms. It will then look at specific proposals for locating opportunities for cooperation.

1.4.3.1 Mechanism design criteria

Multilateral international collaboration mechanisms are used to formalize informal communications and can provide the structure needed for more structured cooperation. Various design criteria have been proposed in order to construct a sustainable mechanism for cooperation that can accommodate the rise of new actors in the *Space Exploration 3.0* era.

Correll and Peter (2005) are concerned with creating an enduring exploration vision. The authors argue that traditionally space exploration plans have been made at the national level and were driven by foreign policy and cost-sharing considerations. One problem that arises is that projects in different countries are likely be unaligned in terms of funding and schedule thus making cooperation difficult. Furthermore the authors note a change in the hierarchy of space powers driven by changes in government and industrial space technologies and capabilities. This new context will allow for a

method for quantifying the benefits of NASA technology transfer” AIAA 2011-7329, Long Beach, September 2011.

proliferation of international cooperation in space activities since space agencies could cooperate *a la carte* instead of with a ‘set menu’ as in the Cold War.

The authors argue that the solution for an enduring exploration vision is for it to be flexible so as to accommodate changes in priorities of established actors while allowing for the inclusion of non-traditional partners. To accomplish this it is recommended that metaprinciples and open-system principles be adopted and applied at all levels of cooperation – hardware, software, programmatic, political and cultural. Metaprinciples relate to the design of enduring exploration architectures that “require openness to interaction between the various sectors and participants, such as national interests, the scientific community, commercial interests, the general public and the private sectors”.⁵⁶ Open-systems principles refer to architectures and systems that are collaborative in nature, have flexible decision-making, and whose objective is to create growth in participation and functionality.⁵⁷ The challenges to adopting an open-systems architecture are cost overruns, delays in schedules, and historic legacies manifested in entrenched interests.

Ehrenfreund and Peter (2009) work toward identifying guidelines for designing a sustainable global space exploration platform by analyzing the activities and objectives of various space exploration programs. A sustainable platform, they argue, should be built on stakeholder integration so as to accommodate the growing influence of non-state actors as outlined in the *Space Exploration 3.0* framework. Stakeholder integration needs to occur at intranational and international levels. At the intranational level government, industry, the scientific community, and the public as stakeholder must be aligned to as to create a strong national base of support for space exploration activities. Building on this national-level foundation international stakeholder integration can occur via cooperation and global partnerships. Also, for space exploration the main issue will be the availability of resources, therefore there is a need to integrate private actors so as to move from a technology-push to a market-pull scenario. In this scenario private sector actors could provide services and exploit existing government-funded space infrastructure.

⁵⁶ Correll and Peter. “Odyssey: Principles for enduring space exploration.” *Space Policy* 21 (2005): 251-258.

⁵⁷ *ibid*

To facilitate the alignment of main stakeholders the authors apply a SMART⁵⁸ analysis to evaluate the strategic planning of global space exploration. It was found that to efficiently implement a long-term space exploration strategy requires a better definition of SMART and performance objectives. To achieve this stakeholder interdependency, the authors suggest a focus on information exchange, organizational knowledge, and human capital. It is acknowledged however that a political environment capable of providing balanced technology protection and that can establish synergies between different strategic national goals is required to pursue long-term missions.

Schaffer (2008a; 2008b) has researched what design criteria are necessary for a desirable multilateral international coordination mechanism for space exploration. The author published two papers that utilize synthesized informal interviews with representatives from 10 of the Global Exploration Strategy⁵⁹ participating countries to identify desirable criteria for a coordination mechanism. One of the papers grouped the perspectives of spacefaring nations and contrasted their required criteria with US criteria requirements. It was found that the main overlap between the US and other actors is a support for independence, flexibility, and a clear scope. The only area of disagreement between the two sides was that the US was concerned over who could participate in the mechanism citing foreign policy implications of collaborating with non-preferred partners.⁶⁰

The second paper builds upon these findings by contrasting required criteria synthesized from informal interviews with successful features of existing mechanisms for international collaboration. The analysis considered the following existing mechanisms: the Committee on Earth Observation Satellites, the Group on Earth Observation, the International Agency Consultative Group, the International Space Station, the European Space Agency, ITER, and the Antarctic Treaty System. It was found that no existing

⁵⁸ SMART analysis is used in project management to evaluate whether goals and objectives have been achieved. SMART is an acronym for the following objectives: Specific, Measurable, Acceptable, Realistic, and Time-bound.

⁵⁹ The Global Exploration Strategy is a vision of a globally coordinated exploration that was jointly developed by 14 contributing space agencies and published in 2007. In alphabetical order these agencies include: ASI (Italy), BNSC (United Kingdom), CNES (France), CNSA (China), CSA (Canada), CSIRO (Australia), DLR (Germany), ESA (European Space Agency), ISRO (India), JAXA (Japan), KARI (Republic of Korea), NASA (United States), NSAU (Ukraine), Roscosmos (Russia).

⁶⁰ Schaffer, Audrey M. "What do nations want from international collaboration for space exploration?" *Space Policy* 24 (2008); pp. 95-103. Pg. 101-102.

mechanism adequately satisfied the requirement criteria of the US and other spacefaring nations and therefore recommended establishing a new mechanism. The proposed new mechanism builds on the previous work and recommends the inclusion of independence, flexibility, and clear scope as key principles.

1.4.3.2 Proposals for international cooperation

Enhancing international cooperation in the era of *Space Exploration 3.0* requires a sustainable multilateral international coordination mechanism. The design criteria of such a coordination mechanism include metaprinciples, stakeholder integration, and must permit independence, flexibility, and provide a clear scope. While these contributions are in regards to the design of a coordination mechanism as a platform it is also necessary to consider various frameworks used to identify and evaluate opportunities for cooperation in space exploration. The following will overview various proposals for international cooperation and the parameters that inform them.

Ansdell et al. (2011) propose a stepping stone approach towards creating a global space exploration program. The approach consists of three steps: (1) creating an international Earth-based field research program to prepare for planetary exploration, (2) increase exploitation of the ISS to use it as a platform for exploration, and (3) a global CubeSat⁶¹ program that supports exploration activities. The authors organize the space community into space powers, emerging space nations, and developing countries. What differentiates these categories is where a state places on a continuum of space capabilities from high complexity with low dependence on foreign partnerships to low complexity with high dependence on foreign partnerships. Achieving ‘established space power’ status requires a state to have proven launch vehicles and to have played a significant role in exploration missions. This interpretation therefore places technical capability as the primary criteria for classifying space capabilities of states.

For each step a different mechanism for collaboration is recommended with each step increasing in level of collaboration, providing emerging space powers and developing countries with the opportunity to participate directly in a space exploration

⁶¹ CubeSats are a type of nanosatellite with a standard size of 10cm³ and weighs approximately one kilogram.

project. The proposed collaboration mechanism for the international Earth-based field research program in preparation of planetary exploration would be modeled on the Scientific Committee on Antarctic Research (SCAR). SCAR is an in-situ exploration model that facilitates regular meetings and information exchanges about various research. Data sharing would support collaboration for increasing exploitation of the ISS where data generated from an experiment would be used as payment for renting space on the ISS. It is recommended that UN COPUOS and the Committee on Space Research take leading roles in organizing this collaboration. Finally collaboration for the global CubeSat program would operate on the ‘data sharing in exchange for ridesharing’ model. This arrangement would allow partner nations to share data generated from their CubeSat as payment for a space launch vehicle-providing partner hosting the payload.

Broniatowski et al. (2008) contribute a systematic framework to evaluate proposals for international cooperation in space exploration. The framework builds on six types of international cooperation representing various degrees of collaboration by adding technical and policy parameters. The authors argue that previous frameworks have been too focused on technical aspects and therefore undervalue the impact of policy factors. Technical parameters utilized by this framework are cost, schedule, and performance and are considered main determinants of system success. Policy parameters refer to the political utility from the perspective of each partner nation and are constructed to capture domestic and foreign policy concerns. More specifically, the authors identify the effect of national space activities on the domestic economy, national security, national prestige, influence on policy at global and regional levels, and on desired technical capabilities as key factors in this calculation. Furthermore policy impediments must be considered.

The authors concede that the list of factors constituting a country’s political utility is not exhaustive and cannot apply to each country equally. Instead, policy parameters need to be updated at the time of decision-making and be informed by a national environment to capture the realities of a given context.

Szajnfarder et al. (2011) create and evaluate various collaborative space exploration architectures⁶² using NASA, CSA, JAXA, and the ESA in their analysis. The goal of their analysis is to identify a sustainable exploration strategy. Collaboration

⁶² For a definition of ‘collaboration architecture’ see page 31.

architectures are based on near-Earth object (NEO) and Moon-first destination scenarios. The technical requirement to support each destination and the technological capability of the four space agencies inform the technical parameters of the architecture. Political parameters for each space agency were derived from various sources including press articles, reports, and interviews with key individuals. Using these sources the authors established each agency's priorities and capabilities.

The main findings of the study were found from overlaying technical and political collaboration architectures to determine the feasibility of international cooperation in developing the various technical requirements needed to support NEO and Moon-first missions. It was found that politically the US needed control of a 'security core' including crew capsule, launch vehicle and heavy launch vehicle. Given this US requirement international contributions were most likely to be in robotic precursor missions and planetary access and operations. These potential areas of contribution for international partners are therefore susceptible to whether the US chooses a NEO or Moon-first approach. For example a NEO destination, such as an asteroid, would not require contributions in planetary access and operations, such as a habitation module. In this scenario then the potential areas of contribution for international partners is more limited. Opportunities for international cooperation with the US is therefore strongly influenced by the US' desired destination.

Given the relative lack of opportunities for international cooperation for NEO-first approaches, the authors suggest that a Moon-first approach is more desirable. The Moon-first approach is also considered to be more politically palatable since it stirs greater interest, scope and prestige. Finally the authors find that a sustainable exploration strategy should be destination-driven since it is the politically feasible approach.

1.4.4 Critique of literature

The above discussion was intended to provide a background on how to facilitate international cooperation in space exploration in the current geopolitical environment. The goal of this study is to help identify opportunities for international cooperation with China in space exploration activities. Building on existing literature this study can now

argue that the conditions for cooperation in the *Space Exploration 3.0* era are increasingly participatory and that national space policy is a product of both domestic bargaining processes and influences from the international environment. This insight is relevant for this study as it suggests that new configurations of cooperation are available. Specifically, it cautions against over-emphasizing state-to-state partnerships instead recommending that linkages between new domestic and international actors be considered. The body of literature for international cooperation in space exploration however is still relatively underdeveloped. For this reason the literature review is more descriptive for the articles chosen but limited in breadth.

The key points relating to mechanism design criteria are that a sustainable mechanism requires flexibility to accommodate the interests of a diverse range of actors. This requirement is in response to the new *Space Exploration 3.0* international environment. Contributing authors believe that these recommendations can be achieved by applying open-system architectures at various levels, by promoting stakeholder integration, and by including principles of independence, flexibility, and a clear scope.

Much of the literature related to proposals for international cooperation and collaboration employ collaboration architectures, a common method used in engineering and applied by authors with technical backgrounds. Generally, collaboration architectures create matrices that outline the capabilities of partners in relation to various subtasks needed to complete a project. These capabilities can be measured in terms of technical capabilities or policy considerations and subsequently overlaid to identify potential opportunities for cooperation.

In relation to these discussions two points need elaboration. First, the idea of stakeholder integration has particular salience. New actors in space exploration are a major driver in the shift to Space Exploration 3.0. As referenced earlier in this work, the new era includes states, non-government organizations, universities, and industries; states of course remain the central actors.⁶³ Developing a methodology to capture the contributions of new actors is not a straightforward task. In regards to national space programs, previous methodologies such as aggregate number of satellite launches have

⁶³ OECD (2012), “Principal actors in the space economy”, in *OECD Handbook on Measuring the Space Economy*, OECD Publishing.

been used to measure national space activities grossly misrepresented national space activities.⁶⁴ Furthermore space activities of developing countries were systemically excluded.⁶⁵

Due to the increasingly participatory character of space exploration other actors such as NGOs are having a measurable effect on space exploration activities. Space related NGOs themselves are of diverse makeup and have different roles that mainly assist with capacity building. One study surveys the efforts of four prominent space related NGOs – the Space Advisory Council, EURISY, The Planetary Society, and the Secure World Foundation – and found significant contributions in outreach activities, space awareness, dissemination of the benefits of space activities to the general public, education campaigns, and capacity building particularly in developing countries.⁶⁶ Furthermore NGOs can be used as proxy for diplomacy and communication between policymakers making them an effective option for Track Two diplomacy strategies.⁶⁷ An example of this is the work done by the International Astronautical Federation (IAF). The IAF’s mission is to “foster dialogue between scientists around the world and support international cooperation in all space-related activities”.⁶⁸ In this pursuit the organization has co-organized a number of conferences including the Global Space Exploration Conference in 2012 and the IAC, with the 64th IAC having recently taken place in September 2013 in Beijing, China.

To summarize developing countries, space-interest NGOs and private actors are contributing to space exploration activities in various ways. The idea of stakeholder integration is needed to accommodate the interests and concerns of these actors so as to create an environment conducive to participatory space exploration. Including new actors in a meaningful way is a key component in creating a sustainable space exploration strategy.

⁶⁴ European Space Policy Institute. Perek, Lubos. “Cooperation within the UN system.” *Studies in Space Policy: The Fair and Responsible Use of Space* vol. 4, 2010. 101-108.

⁶⁵ Wood, Danielle and Annalisa Weigel. “A framework for evaluating national space activity.” *Acta Astronautica* 73 (2012): 221-236.

⁶⁶ Lukaszczyk, A. and R. Williamson. “The role of space related non-governmental organizations (NGOs) in capacity building.” *Advances in Space Research* 45 (2010): 468-472.

⁶⁷ Ibid, p.468.

⁶⁸ International Astronautical Federation: About. Accessed April 18th 2013.
<http://www.iafastro.com/index.php/about>

The second point regarding mechanism design is that to a large extent the recommendations have materialized in the form of the International Space Exploration Coordination Group (ISECG). ISECG is a non-binding, voluntary international coordination mechanism whose purpose is to develop “non-binding findings, recommendations and other outputs as necessary for use by Participating Agencies”.⁶⁹ ISECG activities are based on four principles: ‘open and inclusive’ ensures that ISECG receives inputs from all interested agencies and facilitates consultations among agencies; ‘flexible and evolutionary’ in that existing coordination mechanisms are considered; ‘effective’ refers to participating agencies recognizing the benefit of coordination and encourages agencies to act upon anticipated results; and ‘mutual interest’ that claims ISECG activities to be of benefit to all participants, respect national contexts, and allows for optional participation on specific projects.⁷⁰ In sum, ISECG is a mechanism for international collaboration in space exploration that assumes a state-focused and consensus-driven approach whose products are non-binding. As such, the value of ISECG is in its power to influence the strategic orientations of actors in space exploration. The critique of ISECG as a platform for cooperation is that it is state-focused and therefore cannot accommodate the plethora of non-state actors.⁷¹

How are Chinese space exploration activities seen in the existing literature on international cooperation in space exploration? Interestingly, China is often excluded from collaboration architectures despite their status as an ‘emerging space power’ stakeholder. The reason for this is due to the fact that the analytical frameworks and collaboration architectures are proposed by Western analysts who do not feel qualified to assess Chinese capabilities and motivations because of language barriers and limits of

⁶⁹ International Space Exploration Coordination Group. *Workplan of the International Space Exploration Coordination Group (ISECG)*. ISECG, 2011. 21 pages.

http://www.globalspaceexploration.org/c/document_library/get_file?uuid=54c9a954-e112-40a2-9228-3c1d2d9e6082&groupId=10812

⁷⁰ International Space Exploration Coordination Group. *Annual Report 2011 of the International Space Exploration Coordination Group*. ISECG, 2011. 40 pages. Pg.7

http://www.globalspaceexploration.org/c/document_library/get_file?uuid=757abb46-0e23-4bfc-8c1c-dde1320faadc&groupId=10812

⁷¹ Ehrenfreund, P. and N. Peter. “Toward a paradigm shift in managing future global space exploration endeavors.” *Space Policy* 25 (2009): 244-256.

open, reliable, and accessible information.⁷² From the author's reading of existing literature information in relation to describing important factors in China's political utility calculation have been scattered, oversimplified, or acknowledged as a limitation as left to future work. Some Chinese scholars and a few think-tank reports have attempted to improve our understanding on this point, however these contributions have yet to meaningfully penetrate literature regarding mechanism design and collaboration architectures.

The *China's Space Activities White Paper* indicates that China is positioning itself to take advantage of an increasingly participatory space environment. First, China has signed 71 bilateral space agreements with various partners and has been actively involved in designing, manufacturing, providing in-orbit delivery, and providing ground operations training for developing countries' satellite programs.⁷³ Also the utility of NGOs in facilitating cooperation in space activities has been recognized by Chinese political leaders who have expressed interest in maintaining connections with NGOs as part of their multilateral cooperation strategy: "China takes part in activities organized by the International Astronautical Federation, International Committee on Space Research, ISECG,... and other non-governmental space organizations and academic institutes".⁷⁴ This position is evidenced by China hosting the 2013 IAC in Beijing and is also indicated from their desire participate more actively in ISECG in the near future in order to further align their space exploration activities with the international community.⁷⁵

There is a gap in the literature in regards to defining China's space exploration ambitions. Analytical frameworks and collaboration architectures used to identify and evaluate opportunities for international cooperation in space exploration require that the political utility of partner countries be understood and defined. China has expressed interest in expanding cooperation emphasizing the need to adequately understand Chinese ambitions in space exploration. The contribution of this work will be to better define China's calculation of its political utility. These findings will strengthen existing

⁷² This limitation is explicitly acknowledged by the Szajnfalvi et al (2011): pg.5, and implicitly by Broniatowski et al (2008): 183.

⁷³ White Paper. Information Office of the State Council: The People's Republic of China. *China's Space Activities in 2011*. 2011, Beijing.

⁷⁴ Ibid.

⁷⁵ Question submitted by the author at the 64th IAC. The question was answered by the 'heads of space agencies' plenary session.

analytical frameworks and collaboration architectures by providing more reliable information about Chinese ambitions in space that can be inputted into these frameworks. The end result will be an increased accuracy in identifying opportunities for cooperation and collaboration of various space exploration projects.

2. China's civilian space sector

The following section will describe the organizational and industrial infrastructure of China's space industry to gain insight on the main actors driving China's civilian space program. To begin this investigation it is necessary to unpack the 'black box' of China's decision-making processes to introduce the positioning of political, government, and military actors and how they exert influence on the execution of space exploration projects. It will be shown that fragmented authoritarianism and the 'inside access model' are useful frameworks that provide insight on policy making and policy agenda setting respectively for China's space program. This section will conclude with a discussion on China's position towards international cooperation and the barriers they face as caused by domestic trends. Specifically, the role of the PLA and policies promoting civil-military integration will be considered.

2.1 Organization

The following section provides an introduction to the organization and policy-making processes in China's space sector.

2.1.1 Organizational structure

The space program has a strategic importance and role in attaining national and economic security. The importance of the program is reflected by the apex of decision-making power overseeing space activities that involves China's most powerful political organs including the CCP Central Committee, the Central Military Commission, and the State Council, to whom the PLA General Armaments Department (PLA GAD) report.⁷⁶

China divides its space-related activities into three categories: space technology, space science, and space applications.⁷⁷ Space science and applications identify what missions are most desired while space technology is oriented to develop the technology needed to support these missions. The Chinese Academy of Sciences (CAS) advises

⁷⁶ Project 2049 Institute, pg. 11

⁷⁷ Chinese Academy of Sciences. *Space Science & Technology in China: A Roadmap to 2050*. Beijing: Science Press Beijing, 2010. Print.

Chinese political and government leadership on the nation's science and technology (S&T) development and is in charge of organizing China's space science missions.⁷⁸ They have published an important roadmap entitled *Space Science & Technology in China: A Roadmap to 2050* that provides a detailed account of China's ambitions in space sciences, space applications, and space technologies. An important institute for space exploration missions with CAS is the National Space Science Center (NSSC) who is responsible "for planning, selecting, developing, launching and managing the operation of China's space science satellite missions".⁷⁹

The implementation of space policy by the space bureaucracy however remains difficult to decipher, in part due to the confusion of recent, significant bureaucratic restructurings.⁸⁰ Indeed, as Johnson-Freese notes the organizational complexity still proves problematic: "understanding the organizational charts of China's aerospace and policy structures has been and remains an important but often elusive goal for Western analysts".⁸¹ From what is known the PLA GAD have significant influence over the operations civilian and military space activities. Due to the absence of an empowered civilian space organization in China, executive authority for civil and military space activities is assigned to the PLA GAD. These responsibilities include coordinating the R&D and manufacturing of space systems, and overseeing launch services for both commercial and military purposes.⁸² PLA GAD is also responsible for the manned space program and the execution of national and military space acquisition policies.⁸³

The main civilian space agency is the China National Space Administration (CNSA). They are the "governmental organization of the PRC responsible for the management of space activities for civilian use and international space cooperation with other countries".⁸⁴ Their functions include: studying and formulating policies and regulation for the space industry; organizing and implementing major space projects and

⁷⁸ Ibid, preface.

⁷⁹ National Space Science Center, Chinese Academy of Sciences. "A Snapshot of NSSC." Web. Accessed 15 October 2013. <http://english.nssc.cas.cn/au/ac/>

⁸⁰ Cheng, Dean. "Reflections on Sino-US Space Cooperation." *Space and Defense*. Eisenhower Center for Space and Defense Studies, US Air Force Academy, Colorado. (Winter 2009): 10.

⁸¹ Johnson-Freese (2009)

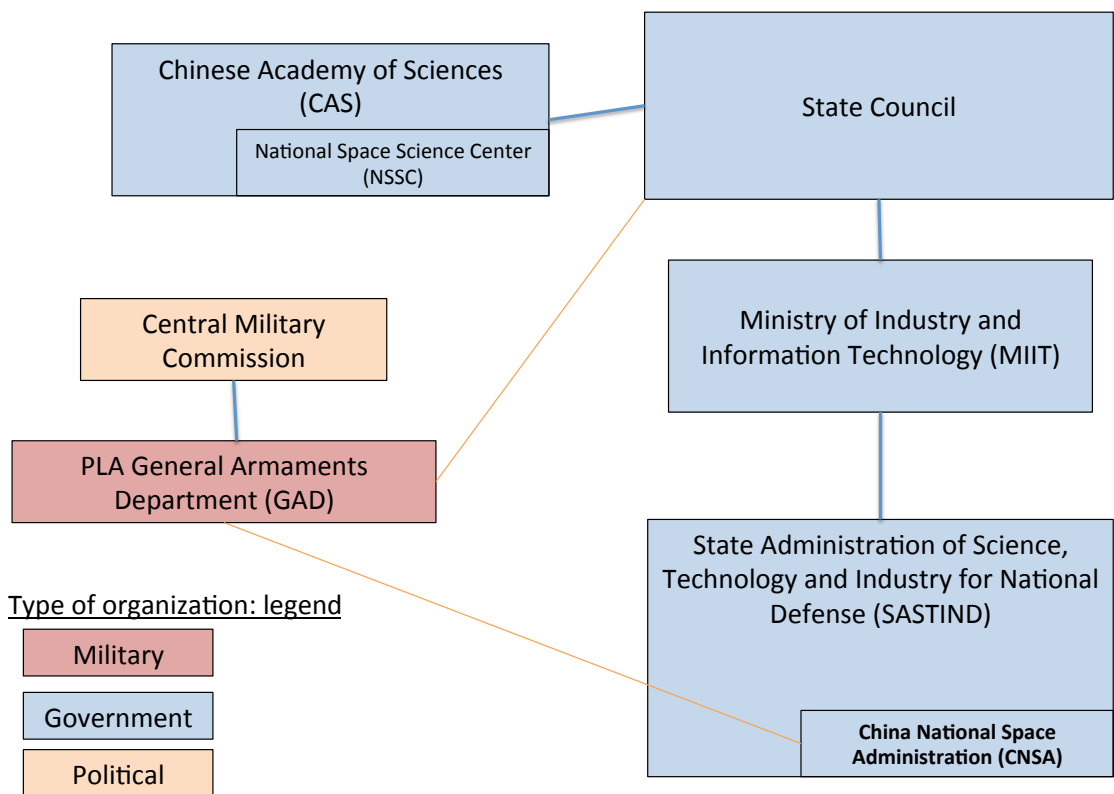
⁸² Project 2049 Institute, pg. 8

⁸³ The everyday operation of the manned space program is looked over by the Manned Engineering Office.

⁸⁴ China National Space Administration. "China National Space Administration." Print. 2013. 56 pages.

programs; demonstrating, approving, implementing and supervising civilian space scientific research projects; and managing international space cooperation, participating in international organizations on behalf of the Chinese government.⁸⁵ To expand and deepen exchanges and cooperation the CNSA has established the inter-agency Coordination Committee for International Cooperation (CCIC). The CCIC is responsible for making proposals and providing suggesting for future and existing international cooperation.⁸⁶ The chart below summarizes the organization of these actors⁸⁷:

Selected players in the Chinese space program



⁸⁵ Ibid.

⁸⁶ Ibid.

⁸⁷ This chart represents a small selection of key players active in China’s civilian space program. Its purpose is to provide a visualization to assist the reader in understanding the key players and their position in the hierarchy of actors. Of course there are other key actors such as the Ministry of Science and Technology that are excluded from this chart. To the author’s knowledge a comprehensive chart detailing the organization of China’s space program has not yet been produced, but would be a valuable contribution for future work.

The development of space technologies is allocated to two major state-owned enterprises (SOEs) the China Aerospace Science and Technology Corporation (CASC) and the China Aerospace Science and Industry Corporation (CASIC). These two SOEs were birthed in 1999 from the split of the China Aerospace Science Technology Corporation to create a structure that could facilitate greater market competition to provide greater incentives for innovation and efficiency.⁸⁸ CASC and CASIC perform similar activities and are the two most important organizations in China's space industrial infrastructure; both subordinate to the PLA GAD.⁸⁹ CASC and CASIC have similar organizational structures that include a corporate-level structure and oversee various academies that are organized into "R&D and/or design departments, research institutes focusing on specific sub-systems, sub-assemblies, components, or materials; and then testing and manufacturing facilities".⁹⁰ As SOEs the enterprises reiterate their adherence on their official websites to national interest above all else and conduct space activities to serve the goals of the country.⁹¹

CASIC comprises of seven research institutes, two research and production bases, six public companies, and more than 600 enterprises and institutions.^{92,93} It specializes in a broad range of defense missile systems in addition to solid carrier rockets and space technology products. CASIC's first academy is notable as it has designed and fielded microsattellites.⁹⁴ CASC is a conglomerate that includes over 125 enterprises who are mainly engaged in "the research, design, manufacture and launch of space systems such as launch vehicles, satellites and manned spaceships as well as strategic and tactical

⁸⁸ Defense Group Inc. Mulvenon, James and Rebecca Samm Tyroler-Cooper. "China's Defense Industry on the Path of Reform." Prepared for the US-China Economic and Security Review Commission, 2009. 74 pp. pg.18.

⁸⁹ China Aerospace Science and Technology Corporation (CASC). The Nuclear Threat Initiative. 10 August 2012. Web. Accessed 14 April 2013. <http://www.nti.org/facilities/64>

⁹⁰ Project 2049 Institute, pg. 11

⁹¹ China Aerospace Science and Industry Corporation Company Profile. China Aerospace Science and Industry Corporation. Web. Accessed 14th April 2013. <http://www.casic.com.cn/n16/n1100/n2768/index.html>

⁹² China Aerospace Science and Industry Corporation Company Profile. China Aerospace Science and Industry Corporation. Web. Accessed 14th April 2013. <http://www.casic.com.cn/n16/n1100/n2768/index.html>

⁹³ See Appendix A-1 to view all the academies, institutes, and subsidiaries included within CASIC's organizational structure (Chinese only).

⁹⁴ Project 2049 Institute, pg. 20

missiles, and also provides international commercial satellite launch services”.^{95,96} The China Academy of Launch Technology (CASC First Academy) is the largest entity involved with developing and manufacturing space launch vehicles and is a leading organization in China’s *Shenzhou* program.⁹⁷ The Academy of Space Propellant Technology (CASC Sixth Academy) is concentrated on research, development, and production of liquid fueled propulsion systems and is a key organization in the development of the Long March V heavy lift launch vehicle (See appendix A-3).⁹⁸ CASC is also the parent company to the China Great Wall Industry Corporation (CGWIC) who are the only commercial organization authorized by the Chinese government to provide international clients with commercial satellite launch services and space technology.⁹⁹

Subordinate companies in CASC and CASIC have considerable autonomy in conducting business operations supporting China’s space program and have even established international networks “linking China’s aerospace and missile sector to capital, know-how, and technology in the market”.¹⁰⁰ Competition between the two SOEs is unique in that competition will not be in terms of products but in systems of organization and their operational mechanism.¹⁰¹ Subsidiaries of these SOEs do however compete for contracts in the international space launch vehicle market that provides CASC and CASIC with incentives for efficiency and innovation.¹⁰² Each academy focuses on a core competency and is accountable for profit and loss.¹⁰³

⁹⁵ China Aerospace Science and Technology Corporation Company Profile. China Aerospace Science and Technology Corporation. Web. Accessed 14 April 2013.

<http://english.spacechina.com/n16421/n17138/n17229/c127066/content.html>

⁹⁶ See Appendix A-2 to view the specialized companies, R&D and production complexes, and directly subordinated units included within CASC’s organizational structure.

⁹⁷ Project 2049 Institute, pg. 17

⁹⁸ *ibid*, pg. 19

⁹⁹ The CGWIC make Chinese launching services available to international customers. The Long March rocket series of next-generation carrier rockets is the premier series having conducted 67 successful launches, and in 2010 it had an equal amount of space launches (15) as the US. For more information see: China Great Wall Industry Corporation Company Profile. China Great Wall Industry Corporation. Web. Accessed 14 April 2013. <http://www.cgwic.com/About/index.html>

¹⁰⁰ Defense Group Inc., pg.19

¹⁰¹ *ibid*

¹⁰² *ibid*

¹⁰³ Project 2049 Institute, pg. 11

2.1.2 Policy-making processes

The process in which policy is made and implemented in China is changing. Simply put, one must be careful when blanketing Chinese politics as authoritarian as it does not appreciate the significant changes from previous leadership regimes: “the term [authoritarianism] is so absurd that it serves more as an ideological curse than as an instrument for academic analysis”.¹⁰⁴ China’s civilian space program however is not easily delineated from its military space operations - projects deliberately cut across both divisions.

Besha’s (2010) case study of the genesis of the Chang’e lunar orbiter recorded the interactions of relevant actors enabling and constraining its development. This case study was guided by, and provided support for, two theories: Kenneth Lieberthal’s ‘fragmented authoritarianism’ and Shaoguang Wang’s ‘inside-access model’.

Fragmented authoritarianism is an institutionalist and pluralist framework describing the influence of different actors in making policy decisions in the modern reform era in China. The framework was proposed by Kenneth Lieberthal asserts that the system is ‘fragmented’ in that lines of authority outside of the center are not clear leading to an incrementalism in policy making. The system is ‘authoritarian’ as a centralized power exerts high degrees of discipline and public policy input from citizens is relatively closed.¹⁰⁵ Wang suggests a typology of six agenda setting models that are differentiated by the degree of public participation and the initiator of an agenda item. Agenda setting refers to “the process of prioritizing public issues according to their importance” and can be divided into three types: media, public, and policy.¹⁰⁶ The latter is most applicable to this purview of this paper. The policy agenda type is a “set of issues under serious and active consideration by political decision makers at any given time”.¹⁰⁷ The inside-access model for agenda setting is characterized by a low degree of public participation and has advisors as the source initiators of the agenda.

¹⁰⁴ Wang, Shaoguang. “Changing Models of China’s Policy Agenda Setting.” *Modern China* 34:1 (2008): 82.

¹⁰⁵ Lieberthal, Kenneth. *Governing China: From Revolution through Reform* 2nd ed. W.W. Norton & Co, 2002. Print.

¹⁰⁶ Wang, (2008): 57

¹⁰⁷ *ibid*, p.58

In charting the development of the Chang'e lunar orbiter fragmented authoritarianism helped explain “the endless sessions of consensus building and incrementalism” and “explains the utility and need of leading small groups, which are able to coordinate across bureaucratic organs more likely to fight with each other over scarce resources.”¹⁰⁸ The inside access model was valuable in describing agenda-setting since China’s space program does not have a clear separation of military and civilian space operations, decision-making excludes the input of citizen groups, and space exploration is inherently sensitive due to its inextricability with national security issues. Although Besha concedes that the findings in the Chang’e lunar orbiter case study may not necessarily translate as an explanatory tool for the human spaceflight program, the author notes there may be similarities between the two programs as many of the leadership personnel is shared.

The inside-access model and fragmented authoritarianism will serve a useful point of departure in unpacking the black box of policy making in China’s space program. Specifically these frameworks suggest that coalitions of support and the approval of political elites have significant influence over the creation and implementation of Chinese national space policy.

2.2 China and international cooperation in space exploration

The following sections will describe China’s official position towards international cooperation and barriers that impede further cooperation.

2.2.1 China’s official position on international cooperation

China’s official position towards international cooperation in space exploration can be found in their White Paper on space activities, the most recent being released in December 2011. This document encourages cooperation and states that all international exchanges and cooperation should “promote inclusive space development on the basis of

¹⁰⁸ Besha, Patrick. “Policy making in China’s space program: A history and analysis of the Chang’e lunar orbiter project.” *Space Policy* 26 (2010): 221.

equality and mutual benefit, peaceful utilization and common development”¹⁰⁹.

Furthermore the White Paper expresses that international cooperation should adhere to the ‘UN Declaration on International Cooperation in the Exploration and Use of Outer Space for the Benefit and in the Interest of All States, Taking into Particular Account the Needs of Developing Countries’.

This pro-cooperation position can be seen in remarks made by Wang Zhaoyao, Director of the China Manned Space Agency, at the 64th International Astronautical Congress:

“It has been China’s consistent pursuit to carry out international cooperation and exchange on the principle of equality and mutual benefit, mutual respect and transparency. China has collaborated extensively with many other countries and regions in space technology, space medicine research, space science experiments and astronaut selection and training. In the construction and operating phase of our space station, we will seek for international cooperate on in an even more open manner and [are] willing to share space development accomplishments with other countries, especially developing countries.”¹¹⁰

The key points regarding China’s foreign policy stance are mutual respect and equality. This is found in all of China’s White Papers on its space activities and is seen as necessary to support cooperation.¹¹¹

In regards to China’s accomplishments in international cooperation the document notes a number of bilateral agreements and participation in various multilateral coordination mechanisms. Key areas for future cooperation in the next five years are also presented and include scientific research on space astronomy, space physics, micro-gravity science, space life sciences, and deep-space exploration among others. Technological cooperation is also highlighted, specifically for projects in China’s human spaceflight program and space science research and experiments.

¹⁰⁹ White Paper. Information Office of the State Council: The People’s Republic of China. *China’s Space Activities in 2011*. 2011, Beijing.

¹¹⁰ “Wang Zhaoyao – China Manned Space Program to Carry out International Cooperation in an Open Manner.” *China Manned Engineering Office*. 25 September 2013. Web. Accessed 2 November 2013. China Manned Space Engineering Office. “Tiangong I / Shenzhou X Manned Spaceflight Mission.” Web. Accessed 14 Oct 2013. <http://en.cmse.gov.cn/list.php?catid=207>

¹¹¹ For a discussion China’s foreign policy stance towards Sino-US cooperation in space see: Shen, Dingli. “A Chinese Perspective on China-US Cooperation in Space.” in *Space and Defense* 2:3 (2009): 64-75.

2.2.2 Barriers to international cooperation for China

Chinese national space policy documents indicate that it is open for international cooperation in various space explorations activities. There are however domestic factors that impede China's ability to expand these partnerships. Two of these factors are the role of the PLA in China's space activities and a policy encouraging CMI of technologies. The role of the PLA has consequences in communications and ideology; CMI has consequences for dual-use technologies and unwanted technology transfer.

The blurring between military and civilian space activities in China has created a lack of transparency. From what is known about the organizational structure the PLA has amassed significant clout over many of the main administrative and industrial actors in China's space sector.¹¹² The interpretation of China's space ambitions has been to assume a significant military dimension to China's civilian space activities.

It is important to consider that distorted information regarding Chinese ambitions in space stemming from ineffective communication are not necessarily deliberate i.e. misunderstandings do not originate from a lack of transparency. Much miscommunication has occurred due to the difficulty for Western analysts to monitor and understand space-related organizational changes in China and to find reliable and well-translated Chinese sources.¹¹³ The consequence of this misunderstanding has led to confrontational interpretations that emphasize and exaggerate Chinese civilian space activities as only being part of a grand military space strategy,¹¹⁴ although this view has provoked criticism.¹¹⁵

The role of the PLA has also fuelled ideological differences that act as a major barrier to cooperation in the Sino-US case. Sino-US bilateral cooperation in space is effectively stalled as a consequence of section 1340(a) of NASA's budget that prohibits NASA to spend funds "to enter into a contract of any kind to participate, collaborate, or

¹¹² Defense Group Inc., pg.10-11.

¹¹³ Johnson-Freese (2009): 56.

¹¹⁴ For example see Tellis (2007)

¹¹⁵ For example see Zhang (2013)

coordinate bilaterally in any way with China or any Chinese-owned company”.¹¹⁶ The law was put forth by Congressman Frank Wolf and has clear ideological undertones:

“I want to be clear: the United States has no business cooperating with the People’s Liberation Army to help develop its space program. We also should be wary of any agreements that involve the transfer of technology or sensitive information to Chinese institutions or companies, many of which are controlled by the government and the PLA...there will come a day when the Chinese communist government will fall, repressive, totalitarian regimes always do. And when that day comes, books will be written about who helped sustain this government in their final days. Will U.S. companies feature in that narrative? Will the U.S. government?”¹¹⁷

It should be noted that this legal barrier does not prohibit Sino-US cooperation through multilateral mechanisms, as was clarified by the recent admission of Chinese scientists to a conference for US and international teams working on NASA’s Kepler space telescope program.¹¹⁸

A controversial policy guiding Chinese civilian space activities is the concept of CMI. CMI is an effort to leverage investments made in the civilian sector by finding an application for military potential. This principle was proposed by the Sixteenth Party Congress in 2003 and is known as *Yujun Yumin* (Locating Military Potential in Civilian Capabilities). As a result Western companies who cooperate with China understand that transfer of capital and technology may be used to exploit dual-use applications.¹¹⁹ The CMI policy is well advertised as major actors within the organizational and industrial infrastructure including the Ministry of Industry and Information Technology (MIIT), CASC, and CASIC all cite CMI as key components of their respective mandates on their organizational websites.

Military application of dual-use technologies has created concern from the international community towards China in part due to the secrecy that shrouds Chinese

¹¹⁶ National Aeronautics Space Administration. “Class deviation implementing NASA restrictions on funding activity with the People’s Republic of China (PRC).” *NASA*. 8 February 2012. Web. Accessed April 14th 2013. <http://www.hq.nasa.gov/office/procurement/regs/pic12-01A.html>

¹¹⁷ “Wolf: U.S. Should Not Cooperate With People’s Liberation Army to Help Develop China’s Space Program”. 2 November 2011. Web. <<http://wolf.house.gov/index.cfm?sectionid=34&itemid=1813>>

¹¹⁸ *Wolf Letter To NASA’s Bolden Correcting Record On Restrictions Involving Chinese Nationals*. October 8, 2013. <http://wolf.house.gov/press-releases/wolf-letter-to-nasas-bolden-correcting-record-on-restrictions-involving-chinese-nationals/>

¹¹⁹ Defense Group Inc., pg.5-6

space activities.¹²⁰ Dual-use technologies themselves however are not necessarily a concern; indeed most space actors see dual-use as desirable as it avoids duplication and increases the rate of return on investments.¹²¹ Due to the fact that space exploration operates on the frontiers of science and technology there is an intrinsic acknowledgement that advances made in pursuit of these projects will likely embody potential for alternative use. One of the most often cited benefits of space exploration activities are spinoff applications. Problems arise when the actions of other actors are assumed to be malicious, as Johnson-Freese notes: “the U.S. assumption is that if dual use technology is being developed in China, it is for military purposes. While that assumption clearly overreaches, China is developing space technology for military as well as civilian purposes”.¹²²

As was discussed in the introduction to this paper the challenge of unwanted technology transfer is addressed through export control regimes. An effective export control regime strikes a balance between a due diligence to non-proliferation efforts while reducing trade barriers to encourage growth of the commercial sector. In regards to China’s export control regime two major space powers – the US and the EU – have taken a cautious approach with China, albeit for similar yet different reasons. First it has been argued that the main problems of China’s export control regime are the lack of transparency of China’s space ambitions and poor technology safeguards.¹²³ Furthermore there has been criticism that China has not been proactive in participating in international non-proliferation regimes nor have they subscribed to an international code of conduct.¹²⁴

The US posture towards China is informed by the Cox Commission Report in October 1998 that concluded US satellite manufacturers violated US export control regulations by providing data and helping Chinese scientists resolve technical issues, despite the findings of this report having been questioned.¹²⁵ In response the US imposed an ITAR export license ban that prohibits the export or re-export of satellites with US

¹²⁰ Nardon, Laurence. “Developed Space Programmes” in *The Politics of Space: A Survey* by Eligar Sadeh. (2011).

¹²¹ IFRI Security Studies Center, pg.8

¹²² *ibid*

¹²³ Mineiro, Michael C. “An inconvenient regulatory truth: Divergence in US and EU satellite export control policies on China.” *Space Policy* 27 (2011): 213-221.

¹²⁴ Zhao and Bian (2011)

¹²⁵ Mineiro (2011) pg.215

technology to China.¹²⁶ From the perspective of the EU the main challenges to collaboration with China are a lack of intellectual property rights protection and the potential of an undesired application of dual-use technology.¹²⁷ To resolve these issues a reformed export control system is recommended to allow Europe to benefit from China's rise while not alienating their relations with the US.

In response to these challenges China has been working towards ameliorating their domestic export control regime. Underlying the concerns noted above is that China does have a sophisticated legal framework supporting a domestic export control regime, however effective and efficient enforcement remain a challenge.¹²⁸ A second area needing progress is the level of Chinese participation in major multilateral nonproliferation export control regimes. It is important to consider however that although China is not a member of many international non-proliferation regimes it has employed similar policies to control arms exports, including space items and missiles. Also the reluctance to adhere to the HCOC is due to the various security-related restraints that would impede China's growth.¹²⁹ Nevertheless greater participation with international efforts seems beneficial.

¹²⁶ The ITAR export license ban however is considered to be a failed containment policy as European commercial satellite manufacturers developed ITAR-free technologies to access Chinese launching services. In fact the ban has been more of an isolating force against US commercial launch service. See Mineiro (2011)

¹²⁷ Stumbaum (2009)

¹²⁸ Zhao and Bian (2011), pg. 111

¹²⁹ Various scholars have researched China's non-adherence to the code of conduct and have found three factors: China disagrees with the restraint on the creation of ballistic missiles; moves towards transparency should be voluntary; and a disagreement of the advance notice for a ballistic-missile launch. For more information see Zhao and Bian (2011).

3. Case studies

The rise of new actors participating in space exploration missions and the increase in motivations to explore space are changing conditions for cooperation in the space environment. In response to these new conditions spacefaring countries have expressed a preference for flexible, non-binding mechanisms to coordinate multilateral cooperation. A key variable in identifying opportunities for cooperation are policy parameters that encompass domestic and foreign policy considerations. Although there can be overlap in policy parameters between countries these parameters must be adjusted to accurately capture a particular country's goals from its space exploration activities. This section seeks to define China's policy parameters by answering the question: What does China want from its civilian space exploration program? This section will dissect China's national space policy for space exploration by elaborating on the domestic and foreign policy considerations informing their position on two major domestic space programs and three international space projects. This elaboration will enable a deeper understanding of the calculation of political utility China attributes to its space exploration activities.

3.1 Summary of analysis

The goal of this analysis is to understand China's calculation of political utility from its space exploration activities. As identified by existing literature the policy parameters influencing this calculation come from domestic and foreign policy considerations. To capture these considerations two research questions will be used to structure the analysis:

1. What domestic policy considerations influence how China sets its space exploration goals?
2. How does the international environment enable and constrain opportunities for international cooperation in space exploration available to China?

The first research question has the goal of defining China's space exploration ambitions as driven by domestic interests. The case studies chosen for this analysis are the two major space exploration programs in China: Project 921 and the Lunar Exploration Program. To answer the research question two guiding questions related to motivation and integration will be used. Motivation will answer why China decided to pursue the program and to identify the main actors involved. Integration will briefly identify how the space program is integrated with other government S&T policies or initiatives. This consideration is important, as it will provide evidence for to what degree S&T development should be emphasized as a policy parameter in China.

The second research question has the goal of describing foreign policy considerations by analyzing three cooperative space projects. The space project case studies were selected to include cases where China experienced project success and failure, and a project that has had international success but in which China has been excluded. Respectively, these three space projects include: Yinghuo-1 (Mars space probe), Kuaifu (space weather satellites), and the ISS (space laboratory). These cases have been cited in various presentations given by authoritative figures from CAS regarding the current status of Chinese space science and space technology programs and international cooperation, signifying their importance.¹³⁰ Each case will be analyzed systematically by looking at mission objectives, responsibilities assigned to contributing partners and the barriers encountered. Investigating these cases will highlight barriers China faced in these projects, illustrating the constraints imposed by the international environment as well as the degree of international collaboration achieved.

The analysis will utilize two contributions from the Broniatowski et al. (2008) study. First, policy parameters will be represented by five categories: national prestige, national security, economic development, S&T goals, and influence at regional and global levels. These categories are not mutually exclusive or necessarily applicable in every case. Nevertheless they are considered to capture the most important policy

¹³⁰ For example see: Dr. Jing Guifei. "Status of Space Technology and its plans in China." National Remote Sensing Center, Ministry of Science and Technology of China 2012; Ji Wu. "Chinese Space Science Programs and International Cooperation." Center for Space Science and Applied Research. 2013.

considerations and will be used to analyze the space program case studies.¹³¹ Second, to give context to the degree of cooperation achieved in the selected space projects the ‘six types of international cooperation’ will be employed. This will help address the degree to which the international environment enables and constrains opportunities for cooperation for China.

Together the selected space programs and space projects will illustrate main policy parameters in China’s domestic (space programs) and foreign (space projects) space exploration missions. The selection of programs and projects is also useful in that projects are not as encompassing as programs, and can therefore capture incremental opportunities for cooperation. This specificity allows the analysis to more accurately measure the degree of international cooperation achieved by China.

3.2 RQ1: What domestic policy considerations influence how China sets its space exploration goals?

3.2.1 Project 921

China’s human spaceflight program was put on China’s agenda as a result of Plan 863, an outline submitted by four prominent Chinese scientists who identified seven ‘breakthrough’ areas in which China could catch up with other international leaders.¹³² From the initial proposal in March 1986, the Shenzhou and Tiangong programs were eventually created in 1992 with the approval of Project 921 - the human spaceflight program. The program included the development of a spaceship (*Shenzhou or Project 921-1*) and a multi-modular space station (*Tiangong or Project 921-2*) (See appendix A-4

¹³¹ Developing a new analytical framework is beyond the scope of this paper. Instead, the findings of this study may support the future development of more adequate framework.

¹³² Feigenbaum, Evan A. “Who’s Behind China’s High-Technology ‘Revolution’?” *International Security* 24:1 (1999): 95-126; Kulacki and Lewis (2009): 24

and A-5). The program continues to be overseen by the China Manned Space Engineering Office.¹³³

The Shenzhou program's mandate was to develop a spacecraft capable of transporting taikonauts and various science experiments into space.¹³⁴ There have been ten Shenzhou spacecraft mission launches since November 1999, with the Shenzhou-5 mission on October 15, 2003 being a significant achievement as China became the third country to independently launch a person into space.¹³⁵ Shenzhou-7 (September 2008) and Shenzhou-9 (June 2012) missions were also major accomplishments as the former conducted China's first extravehicular space activity and the latter successfully performed a manual docking with the Tiangong-1.¹³⁶ The most recent mission, Shenzhou-10, had a crew of three taikonauts who carried out various scientific experiments, and conducted an automated and manual docking.¹³⁷ During this mission a very popular 'space lecture' was given by Wang Yaping, China's second female astronaut, and broadcasted to over 60 million students and teachers across China.¹³⁸ The completion of the Shenzhou-10 mission marked the end of the Shenzhou program.

The Tiangong program is a three-part program with the goal of building a modular space station by 2020. The state-level space laboratory will be capable of hosting astronauts long-term, will be used as a platform for space science experiments, and will be open to international partners. The Tiangong-1 space laboratory module was successfully launched in September 2011. It has a primary function of facilitating docking tests and space rendezvous that will provide the foundation for the building of subsequent space laboratories and space stations.¹³⁹ Tiangong-2 and Tiangong-3 space

¹³³ China Manned Space Engineering – Constitutes. China Manned Space Engineering. Web. Accessed April 14th 2013. <http://en.cmse.gov.cn/list.php?catid=43>

¹³⁴ China Manned Space Engineering Office. "Tiangong I / Shenzhou X Manned Spaceflight Mission." Web. Accessed 14 Oct 2013. <http://en.cmse.gov.cn/list.php?catid=207>

¹³⁵ People's Republic of China. The Information Office of the State Council. "China's Space Activities 2011." 12 October 2006. www.fas.org/spp/guide/china/wp2006.pdf

¹³⁶ "Chinese Taikonauts Return as Heroes After Landmark Spacewalk", *Xinhua News*. 28 September 2009. Web. Accessed April 18th 2013. http://news.xinhuanet.com/english/2008-09/28/content_10128407.htm

¹³⁷ China Manned Space Engineering Office. "Tiangong I / Shenzhou X Manned Spaceflight Mission." Web. Accessed 14 Oct 2013. <http://en.cmse.gov.cn/list.php?catid=207>

¹³⁸ "Chinese Astronauts Beam 1st Science Lesson from Space." *SPACE.com*. 20 June 2013. Web. Accessed 16 Oct 2013. <http://www.space.com/21644-china-astronauts-science-lesson-shenzhou10.html>

¹³⁹ China Space Activities 2011 White Paper

laboratories have expected launch dates in 2015 and 2018 respectively.¹⁴⁰ Once connected the three Tiangong modules will complete China's multi-module space station.

Exact motivations used in the duration of the Shenzhou program are not explicit and has provoked various explanations.¹⁴¹ Western scholars tend to emphasize the symbolic significance of human spaceflight. For example human spaceflight as a 'status marker' is considered as an admission ticket to being a super power and is therefore the most significant motivation for human spaceflight for China's political elite.¹⁴² Supporting this view is the observation that the national prestige associated with accomplishments from Project 921 has been primarily advertised domestically in contrast to other countries who tend to prefer international exposure.¹⁴³ It is important to note however that the link between national prestige and human spaceflight is not uncommon. Indeed the motivation for sustaining a human spaceflight program is often attributed to being prestige-driven due to the high costs of human missions relative to robotic missions, although analysts seem to see this as particularly true in the Chinese case. Chinese authors in contrast take a more comprehensive view, arguing that the Project 921 must be understood in the context of China's national development strategy where space technology plays a key role in China's economic development.¹⁴⁴ This view has also been broadened to include other national strategic goals including social improvement and progress in S&T.¹⁴⁵ These positions have tended to cite economic benefits gained from China's commercial space sector and spinoffs in space applications technologies as evidence for emphasizing economic development. Finally the scientific community and representatives from academies developing the requisite space technologies for Project 921 see the main reasons for China's human spaceflight program as: to explore outer space peacefully with the international community for the benefit of all mankind; to

¹⁴⁰ "China plans to launch Tiangong-2 space lab around 2015: official." *Xinhua News*. 26 June 2013. Web. Accessed 8 November 2013. http://news.xinhuanet.com/english/sci/2013-06/26/c_132488266.htm

¹⁴¹ Kulacki and Lewis (2009): 31

¹⁴² Cunningham, Fiona. "The Stellar Status Symbol: True Motives for China's Manned Space Program." *China Security* 15 (2009): 73-88; Kulacki and Lewis (2009).

¹⁴³ Sheehan, Michael. "'Did you see that, grandpa Mao?' The prestige and propaganda rationales of the Chinese space program." *Space Policy* 29 (2013): 107-112.

¹⁴⁴ Chunsi, Wu. "Development Goals of China's Space Program." *China Security* 2 (2006): 107-115.

¹⁴⁵ Dangen, Sun. "Shenzhou and Dreams of Space." *China Security* 2 (2006): 60.

promote ‘leap-frog’ progress in scientific and technological innovation; impetus for national economic development; realize the Chinese dream of flying into space.¹⁴⁶

The human spaceflight program is strongly integrated with China’s comprehensive national S&T development plan that focuses on national security and long-range economic competitiveness. Space was identified as a strategic technology field in Plan 863 and is seen a key driver to achieve national development goals. Ongoing support for the human spaceflight program can be seen in its identification as an engineering megaproject in the *Medium- to Long-Term Plan for the Development of Science and Technology 2005-2020* (MLP).

3.2.2 Lunar Exploration Program

China’s Lunar Exploration Program (*Chang’e program*) is part of their deep space exploration strategy. The program was approved in 2004 and is supervised by State Administration for Science, Technology and Industry for National Defense’s Lunar Exploration Engineering Center and the CAS Lunar Exploration Engineering Department.¹⁴⁷ In total more than 200 universities, laboratories, and research institutes have contributed to the development of Chang’e in addition to CAS, CASIC, CASC, and their affiliates.¹⁴⁸ The idea of establishing a lunar exploration program originated with Ouyang Ziyuan who held a leadership position in the Institute for Geochemistry in CAS. As an expert in lunar geology Ziyuan was able to create an advocacy group of prominent Chinese scientists to advance the idea of Chinese lunar exploration mission. After submitting a number of feasibility studies to China’s political leadership, benefiting from organizational changes that gave more power to scientists within the advocacy group, a three-phase, five-mission long-term lunar exploration program was approved by the Party Central Committee under Premier Wen Jiabao in January 2004 (See appendix A-6).¹⁴⁹

¹⁴⁶ Zongpeng, Zhu. “The current situation of China manned aerospace technology and the direction for its further development.” *Acta Astronautica* 65 (2009): 308-311.

¹⁴⁷ Project 2049 Institute, pg.26.

¹⁴⁸ Study of Innovation and Technology in China. Lu, Hanlu. “The Chinese Chang’e Lunar Exploration Project and Its Management Structure.” University of California Institute on Global Conflict and Cooperation, 2012. 6pp.

¹⁴⁹ Besha (2010)

The program is organized into three stages: orbiting, landing, and sample-return.¹⁵⁰ Chang'e-1 was launched in October 2007 and achieved its scientific objectives of obtaining a three-dimensional stereo image of the lunar surface, studying the distribution of useful elements, surveying thickness of lunar soil, and exploring the environment between the Moon and the Earth. Chang'e-2 launched in October 2011 and, *inter alia*, created a full high-resolution map of the moon, circled the Lagrangian Point L2, and continues to gather data to lay the foundation for future deep-space exploration missions.¹⁵¹ Chang'e-3 (2013) and Chang'e-4 (2015) missions constitute the second stage of the lunar exploration program and will perform a lunar soft landing with two rovers to survey the lunar surface.¹⁵² The Chang'e-5 (2015-2020) mission will send small robotic vehicles to the lunar surface to conduct a sample-return mission.¹⁵³

A number of motivations for the lunar exploration program have been proposed. An in-depth case study of policy-making in the Chang'e program found that the original argument made by Ouyang Ziyuan was to launch a rocket to the moon in 1997 to coincide with the hand over of Hong Kong to China; linking these two events would provide a significant contribution to garner national prestige.¹⁵⁴ This justification however was rejected numerous times by China's political and military elite, as subsequent feasibility studies were needed to demonstrate the scientific value of a lunar exploration program.¹⁵⁵ Other analyses find that the Chang'e program's main purpose is for China to demonstrate technological advancement. This advancement is fuelled by indigenous innovation, a key aspect to China's S&T development strategy, and enables national prestige to be built by advertising the program's successes.¹⁵⁶

Similar to Project 921 the lunar exploration program is also deeply integrated with China's S&T development goals. The Chang'e program is coupled with human

¹⁵⁰ China Space Activities 2011 White Paper

¹⁵¹ *ibid*

¹⁵² *ibid*

¹⁵³ "Lunar mission: craft to conduct re-entry tests before 2015". *Xinhua News*. 14 March 2013. Web. Accessed 14 April 2013. http://news.xinhuanet.com/english/china/2013-03/14/c_132232333.htm

¹⁵⁴ Beshu (2010): 216.

¹⁵⁵ *ibid*

¹⁵⁶ Study of Innovation and Technology in China: 5-6.

spaceflight as an engineering mega-project in the MLP and therefore has access to additional financial resources and higher quality human capital.¹⁵⁷

3.2.3 Discussion

The analysis for the first research question looks at the motivation for each program and their integration with other government S&T development initiatives. The analysis of these space programs is believed to provide meaningful insight on China's domestic policy considerations that influence Chinese national space exploration-related policies.

It was found that there is no consensus on a specific motivation driving China's human spaceflight program. Instead a set of motivations were suggested related to China's national development plan, specifically in areas of economic development, social progress, and technological capability. Western analysts tended to emphasize the soft power gained from a human spaceflight program supporting a view of national prestige and status as key motivators. In regards to the Lunar Exploration Program the motivations were found to be primarily science-driven. This is reflected in the numerous feasibility studies and advocacy coalitions needed to convince political leadership to support the program. The motivations for the lunar exploration program are most likely less debated than those for Project 921 due to the fact that the program thus far has been a series of robotic missions. As such the intangible effects of a human mission are not as potent.

The most significant integration of these space programs is with China's national S&T and economic development strategy. Both programs are included as engineering megaprojects in the MLP and have been opportunities to facilitate indigenous innovation. To appreciate the implications of their inclusion as megaprojects it is necessary to understand the function of the MLP in China.

The MLP has significant influence in guiding the development of China's national science plans. It proposes new national R&D projects, introduces new

¹⁵⁷ Cao, Cong, Richard P. Suttmeier, and Denis Fred Simon. "China's 15-year science and technology plan." *Physics Today* 59:12 (2006): 39-40.

‘megaprojects’, and provides policies to guide their implementation.¹⁵⁸ The most recent rendition, introduced in January 2006, was drafted over two years with input from over 2000 members in technical communities and corporate executives.¹⁵⁹ The MLP was created to address a number of critical problems in China’s scientific and technological development including: a weak record in of innovation in commercial technologies; the failure of technological capabilities to address key national needs in energy, resource utilization, and public health; lack of defense-related technological innovation; poor results in keeping talented Chinese scientists to career opportunities abroad.¹⁶⁰

In pursuit of these goals the MLP introduces 12 national megaprojects¹⁶¹ that will “integrate government guidance with markets, promote innovation and input patterns with industries as principle entities, and realize the integration of industry-university-research institutes”.¹⁶² This approach reflects China’s desire to further locate R&D in industrial enterprises in the national innovation system. Megaprojects employ Megaproject Leading Small Groups for direction and are coordinated through an inter-agency process including the Ministry of Science and Technology, the National Development and Reform Commission, the Ministry of Finance, the MIIT, and the Ministries of Agriculture and Public Health.¹⁶³ Funding schemes for megaprojects go beyond resources provided by the central government to include funds from local governments, financial institutions and enterprises, and have preferential access to the best human capital.¹⁶⁴

The idea of indigenous innovation (*zizhu chuangxin*) was first introduced during the preparation of the MLP document in 2003 in response to a desire to shift from cheap export driven economic growth to diversified sources of GDP expansion and secondly to

¹⁵⁸ CENTRA Technology Inc. Springut, Micha, Stephen Schlaikjer, and David Chen. “China’s Program for Science and Technology Modernization: Implications for American Competitiveness.” Prepared for the US-China Economic and Security Review Commission, 2011.140 pp. pg.38-39.

¹⁵⁹ Cao et al, (2006): 38

¹⁶⁰ Cao et al, (2006): 39-40

¹⁶¹ Although the MOST website lists only 12 mega-projects it is believed that three projects remained unannounced. CENTRA Technology Inc. (2011)

¹⁶² Ministry of Science and Technology, “Mega-projects of Science Research for the 10th Five-Year Plan.” http://www.most.gov.cn/eng/programmes1/200610/t20061008_36198.htm

¹⁶³ CENTRA Technology Inc., pg.44

¹⁶⁴ *ibid*, p.45

secure supply chains for advanced technologies.¹⁶⁵ It is best understood as “a series of investments and industrial policies designed to enhance the role of innovation in the PRC’s economic growth”.¹⁶⁶ The drive for indigenous innovation is considered a key contributor to upgrade China’s industrial structure and has been emphasized in the Ninth, Tenth, and Eleventh Five-Year Plans.¹⁶⁷

Some empirical evidence showcases examples of the extent to which indigenous innovation played a role in these programs. First, although visual similarities between *Shenzhou* and the Russian *Soyuz* suggested a heavy Chinese reliance on foreign technical assistance, subsequent analyses found that autonomous propulsion and flight, solar power and control systems were specific to the *Shenzhou* design. These specifications were needed to allow *Shenzhou* to facilitate other human spaceflight techniques needed to complete its missions including extravehicular activity, rendezvous and docking.¹⁶⁸ The *Chang’e* program was able to attract a number of highly skilled S&T personnel by providing projects at the frontiers of basic and applied science research and whose contributors gain societal respect.¹⁶⁹ The sustainability of the drive for indigenous innovation seems promising, as 80% of the workforce involved with Project 921 are and leading scientists and engineers involved with *Chang’e* are under forty years old.^{170 171}

Project 921 and the Lunar Exploration Program case studies demonstrate that both programs are central to China’s economic and S&T development goals. Their identification as mega-engineering projects and as platforms for indigenous innovation support this position. It can therefore be said that China’s space exploration programs have a pragmatic dimension as they are seen as proxies on upgrading the domestic economy and enhancing technological capability. As such the two related policy parameters gaining weight would be economic development and S&T development.

¹⁶⁵ O’Brien, Robert D. “China’s Indigenous Innovation: Origins, Components and Ramifications.” *China Security* 18 (2010): 52-54.

¹⁶⁶ *Ibid.*, p.52.

¹⁶⁷ Kim, Min-Jeong and Jai S. Mah. “China’s R&D Policies and Technology-intensive industries.” *Journal of Contemporary Asia* 39:2 (May 2009): 265.

¹⁶⁸ Encyclopedia Astronautica. “Shenzhou”. <http://www.astronautix.com/craft/shenzhou.htm>

¹⁶⁹ Study of Innovation and Technology in China, p.5-6.

¹⁷⁰ IFRI pg.8

¹⁷¹ Study of Innovation and Technology in China, p. 5

3.3 RQ2: How does the international environment enable and constrain opportunities for international cooperation in space exploration available to China?

3.3.1 Kuafu

The Kuafu project is a multi-spacecraft mission that is part of a larger effort to study space weather. It consists of two missions – Kuafu A and Kuafu B – whose operations will support the Meridian program, a China-led international ground-based space environment-monitoring network, and builds on the Double Star program, a successful collaboration between the ESA and China to study the Earth’s magnetosphere.¹⁷² Specifically, the project will consist of three satellites with the first, Kuafu-A, having an expected launch date in 2017.¹⁷³

The Kuafu project was proposed in 2003 at the Space Weather Group meeting of the National Natural Science Foundation of China as a mission capable of providing for China’s space science, space technology, and space weather application goals.¹⁷⁴ Due to its wide impact it is also included in the NSSC *Strategic Pioneer Program on Space Science*¹⁷⁵ – approved space science missions dedicated to understanding the universe and Earth and to seek new discoveries and breakthroughs.¹⁷⁶ Cooperation for the project is organized through the Kuafu Coordination and Planning Committee.¹⁷⁷ The committee is authorized by the CNSA and represents Peking University, CAS, CASC, and the Chinese Meteorological Administration.

¹⁷² The Double Star Program together with the Cluster team won first prize of the 2010 National Science and Technology Progress Award and was awarded the Laurels for Team Achievement Award by the International Institute of Aeronautics in 2010. For more information about the program see: http://english.nssc.cas.cn/missions/PM/201306/t20130605_102885.html

¹⁷³ Human Spaceflight and Operations. “Kuafu SWE Mission.” European Space Agency. 2012. Available at: http://www.belspo.be/belspo/space/doc/euPolicy/2012_07_03/KuaFu.pdf

¹⁷⁴ “Kuafu” mission – Space Weather Explorer Assessment Study Report, 6 July 2005

¹⁷⁵ The Strategic Pioneer Program on Space Science includes five missions and two studies to be implemented during the tenure of the Twelfth Five-Year Plan.

¹⁷⁶ Strategic Pioneer Program on Space Science, pg.3

¹⁷⁷ Chuan-Yi Tu, Rainer Schwenn, Eric Donovan, Jing-Song Wang, Li-Dong Xia, and Yong-Wei Zhang. “Kuafu Project: International Collaboration.” Kuafu Study Team. 2006. Available at: http://ilwsonline.org/china_kuafu.pdf

International cooperation has been a central feature in the early phases of the Kuafu project, as is evidenced by the pre-engineering assessment study phase where partners from 11 countries were involved in the collaboration.¹⁷⁸ This study phase provided a basis for how responsibilities would be assigned to different partners. The Kuafu-A satellite will be located at the L1 Lagrangian point and will continuously monitor the Sun, specifically scanning for Coronal Mass Ejections and measuring the Interplanetary Magnetic Field.¹⁷⁹ It will include a number of in-situ and remote observation instruments where six are to be contributed by CAS, two are open to European interest, and one with potential interest from Switzerland.¹⁸⁰ Operations will be shared, however the majority of the responsibility will be handled by Europe due to the lack of adequate antenna infrastructure for real-time operations available in China.

The Kuafu-B missions include two identical satellites to be delivered using the Long March 3B launch vehicle into the Molniya orbit to monitor the Earth's magnetosphere in the polar regions. A feasibility study to assess technical requirements and costs done by the ESA confirmed that European small satellite platforms were sufficient, although modifications would need to be made to ensure interoperability and to adhere to ITAR restrictions.¹⁸¹ However, the program proposal submitted by the ESA for participation in Kuafu-B was not approved at the ESA Council of Ministers Meeting in November 2012.

A major impediment to the project occurred from the 2012 ESA Council of Ministers Meeting that did not approve ESA participation in Kuafu-B. The reasons for non-approval remain unclear. One possible explanation suggests that the mission required participation from the ESA's Space Situational Awareness (SSA) Programme and the Science Programme, where the SSA Programme declined participation.¹⁸² Another

¹⁷⁸ Yang, Jun. "International Cooperation Plan for Kuafu." Director-General, National Center for Space Weather, on behalf of Kuafu Coordination and Planning Committee. 2005. Available at: http://ilwsonline.org/china_kuafuplan.pdf

¹⁷⁹ Human Spaceflight and Operations. "Kuafu SWE Mission." European Space Agency. 2012. Available at: http://www.belspo.be/belspo/space/doc/euPolicy/2012_07_03/KuaFu.pdf

¹⁸⁰ *ibid*

¹⁸¹ *ibid*

¹⁸² UCL Department of Space and Climate Physics: Mullard Space Science Laboratory. 30 January 2013. "Mission Status and Developments: Kuafu." http://www.ucl.ac.uk/mssl/about-mssl/newsletter/volume-10/newsletter_1212.pdf

possible explanation could be on financial restrictions thereby leading to the ESA's withdraw from the project.¹⁸³

3.3.2 Yinghuo-1

Yinghuo-1 (YH-1), or the Martian Space Environmental Exploration Orbiter, was a Chinese-built microsatellite hosted on the Russian Phobos-Grunt sample return spacecraft to investigate the Martian space environment and the solar wind-planet interaction.¹⁸⁴ Specifically, a series of scientific explorations would fulfill mission objectives of studying the Martian magnetic field, particle variation and distribution, ionosphere, gravity field, and various topographical investigations.¹⁸⁵ The scientific motivation for undertaking the mission was to help China improve its accuracies in deep-space telemetry and telecontrol, orbit determination and injection, increase engineering capacity to build space probes, and to promote planetary exploration and basic physics research.¹⁸⁶ Among the many scientific gains to be accrued from the mission the main benefit will be to provide China's space agency with experience flying and operating a spacecraft in deep space. Launching on November 8th 2011, the YH-1 was to be China's inaugural spacecraft in their Mars exploration program, however an engine malfunction with the Phobos-Grunt probe left the spacecraft stranded in Earth orbit.¹⁸⁷

The NSSC initiated the YH-1 project, managed cooperation with Russia and was the leading institute for scientific application systems and payload development. Design and development of YH-1 microsatellite payload were delegated to the Shanghai Academy of Spaceflight Technology for design and the Shanghai Satellite Engineering

¹⁸³ "Ministerial Council 2012: Space Situational Awareness." European Space Agency News. 14 November 2012. Web. Accessed 8 November 2013.

http://www.esa.int/About_Us/Ministerial_Council_2012/Space_Situational_Awareness_SSA

¹⁸⁴ National Space Science Center, Chinese Academy of Sciences. "International Cooperation Projects." Web. Accessed 15 October 2013. <http://english.nssc.cas.cn/ic/ip/>

¹⁸⁵ Wu Ji et al. (2010) "Scientific Objectives of China-Russia Joint Mars Exploration Program YH-1." *Chinese Astronomy and Astrophysics* 34 (2010): 168-170.

¹⁸⁶ Chang-ya, Chen, Hou Jian-wen and Zhu Guang-wu. "The Key Techniques and Design Features of YH-1 Mars Probe." *Chinese Astronomy and Astrophysics* 34 (2010) 218.

¹⁸⁷ National Space Science Center, Chinese Academy of Sciences. "YH-1, Martian Space Environmental Exploration Orbiter. 5 June 2013. Web. Accessed 15 October 2013.

http://english.nssc.cas.cn/missions/PM/201306/t20130605_102886.html

Institute for assembly.¹⁸⁸ Under the framework of China-Russia cooperation in space science the YH-1 Phobos-Grunt joint mission was birthed in March 2007 with the signing of a cooperation agreement on the joint exploration of Mars. Specifically, the project was a piggyback mission where the YH-1 microsatellite would be delivered to its destination by Russia's Phobos-Grunt probe. Upon entering the Martian gravitational field YH-1 would detach from Phobos-Grunt and enter into an elliptical orbit around Mars to start its yearlong mission.¹⁸⁹ Under the agreement Russia would provide YH-1 with tracking and communications support for the duration of its mission.¹⁹⁰

There were no significant barriers to cooperation in this project. One consideration however was a delay in the launch date from October 2009 to November 2011 due to the need to improve the Phobos-Grunt probe. During this time some parts in the YH-1 probe needed to be replaced while being stored in China.¹⁹¹

3.3.3 International Space Station

The International Space Station (ISS) is a space laboratory with a permanent human presence located in low Earth orbit. The program is considered to be a remarkable technological and human achievement and is the most politically complex space exploration program ever undertaken.¹⁹² The program was recently extended to continue operations until 2020.

The ISS has a modular structure whose various components have been delivered and installed over the course of its 25-year construction period.¹⁹³ The ISS serves a spectrum of purposes due to the fact that its microgravity and space environment laboratory is unique, allowing for innovative experiments in many fields including biology, physics, material science, Earth and space science, and a number of related

¹⁸⁸ For an elaboration of the technical specifications of YH-1 see Chen et al (2010) "The Key Techniques and Design Features of YH-1 Mars Probe." *Chinese Astronomy and Astrophysics* 34 (2010) 217-226.

¹⁸⁹ Wu Ji et al. (2010) "Scientific Objectives of China-Russia Joint Mars Exploration Program YH-1." *Chinese Astronomy and Astrophysics* 34 (2010): 165.

¹⁹⁰ "Yinghuo 1." *Dragon In Space: China's Space Programme, Past and Present*. 19 January 2013. Web. Accessed 1 October 2013. <http://www.dragoninspace.com/planetary/yinghuo1.aspx>

¹⁹¹ *ibid.*

¹⁹² National Aeronautics Space Administration. "International Space Station: International Cooperation." *NASA*. Web. Accessed April 14th 2013.

http://www.nasa.gov/mission_pages/station/cooperation/index.html#.UnbPvZQpbt

¹⁹³ Encyclopedia Astronautica. "ISS." <http://www.astronautix.com/project/iss.htm>

fields. Furthermore the ISS is a platform for testing spaceflight systems and docking procedures.¹⁹⁴ In regards to space exploration the ISS hosts experiments in basic and applied scientific research that provide supporting knowledge for future exploration missions and can be used as a platform for testing space technologies.

The ISS is a significant collaboration between 16 countries including five principle space agencies and is established on intergovernmental treaties and agreements; China is not included in this collaboration.¹⁹⁵ Contributions from different partners are developed jointly or independently and are assembled (if needed) and mated with the ISS in orbit. The partner who contributes a piece of infrastructure has jurisdiction over that contribution. As a consequence operations on the ISS are complex as each partner has the responsibility to maintain the hardware it provides. Furthermore a number of facilities for mission operations support, communication, construction, and launch and processing are needed to provide support services for the assembly and operations of the ISS. These facilities are dispersed across all partner countries.

Due to the number of contributing partners the ISS program has encountered numerous general impediments to international cooperation. Most notable have been cost overruns and the construction-to-service timespan that lengthens the return-on-investment period.¹⁹⁶ These concerns have led to issues with the political sustainability of the project as partner countries have had difficulty justifying the expense domestically. For China, the impediment to participation has been the US. The US holds veto power over the acceptance of new partners and has rejected China's inclusion on the basis of an insufficient technology capability in space technologies.¹⁹⁷

3.3.4 Discussion

The analysis for the second research question has the goal of identifying foreign policy considerations through the influence of the international environment on China's

¹⁹⁴ *ibid.*

¹⁹⁵ The principle space agencies include the United States, Russia, Europe, Japan and Canada.

¹⁹⁶ Encyclopedia Astronautica, <http://www.astronautix.com/project/iss.htm>

¹⁹⁷ "China wants role in space station." *CNN: Technology*. 16 October 2007. Web. Accessed 20 October 2013.

<http://web.archive.org/web/20080314104006/http://www.cnn.com/2007/TECH/space/10/16/china.space.ap/index.html>

space exploration activities. This influence will be measured by looking at mission objectives, the responsibilities assigned to each partner and barriers faced in three cooperative space exploration projects. Specifically, the former two points will showcase the degree to which the international environment has enabled opportunities for cooperation whereas the latter will identify whether the impediments encountered were general or China-specific in nature.

The degree to which the international environment has enabled opportunities for cooperation for China can be seen in the mission objectives and assigned responsibilities for each space project. The early phases and proposed roles for international partners for the Kuafu A and Kuafu B missions indicate a high level of cooperation. The preliminary assessment study report was prepared from contributions from 11 different countries as a pre-engineering study project to be presented to international team members to solicit support from their respective funding agencies.¹⁹⁸ Furthermore other national projects, such as the Canadian Ravens project, merged with Kuafu.¹⁹⁹ Although the Kuafu-B missions were not approved, the ESA Kuafu Program Proposal provides a detailed account of assigned responsibilities for Kuafu-A. China will contribute the launch vehicle and the majority of science experiment payloads to the Kuafu project. These constitute niche and critical path contributions to the projects, ranking the level of international cooperation at 3 (medium-high). Although the number of participants involved in the project signify a high level of collaboration, from China's perspective the level of cooperation is capped at 3 as the two higher rankings require the project to be spearheaded by a foreign partner (4) and to contribute resources to a multinational organization (5).

The YH-1 Photo-Grunt joint mission was a collaboration between China and Russia where Russia provided China with piggyback services. There was no joint development of space technology as the YH-1 microsatellite was produced indigenously by China. Since the mission was led by a foreign partner (from the Chinese perspective) for mutual benefit the project is ranked with a cooperation level of 4 as a parallel mission.

¹⁹⁸ Chuan-Yi Tu, Rainer Schwenn, Eric Donovan, Jing-Song Wang, Li-Dong Xia, and Yong-Wei Zhang. "Kuafu Project: International Collaboration." Kuafu Study Team. 2006. Available at:

http://ilwsonline.org/china_kuafu.pdf

¹⁹⁹ *ibid.*

The ISS program is supported by the contributions of partner members. The construction of the ISS required high levels of interoperability across system and in its totality is used as a in-situ space laboratory. Although led by the five principle space agencies, most notably the US, the scientific and technological advances gained by experiments performed on the ISS are of mutual benefit for contributing partners. The program falls short of having participants contribute to a space organization who the sets priorities and assigns responsibility, and therefore is ranked at a level 4 cooperation as a parallel mission. However due to China's exclusion, the cooperation is of course ranked at 0.

The impediments faced in these space projects show how the international environment constrains China's opportunities for cooperation. Each of the three cases exemplifies a different situation. First, the YH-1 did not experience any major problems. This is likely due to piggyback mission design that did not require any significant amount of collaboration. In regards to the Kuafu project the ESA Council of Ministers did not approve the Kuafu B mission, possibly due to the unwillingness of the ESA's SSA Programme to participate or due to financial restrictions. These explanations relate to the general barriers to international cooperation, specifically to the unaligned programmatic and funding cycles practical impediments. This finding reveals that cooperation on this project did not create sufficient levels of political sustainability and diplomatic utility for the ESA to continue the mission.

The most serious barrier was found in the ISS case. China has voiced its desire on numerous occasions to participate in the ISS and have gone so far as to design their own space station – Tiangong – to be interoperable with existing ISS infrastructure.²⁰⁰ Nevertheless China's exclusion from the most important and evident collaboration in space exploration stems from ideological differences with the United States. The US' objection to China's participation stems from an ideological dispute between US politicians, or more particularly Congressman Frank Wolf, and the Chinese government. Specifically the objections have been related to China's political system and the involvement of the PLA in civilian space activities. Since Brazil's acceptance into the

²⁰⁰ China Manned Space Engineering Office. "Tiangong I / Shenzhou X Manned Spaceflight Mission." Web. Accessed 14 Oct 2013. <http://en.cmse.gov.cn/list.php?catid=207>

program the salience of ideological differences becomes more apparent as the US' concern of sufficient technological capabilities in space technologies does not hold as China is seen as possessing a higher capability than Brazil.²⁰¹

The three space project case studies provide insight into foreign policy considerations by highlighting how the international environment has enabled and constrained China's opportunities for international cooperation. Together these cases demonstrate how the increasingly participatory character of space exploration has allowed domestic actors within China to cooperate with domestic actors in other countries. The responsibilities delegated to China in the Kuafu case suggest that the 11 contributing countries did not object to China having a critical-path role in providing the launching vehicle. Although there were some practical impediments in each case, and the consequences of the Sino-US relationship, the international environment seems to be showing an acceptance of China as a lead partner in space exploration missions.

²⁰¹ Johnson-Freese (2009): 56.

4. Conclusions

The goal of this study was to define the calculation of China's political utility gained from cooperating with international partners in specific space exploration projects. Guided by liberal international relations theory it was necessary to analyze China's national space policy by considering complex bargaining processes occurring domestically as well as foreign policy considerations imposed by the conditions of the international environment. In this pursuit two domestic space programs and three international space projects were selected as case studies to determine China's motivations for supporting and participating in each activity.

Two main findings emerge from the Project 921 and Chang'e case studies that provide insight into China's policy parameters. First, national prestige as the primary driver is supported by a generalizable view that the cost-benefit of human spaceflight relative to robotic missions is much higher and from the original proposal of the Chang'e program to be created as a prestige-building event. The limitation of national prestige as a primary driver however can be seen in the number of scientific justifications that needed to be made through feasibility studies to obtain political support for the programs. This point is strengthened by the inclusion of both programs as mega-engineering projects in the MLP. Second, space exploration was found to be key part of the national strategy for economic development. The push for indigenous innovation enables China to generate a high-skilled domestic workforce capable of supporting a competitive space industry; growth in the space industry will help facilitate an increased role for innovation in China's economy. Together these findings provide caution in over-emphasizing national prestige as the driving justification for the Chinese human spaceflight and lunar exploration programs. Instead it is found that economic development and progress in S&T development are also significant drivers.

The space project case studies demonstrate how the international environment constrains and enables China's opportunities for international cooperation. It was found that China had achieved a high level of collaboration with many international partners, specifically in the Kuafu project. Furthermore the international environment was found to

have enabled collaboration among a variety of domestic actors from different countries with similar space exploration objectives. Partnerships were constructed synergistically, with China providing space experiment payloads and launching vehicles. These projects therefore provided opportunities for China's space sector to gain much indigenous experience in developing space technologies and space science projects. Constraints imposed by the international environment were found to be consistent with general barriers to international cooperation as well as induced by the role of the PLA in China's space activities. The most salient impediment to further international cooperation was the Sino-US relationship that still excludes China's participation in the ISS. When looking at the whole it is clear that China has taken advantage of other opportunities for international cooperation despite being excluded from the ISS. As new actors gain power in space activities the options for cooperation available to China will continue to increase. The cooperation achieved in the Kuafu and Yinghuo-1 projects however show that collaboration is still limited as there was no significant joint development of space technologies and space science experiments.

From the findings of this work it is possible to vet claims made in existing literature about international cooperation in space exploration. First, results from the space project case studies provide support for the *Space Exploration 3.0* view of the international environment. Collaborations in these projects were supported from a variety of actors, most notably university scientists and various research institutes. This indicates that space exploration is becoming increasingly participatory from a proliferation of actors. The findings also highlight the use of bilateral and multilateral international coordination mechanisms as a means to initiate project cooperation. This is seen in the three space projects where Kuafu was proposed at an international conference, Yinghuo-1 through a bilateral agreement, and the ISS through a series of intergovernmental agreements and memorandum of understandings.

Both programs are also deeply integrated with China's national economic and S&T development plans; their inclusion in the MLP and ability to be used as platforms for indigenous innovation highlight the role of these two programs in this development. This provides support for the 'comprehensive' view of China's space activities endorsed by Chinese scholars. It is possible that the motivations for initial program approval and

those for continued program support differ. As suggested by *Space Exploration 3.0* motivations for space exploration will extend towards economic and scientific reasons. The central role of China's human spaceflight and lunar exploration programs in their national development strategy provides evidence for this perspective.

The findings of this paper aid in better defining China's policy parameters that influence their position towards international cooperation. However the scope and limitations of this work is necessary so as not to overstep the implications of the findings. First the selected space projects are all within the domain of space science, a relatively non-sensitive area for international cooperation. Joint design and development of space technologies would require a much higher level of trust between partners and is left to future work. Second, due to the unavailability of an adequate framework to measure the impact of various criteria within a country's policy parameters the findings of this work do not intend to make solid claims about which criteria should be prioritized. Instead the findings help contextualize space projects within a number of domestic and foreign policy considerations and point towards criteria that should be targeted for further, in-depth analysis.

It should also be noted the author attempted to collect interview data to verify the findings of this research. However due to an insufficient response rate from prominent academics with relevant expertise this dataset was abandoned.²⁰² Furthermore the author held informal meetings with representatives from CASC, CASIC, CNSA, NSSC and CAS at the 64th IAC in Beijing in September 2013. Although these meetings were not formal interviews they did provide a background understanding of the space sector in China in addition to receiving official handouts from each organization. Requests from these organizations regarding more detailed information about cooperation on past projects however was stonewalled as each organization subsequently informed the author via email that they were not permitted to provide such data. These barriers represent some of the challenges researchers face when gathering data on space-related issues in China.

²⁰² A questionnaire was sent with five questions that included the general policy parameters considered by states when evaluating an opportunity for international cooperation. Eight academics were identified from Fudan University, Peking University and Tsinghua University, however only one response was received.

Existing literature does not adequately describe how countries calculate their political utility gained from cooperation. The extent to which ‘policy parameters’ have been developed is insufficient to allow for a thorough investigation. This work suggests that two areas would be particularly useful for future, serious investigations. First it is necessary to develop a methodology to measure the relative importance of different policy parameters. For example it might be possible to gauge the relative importance of national prestige against S&T development goals by investigating how stringent the science-justification vetting process is for space missions. Furthermore methods to measure government strategic communication related to garner national prestige and their actual impact on popular opinion would be useful. Methodologies would need to be developed to measure each criterion so as to be able to weight their relative importance. Building on the recommendation above a systematic analytical framework utilizing weighted criteria would provide significant benefit for future investigations. This systematization would reduce errors that may result from subjective interpretation, which has been especially problematic in trying to decipher the complexity of China’s space program.

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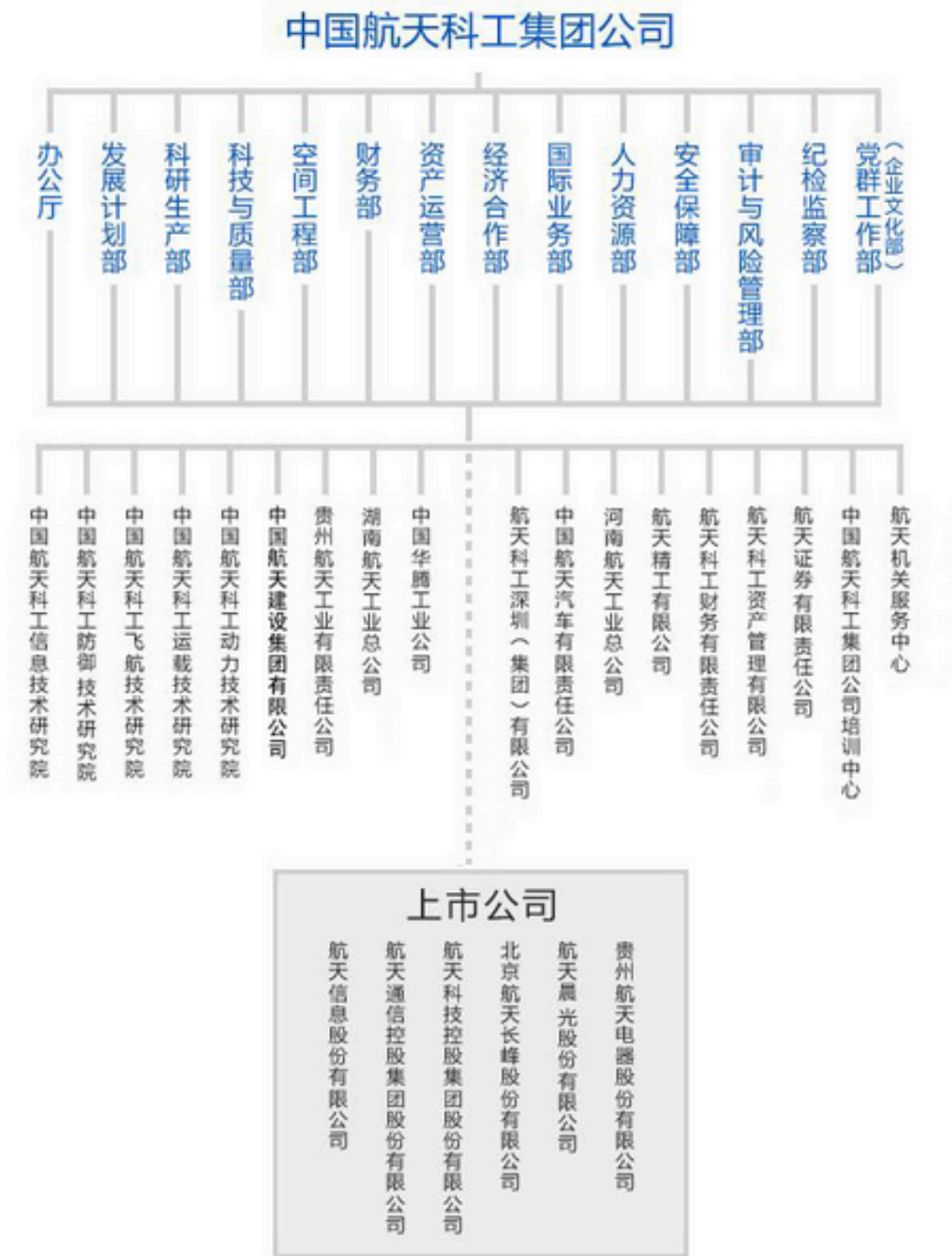
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6. Appendix

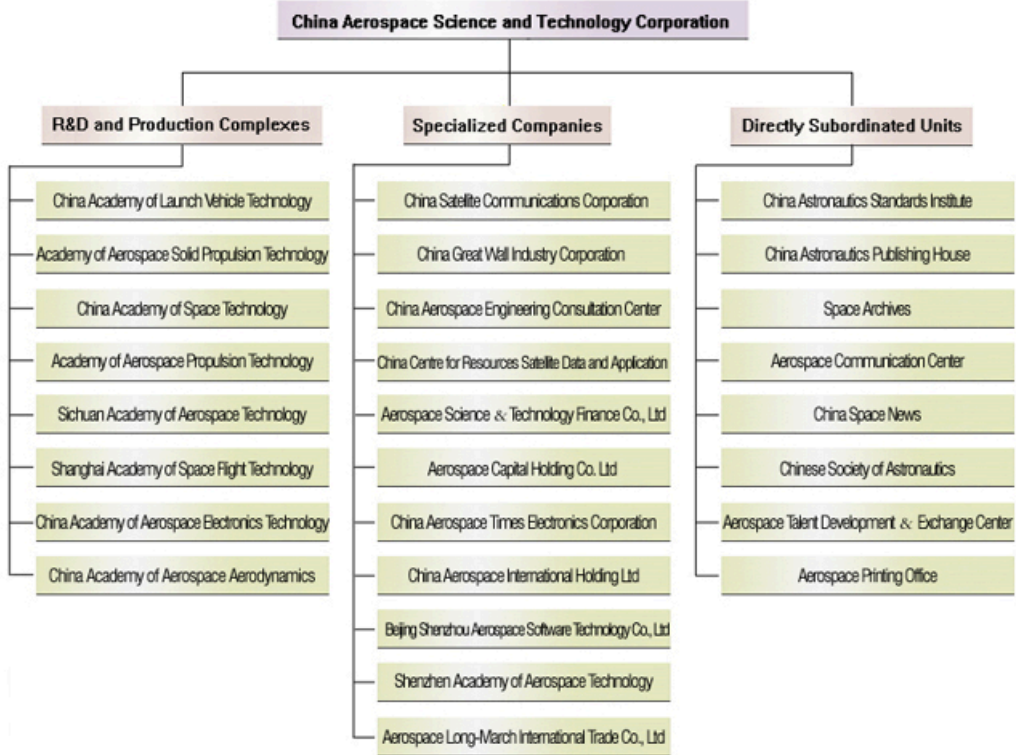
A-1



Source: CASIC website.

Available at: <http://www.casic.com.cn/n101/n127/index.html>

A-2



Source: CASC website

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A-3

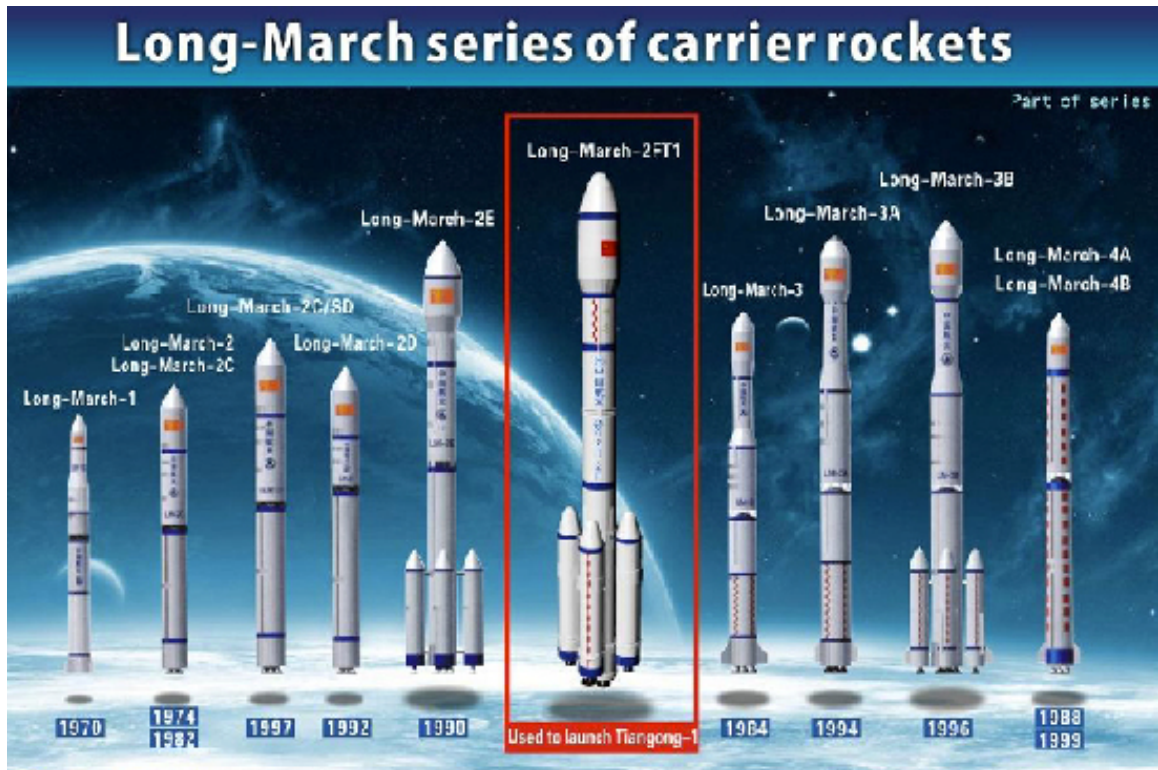


Image: Long-March Rocket series

Source: China Org Cn. Available at: http://www.china.org.cn/china/2011-09/28/content_23512520.htm

A-4

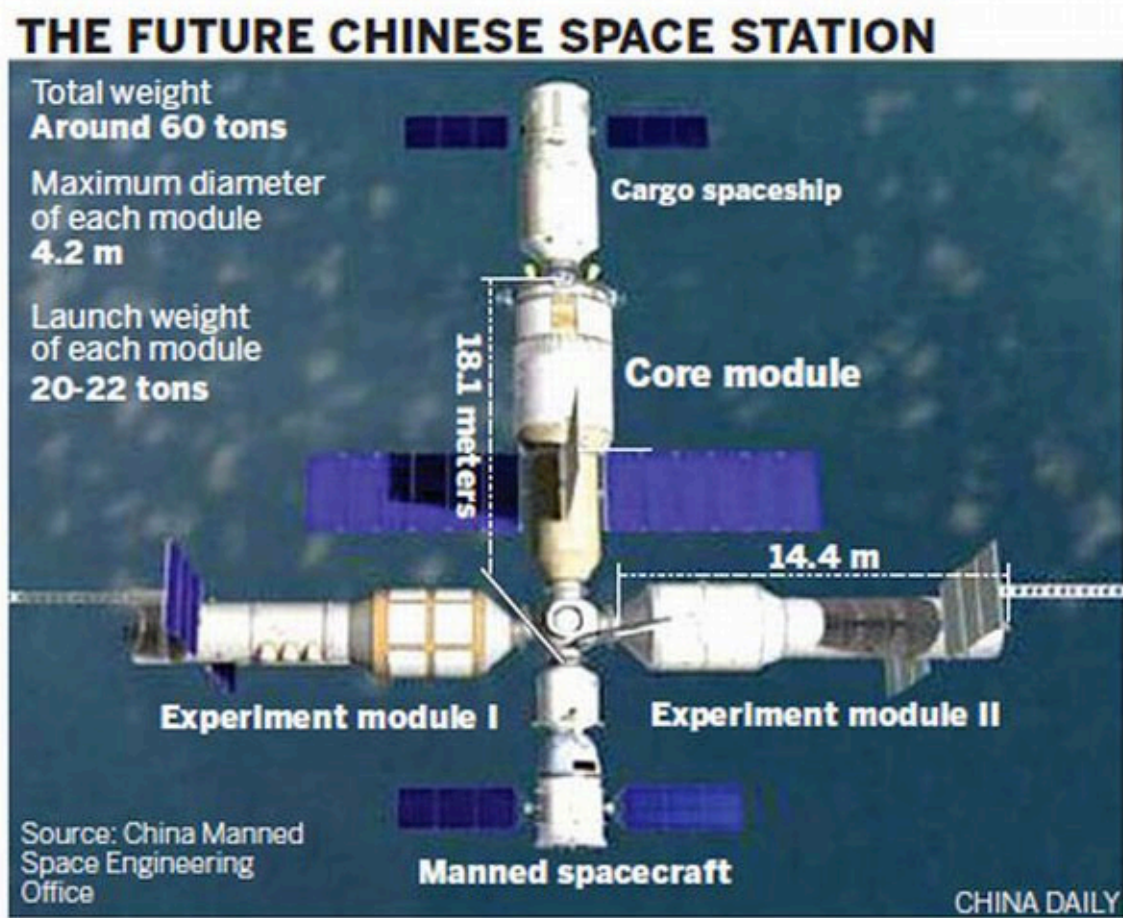


Image: Complete Tiangong Space Station with Shenzhou spacecraft.

Source: China Daily. Available at: <http://moonandback.com/2012/06/18/shenzhou-9-docks-with-tiangong-1/>



Image: China Shenzhou-9 and Tiangong-1

Source: Xinhua News. Available at: http://news.xinhuanet.com/english/photo/2012-06/18/c_131660377.htm

A-6

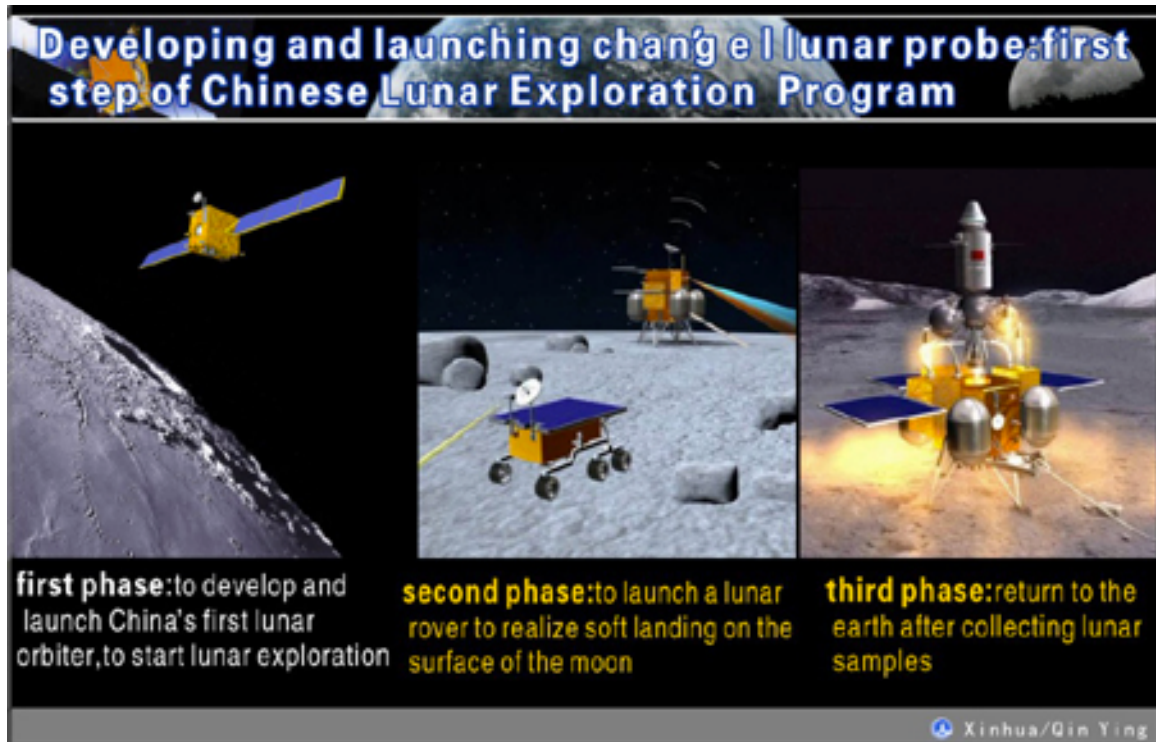


Image: 3 stages of Chang'e program.

Source: Xinhua News. Available at: http://news.xinhuanet.com/english/2007-10/23/content_6930627.htm