PLANETARY CONJUNCTION:
ECONOMICS, POLITICS, AND PARTNERING IN SPACE

BY

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14. ABSTRACT

This study investigates the utility of engaging in strategic space partnerships to gain an understanding of why the United States may, or may not, benefit from such cooperation. It begins with laying the foundation for the theoretical approach. In doing such, it discusses concepts of international relations theory, economic theory, and principal-agent theory. Specifically, realism, liberalism, and constructivism are used to describe behavior of states. Also, the following six economic principles are applied to state behavior: opportunity cost, expected marginal costs and benefits, substitution, diminishing marginal returns, asymmetric information and hidden characteristics, and hidden actions and incentive alignments. Given these tools, the investigation continues using the European Space Agency as evidence and seeks answers to two questions: Does strategic partnering in space benefit the United States? Does it benefit Americaâ\,s strategic partners? The study then proceeds with recommendations for the United States to posture itself in a position of continuous advantage in the space realm. Finally, the investigation culminates with a conclusion and recommended areas for further study.

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The undersigned certify that this thesis meets master's-level standards or research, argumentation, and expression.

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DISCLAIMER

The conclusions and opinions expressed in this document are those of the author. They do not reflect the official position of the US Government, Department of Defense, the United States Air Force, or Air University.

ABOUT THE AUTHOR

Major Justine A. Wopat was commissioned in 1999 from the Reserve Officer Training Corps at the University of South Florida in Tampa. Graduating from Undergraduate Space and Missile Training in 1999, she went on to become a senior missileer and senior space operator with experience in Intercontinental Ballistic Missile (ICBM) operations, joint space operations, test and evaluation, and acquisitions. She has served as an operator and crew member, as well as serving as an instructor multiple times. Also, she has led as a Missile Combat Crew Commander, Senior Space Duty Officer, chief of training, and chief of an operating location. Major Wopat is a Distinguished Graduate from Initial Qualification Training for ICBMs and a Top Third Graduate from Squadron Officer School. She holds a Masters in Human Nutrition from the University of Bridgeport, a Masters in Military Operational Art and Science from the Air Command and Staff College, and a Master of Philosophy in Military Strategy from the School of Advanced Air and Space Studies. Upon graduation from SAASS in June 2013, Major Wopat was assigned as a Nuclear Operations and Strategy Officer to the Pentagon in Washington, D.C.

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I appreciate all of the professional interactions I have had throughout the years to include: the United States' officer and enlisted corps of the Air Force, Marines, Army, Navy, and Coast Guard, in addition to civilians and contractors. I have also had the opportunity to work with noble service members from Botswana, Denmark, Romania, Australia, France, India, Germany, Canada, Australia, and Great Britain, to name a few. To those noted above, thank you all. Your mentorship and guidance throughout the years has helped me become the officer and professional I am today. The devotion and allegiance of all of the men and women voluntarily serving our military in the defense of freedom and democracy is to be respected and appreciated by all humans that benefit from their commitment to missions across the globe.

I would like to dedicate this paper to the memories of my grandparents, my step-father, my brother, and my darling's father. It is times like this that I wish you were all still around to share in the joys I feel when accomplishing such a major milestone. Thank you all for helping me to become the person I am today.

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ABSTRACT

This study investigates the utility of engaging in strategic space partnerships to gain an understanding of why the United States may, or may not, benefit from such cooperation. It begins with laying the foundation for the theoretical approach. In doing such, it discusses concepts of international relations theory, economic theory, and principal-agent theory. Specifically, realism, liberalism, and constructivism are used to describe behavior of states. Also, the following six economic principles are applied to state behavior: opportunity cost, expected marginal costs and benefits, substitution, diminishing marginal returns, asymmetric information and hidden characteristics, and hidden actions and incentive alignments. Given these tools, the investigation continues using the European Space Agency as evidence and seeks answers to two questions: Does strategic partnering in space benefit the United States? Does it benefit America's strategic partners? The study then proceeds with recommendations for the United States to posture itself in a position of continuous advantage in the space realm. Finally, the investigation culminates with a conclusion and recommended areas for further study.

CONTENTS

Illustrations

Table

Chapter 1

Introduction

> *In civilized society [man] stands at all times in need of cooperation and assistance of great multitudes, while his whole life is scarce sufficient to gain the friendship of a few persons.*
>
> -Adam Smith
> *The Wealth of Nations*

Sputnik made history when it launched in 1957, forever marking the first time a human-made object travelled into space. This launch led to a human-space connection that opened up a new frontier for nations to explore, and to use, in efforts to meet their national objectives. Initially, states raced to get into space so they could mark an individual accomplishment. "The space and arms races that began with the launch of Sputnik were destined to determine a global economic champion and to establish the model of development for the world's emerging nation-states."[1] Today, over 55 years after that first momentous launch, many nations choose to involve themselves in cooperative partnerships with others in order to meet their objectives while at the same time conserving their national resources. By having these relationships, nations intend to increase their capacities either to maintain their space-power status or, potentially, to become space powers.

What does spacepower imply? If a nation can utilize the space environment in order to pursue and meet its national objectives, it is said to have spacepower. Therefore, "s*pacepower is the ability of a nation to exploit the space environment in pursuit of national goals and purposes and includes the entire astronautical capabilities of the nation.* A nation with such capabilities is termed a *space power*."[2]

[1] Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), 93.
[2] David E. Lupton, "On Space Warfare" (Maxwell AFB: Air University Press, 1998), 4. The italics within the quote represent emphasis placed upon it in the original text from the source document.

Figure 1: *Sputnik*, the First Artificial Earth Satellite

Source: National Aeronautics and Space Agency, "Image of the Day Gallery" http://www.nasa.gov/multimedia/imagegallery/image_feature_924.html (accessed 12 December 2012)

Defining the General Problem

The 2006 Quadrennial Defense review first formally highlighted the need for building partnership capacity for strategic-level impact. "Building partnership capacity invigorates our efforts and acknowledges that future challenges can be met only through the integrated use of all of the instruments of national power and through the relevant contributions of our international partners."[3] This statement shows that the United States does not intend to meet all future challenges on its own. Nations need to grow in their abilities to effectively engage each other. These partnerships prove ever more important in a fiscally constrained environment. A general problem area then appears; what are the benefits of partnerships for those involved? For purposes of this research, I delve specifically into the space arena as it has already received attention from the United

[3] Donald H. Rumsfeld, *2006 Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), 111.

States government. "Active U.S. leadership in space requires a whole-of-government approach that integrates all elements of national power, from technological prowess and industrial capacity to alliance building and diplomatic engagement. Leadership cannot be predicated on declaratory policy alone. It must build upon a willingness to maintain strategic advantages while working with the international community to develop collective norms, share information, and collaborate on capabilities."[4]

Highlighting the Specific Problem

Does strategic partnering in space benefit the United States? Does it benefit America's strategic partners? At first glance, it appears that strategic partnerships in space could help the nation's budget-constrained situation. Without a thorough investigation, however, the initial assumption that expected economic gains realized from partnering are sufficiently beneficial to warrant a maximum effort could lead to future catastrophes. It may seem common sense that partnering benefits all involved, but a closer look reveals the pitfalls or potential disasters that loom in allowing others to have primary responsibility for space assets critical to the United States' economic and security well-being. Research on this topic may reveal both opportunities and entanglements.

Strategic partnering in space could benefit the United States because it allows for cost-sharing in a fiscally-constrained environment, it serves to enhance or enable other foreign policy goals, and it provides insight into the capabilities, limitations, and plans of United States' partners. As such, the United States "has historically viewed international space cooperation as both a political carrot and a technical way to shape other countries' space activities."[5] On the other hand, strategic partnering in space may not, in fact, benefit the United States. Among other potential detriments, strategic partnering in space may compromise national security, involve complex negotiations and agreements between agents with varied interests, and may lead to increased economic requirements not needed in solo space endeavors.

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[4] Robert M. Gates, and James R. Clapper. *2011 National Security Space Strategy of the United States of America*. (Washington DC: Department of Defense and the Office of the Director of National Intelligence, 2011), 20.

[5] Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 229.

Significance of the Research

Building partnerships in general has received an increased interest as of late. However, strategic space partnerships do not appear to have received thorough investigation at this point in time. With the high cost of operations within the space domain, coupled with ever-dwindling national budgets, the United States needs to explore the risks and benefits of partnering in space to achieve its national objectives. Without a thorough investigation into these relationships, the United States may very well find itself in future quandaries if partners deny access, limit information, allow adversaries the same information, et cetera. This research may help determine whether the United States has considered the consequences of strategic space partnerships and whether they appear beneficial, benign, or harmful to national objectives.

Research Approach

This research is conducted using the Case Study methodology. Since I investigate whether or not cooperative relationships in space benefit those involved, case studies that demonstrate such relationships in the context of space are directly relevant. The European Space Agency was chosen as the case study since it serves as an example of well-established space partnerships. The analysis is qualitative as well as quantitative. Qualitative measurements include partner testimony regarding the perceived benefits of cooperation and the subjective sense of benefits from associated intangible factors. Quantitative analysis includes such items as numbers of projects, launches enabled through partnering, and an evaluation of cost savings or cost-sharing resulting from partnering.

Contributions of the Research and Chapter Outline

This research contributes to the body of knowledge dealing with building partnerships while specifically honing in upon cooperation in space. I look at the relationships using various international relation lenses, economic theory concepts, and the principle-agent theory. The six key economic concepts contributing to this research include: opportunity costs, expected marginal costs and benefits, substitution,

diminishing marginal returns, asymmetric information and hidden characteristics, and hidden actions and incentive alignments. This theoretical approach to the case study may reveal under what conditions space partnerships benefit, or do not benefit, those involved. Chapter Two sets the theoretical foundation and framework used for the exploration of the European Space Agency in Chapter Three. Concepts from international relations theory, economic theory, and principal-agent theory combine to set the stage for investigation of the European Space Agency.

Chapter 2

Theoretical Approach and Research Methodology

Nobody ever saw a dog make a fair and deliberate exchange of one bone for another with another dog.

Nobody ever saw one animal by its gestures and natural cries signify to another, this is mine, that is yours;

I am willing to give this for that.

- Adam Smith
The Wealth of Nations

The most widely known and captivating example of multi-national partnerships and cooperation in space have their genesis with the International Space Station. The launch on November 20, 1998, signifies that countries can successfully cooperate on space programs with each meeting its own particular national interests.[6] While this example hails as the most famous, many other partnerships and cooperative efforts for space exist. What considerations does a nation make when deciding whether or not space partnerships best serve its interests? People act. They act for reasons. More often than not, they act intentionally in pursuit of particular results from their actions. This chapter looks at some of the literature regarding international relations theory, economic theory, and principal-agent theory as a basis for the decision-making process of nations that contemplate pursuit of partnerships.

International Relations Theory

International relations theory provides a conceptual framework to use when analyzing how nations behave. Three approaches dominate: realism, liberalism and constructivism. Realism views the nation-state as the primary actor in international relations and sees international politics as separate from domestic politics. Additionally, international relations result in a zero-sum game wherein the gains of one nation-state

[6] National Aeronautics and Space Administration (NASA), http://www.nasa.gov/mission_pages/station/main/onthestation/facts_and_figures.html (accessed 12 December 2012).

equate to losses by another nation-state.[7] For realists, the ultimate concern of international politics comes from ensuring national interests in an anarchical world. "Anarchy does not mean chaos or disorder but instead the absence of a centralized, legitimate authority."[8]

Purpose	Assumptions	Themes	Concepts	Limitations
- To provide intellectual framework for IR based upon human nature - Serve as an explanatory platform for the behavior of states in the world arena Intellectual ancestors: - Thucydides - Hobbes - Machiavelli	- States are unified actors motivated exclusively by the pursuit and consideration of national interests - The main national interests are survival and security - Human nature dictates that mankind is self-interested and cannot be changed - States are the highest level of authority and do not fall under rules that regulate non-state actors, institutions, or structures	- Sovereign states serve as the basis of interaction for IR - Anarchical world results from states behaving in their self-interests since there is no over-arching global authority	- National interests - Security - Sovereignty - Power politics - Zero-sum game - Competitive, self-help world	- Narrow focus on sovereign states - This limited view does not put much consideration into the role of non-state actors

Table 1: Realism

The classical realist sees the objective of the state as power maximization whereas a neorealist sees the need for security maximization as the highest objective. State equity

[7] Robert Gilpin, *War and Change in World Politics* (New York: Cambridge University Press, 1981), 29.
[8] Daniel W. Drezner, *Theories of International Politics and Zombies* (Princeton: Princeton University Press, 2011), 33.

does not exist since its basis comes from power or security, and smaller states appear irrelevant. Thucydides' Melian Dialogue clearly demonstrates concepts of realism in that, "the strong do what they can and the weak suffer what they must."[9] The realist views the nature of people as self-interested and immutable. Actors in the anarchical, international arena engage in strategic opportunism to advance their own interests since they innately have a lust for power.[10]

Purpose	Assumptions	Themes	Concepts	Limitations
- To provide an alternative view of human nature which seeks a more flexible and positive view of mankind - To explore a world of cooperation within the international system - Intellectual ancestors: - Smith - Locke - Kant	- Internal politics affects external politics: Liberal internationalism - Institutions cause states to behave internally a certain way because of external influence: Liberal institutionalism - Man is mutable and can change for the benefit of all	- War stems from politics - Democracy and free trade can alleviate tendency to go to war - Democratic Peace Theory - Make war obsolete -Trading states rather than military states	- Cooperation - Free markets - Human rights - Rising tide lifts all boats - Complex interdependence -International regimes	- A naive and utopian concept of human nature and for the possibilities for international cooperation - Tendency to exaggerate the role of international institutions, the extent of globalization, and the limited capacity of the state - Democratic Peace Theory falls apart when democratic states appear belligerent

Table 2: Liberalism

Liberalism holds that the individual and the state serve as the primary actors in international relations and that international politics cannot function effectively separate

[9] Thucydides. *The Landmark Thucydides: A Comprehensive Guide to the Peloponnesian War*. Edited by Robert B Strassler and Richard Crawley (New York: Simon & Schuster, 1998), 352.
[10] Drezner, *Theories of International Politics and Zombies*, 45.

from domestic politics. Liberals believe that international relations do not result in a zero-sum game and in the aphorism: a rising tide lifts all boats. Even though all boats rise, their gains may not necessarily prove equal, but the actors remain better off than if they had not engaged in cooperation.[11] International cooperation fostered through regimes and institutions facilitates negotiations and mutually beneficial arrangements among governments.[12] The function of international politics leads to a natural harmony of interests among states and individuals, since their interdependency leads to the benefit of all, especially when focusing on their institutions. "Major actors in world politics therefore have an incentive to realize the benefits that come from long-term mutual cooperation and avoid the costs that come with mutual defection."[13] All states, large and small, matter, and have equal play in the field of international relations. Liberals also declare that people go beyond self-interest, have more of a community mindset, and that the basic nature of humans can reach a higher level of perfection.

Purpose	Assumptions	Themes	Concepts	Limitations
- To explore the implications of acknowledging that potential realities are socially constructed - To show that the world arena will be whatever the actors in it choose for it to be - Intellectual ancestors: - Wendt	- Beliefs play a crucial role in shaping reality - The social and political world is an inter-subjective domain - There is no social realm independent of human activity	- Anarchy is what states make of it - Assesses transformative powers to novel social constructions on the state system (such as the European Union) - Threats are perceptions rather than realities that are responded to	- Social construction - Inter-subjectivity - Identity - Power politics are socially constructed	- Actors are only capable of truly knowing themselves - The socially constructed view of the world will fall to the majority, and not cover the "reality" that everyone perceives

Table 3: Constructivism

[11] Drezner, *Theories of International Politics and Zombies*, 47.
[12] Robert O. Keohane, *After Hegemony: Cooperation and Discord in the World Political Economy* (Princeton: Princeton University Press, 2005), 107.
[13] Drezner, *Theories of International Politics and Zombies*, 47.

Constructivism seeks to explain international relations as a socially constructed phenomenon. The realist notion of power politics does not occur naturally, and therefore can change as a result of human ideas. To the constructivist, the core aspects of international relations derive from socially constructed processes, practices, and interactions. "Students of international politics have increasingly accepted two basic tenets of 'constructivism': (1) that the structures of human association are determined primarily by shared ideas rather than material forces, and (2) that the identities and interests of purposive actors are constructed by these shared ideas rather than given by nature."[14] In any acts of cooperation, the cooperative efforts need interpretation within the context of prevailing expectations and shared beliefs before the actors can fully appreciate the meaning of said cooperation.[15] Group and collective meanings constitute the structures which organize the actions of the actors within the world arena.[16] Constructivists also predict that norms form as a result of more and more people sharing the same ideas. "A norm cascade functions like peer pressure—as people witness others adhering to a particular standard of behavior, they are more likely to conform to that standard of behavior as well."[17] The power of these IR theories comes to bear when using them as lenses to explain why the world works the way it does rather than trying to predict what will happen in the future. Economic theory also has explanatory power in the world arena and is also interpreted using the same three theoretical lenses.

Economic Theory

Six aspects of economic theory deserve attention when dealing with decisions that may result in economic benefit for the actor. These six economic principles include: opportunity cost, expected marginal costs and benefits, substitution, diminishing marginal returns, asymmetric information and hidden characteristics, and hidden actions and incentive alignments. This section describes the characteristics of these individual

[14] Alexander Wendt, *Social Theory of International Politics* (New York: Cambridge University Press, 1999), 1.
[15] Keohane, *After Hegemony*, 56.
[16] Alexander Wendt, "Anarchy is What States Make of it: The Social Construction of Power Politics." *International Organization*, Vol. 46, No. 2 (Spring, 1992), pp. 391-425.
[17] Drezner, *Theories of International Politics and Zombies*, 74.

principles, followed by an American historical example for demonstrative purposes. The next chapter applies these principles to the European Space Agency case study to show their relevance to space partnerships specifically.

First, opportunity cost comes about when an actor faces the challenge of managing limited resources as efficiently as possible. "Taking one action costs one the opportunity to undertake another."[18] When actors consider, manage, and weigh the value of their selected activities in comparison to those not chosen, the opportunity cost represents the sacrifice of not choosing the latter. Opportunity costs are not limited to financial costs since the choices made to maximize benefits may cost time, convenience, or other intangible values as well. "It is important because economics makes a prediction: it is that of the multitude of valuable things from which they must choose, people tend to choose the one thing that is most valuable to them, given the conditions prevailing at the time the choice is made."[19]

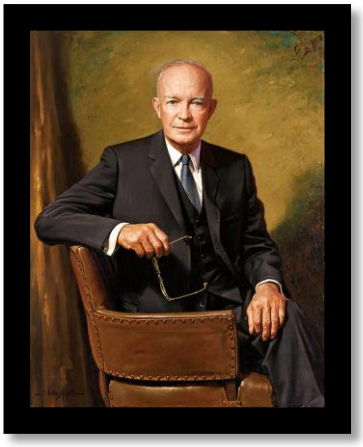

Figure 2: President Dwight D. Eisenhower

Source: Dwight D. Eisenhower Presidential Library and Museum, "Home Page", http://www.eisenhower.utexas.edu/ (accessed 20 February 2013)

[18] Jurgen Brauer, and Hubert P. Van Tuyll, *Castles, Battles, and Bombs: How Economics Explains Military History* (Chicago: University of Chicago Press, 2008), 2.
[19] Brauer, *Castles, Battles, and Bombs*, 12.

There are many ways to exemplify opportunity costs. President Dwight D. Eisenhower famously recognized and characterized opportunity costs in his "Chance for Peace" speech, presented to the American Society of Newspaper Editors on April 16th, 1953. As a former war general, President Eisenhower had a full appreciation for the national opportunity costs associated with war and defense.

> Every gun that is made, every warship launched, every rocket fired signifies, in the final sense, a theft from those who hunger and are not fed, those who are cold and are not clothed. This world in arms is not spending money alone. It is spending the sweat of its laborers, the genius of its scientists, the hopes of its children. The cost of one modern heavy bomber is this: a modern brick school in more than 30 cities. It is two electric power plants, each serving a town of 60,000 population. It is two fine, fully equipped hospitals. It is some 50 miles of concrete highway. We pay for a single fighter plane with a half million bushels of wheat. We pay for a single destroyer with new homes that could have housed more than 8,000 people. This, I repeat, is the best way of life to be found on the road the world has been taking. This is not a way of life at all, in any true sense. Under the cloud of threatening war, it is humanity hanging from a cross of iron.[20]

Second, cost-benefit analysis aids decision makers in their thought processes. "Since the future is uncertain, decision making involves expected marginal benefits to be weighed against expected marginal costs, and the decision rule is straightforward: if the expected incremental benefit of an action outweighs its expected additional cost, then do engage in that action, and vice versa."[21] Here it is important to note two key points. First, the cost of an action can change based upon the methods the decision-maker uses to accomplish the desired end result; cost is negotiable. Second, to assume cost comes solely in the amount of money spent misses a critical concept in decision-making. Aside from money, other, sometimes intangible, factors come to bear in the consideration of cost and benefit. When performing this calculation, people may also include the attainment of such intangible factors as respect, friendship, prestige or other such psycho-social imperatives.[22] "The final price that one is willing and able to pay for any good or

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[20] President Dwight D. Eisenhower, "Chance for Peace" Speech, http://www.eisenhower.archives.gov/all_about_ike/speeches/chance_for_peace.pdf (accessed 20 February 2013).
[21] Brauer, *Castles, Battles, and Bombs*, 17.
[22] Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge: Harvard University Press, 1971), 60.

service one desires has a lot to do with one's valuation of the expected benefit."[23] President John F. Kennedy spoke in terms of cost-benefit analysis when he addressed a joint session of Congress on May 25, 1961 about funding national space endeavors.

Figure 3: President John F. Kennedy Addressing a Joint Session of Congress, May 25, 1961

Source: John F. Kennedy Presidential Library and Museum, "Space", http://www.jfklibrary.org/JFK/Media-Gallery/Space.aspx (accessed 28 February 2013)

> I believe that this nation should commit itself to achieving the goal, before this decade is out, of landing a man on the moon and returning him safely to the earth. No single space project in this period will be more impressive to mankind, or more important for the long-range exploration of space; and none will be so difficult or expensive to accomplish ... Let it be clear that I am asking the Congress and the country to accept a firm commitment to a new course of action, a course which will last for many years and carry very heavy costs: 531 million dollars in fiscal '62—an estimated seven to nine billion dollars additional over the next five years. If we are to go only half way, or reduce our sights in the face of difficulty, in my judgment it would be better not to go at all.[24]

[23] Brauer, *Castles, Battles, and Bombs*, 17.
[24] President John F. Kennedy, "Address Before a Joint Session of Congress, 25 May 1961", http://www.jfklibrary.org/Asset-Viewer/xzw1gaeeTES6khED14P1Iw.aspx (accessed 28 February 2013).

Third, the process of substitution involves the act of identifying alternatives that would satisfy the same need, want, or desire. "The principle of substitution says that if two goods yield comparable benefits users will eventually drift toward usage of the good with the relatively lower price ... More simply: if the benefit is fixed, people reach for the lower-cost item; if the cost is fixed, people reach for the higher-benefit item."[25] Substitutions can be further categorized into either perfect or imperfect substitutions. The perfect substitution completely satisfies the consumer whereas an imperfect substitution only partially satisfies them. Incentives also play a central role in the act of substitution.[26] Two examples of substitution appear in President Harry S. Truman's "Farewell Address to the American People" on January 15, 1953. He discussed General Eisenhower's replacing him in office and he pointed out substituting the atomic bomb for more vast amounts of death during the war.

Figure 4: President Harry S. Truman

Source: Harry S. Truman Presidential Library and Museum, "Truman Library Photographs", http://www.trumanlibrary.org/photographs/index.php (accessed 6 March 2013)

> Inauguration Day will be a great demonstration of our democratic process. I am glad to be a part of it-glad to wish General Eisenhower all possible success, as he begins his term—glad the whole world will have a chance to see how simply and how peacefully our American system transfers the vast power of the Presidency from my hands to his. It is a good object lesson in democracy ... The war against Japan was still going on. I made

[25] Brauer, *Castles, Battles, and Bombs*, 21.
[26] Brauer, *Castles, Battles, and Bombs*, 23.

> the decision that the atomic bomb had to be used to end it. I made that decision in the conviction it would save hundreds of thousands of lives--Japanese as well as American. Japan surrendered.[27]

Fourth, the concept of diminishing marginal returns applies to both production and consumption. "The principle of diminishing marginal returns merely claims that eventually a sense of satiation sets in, if not by the second then perhaps by the third or the fourth helping, commonly expressed as 'oh, boy, am I stuffed!'"[28] As agents increase their total investment, the total return on that investment, as a proportion of the total investment, decreases. One historic example clearly demonstrates the economic principle of diminishing marginal returns in action. The United States Strategic Bombing Survey's account of *The Effects of Strategic Bombing on German Morale* noted this principle first-hand.

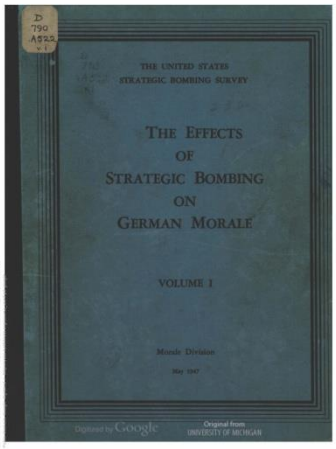

Figure 5: Cover of *The Effects of Strategic Bombing on German Morale*

By the United States Strategic Bombing Survey

Source: United States Strategic Bombing Survey, "The Effects of Strategic Bombing on German Morale", http://babel.hathitrust.org/cgi/pt?id=mdp.39015008510300;seq=11;view=1up;num=1, (accessed 13 March 2013)

[27] President Harry S. Truman, "Farewell Address to the American People", http://trumanlibrary.org/calendar/viewpapers.php?pid=2059, (accessed 6 March 2013).
[28] Brauer, *Castles, Battles, and Bombs*, 24.

> Continuous heavy bombing of the same communities did not produce decreases in morale *proportional* to the amount of bombing ... These observations of the diminishing returns from heavy bombing point to the practical conclusion that the maximum *morale* effects of dropping a given tonnage of bombs on Germany would have been attained by lighter raids as widely distributed as possible, rather than by concentrated heavy bombing in limited areas.[29]

Fifth, asymmetric information and hidden characteristics contribute to the decision-making process. Asymmetric information results when one actor may have more knowledge about a particular good, service, or situation than another actor. Hidden characteristics pose an information problem before an action is taken or before an irrevocable commitment is made.[30] In the world arena, asymmetric information and hidden characteristics can manifest themselves when participants have limited information about the capabilities, limitations, and intentions of others. Decision-makers use the best, most accurate information available to shape the expectations they have of others. "Expectations are a form of information that influences behavior."[31] As a consequence of asymmetric information, actors have the potential to allocate resources inefficiently when they miscalculate their lack of information and derive expectations that do not match reality.

Not all decision-makers will come to the same decision based upon identical information. "Prejudices, preconceptions, and personal experience cause similarly situated commanders to read the same information differently. No fact exists independent of interpretation."[32] Signaling and screening mechanisms provide avenues for the transfer of information from the informed to the uninformed. The use of these mechanisms has the potential to reduce asymmetric information.[33] President Ronald Reagan addressed the principle of asymmetric information and hidden characteristics with subtlety during his national address about his upcoming trip to Geneva to meet with then General Secretary of the Communist Party of the Soviet Union, Mikhail Gorbachev.

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[29] United States Strategic Bombing Survey, "The Effects of Strategic Bombing on German Morale", (accessed 13 March 2013).
[30] Brauer, *Castles, Battles, and Bombs*, 28.
[31] Brauer, *Castles, Battles, and Bombs*, 32.
[32] Brauer, *Castles, Battles, and Bombs*, 195.
[33] Brauer, *Castles, Battles, and Bombs*, 30.

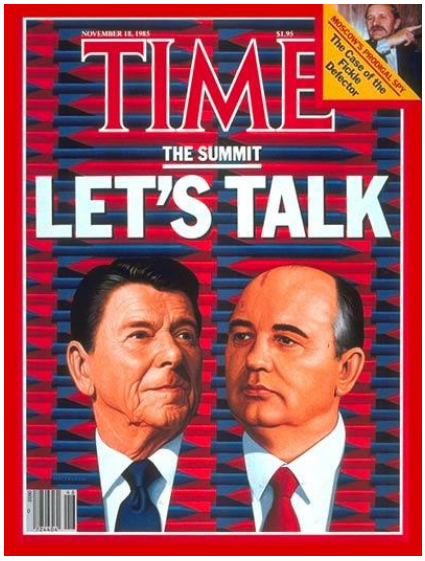

Figure 6: Cover of *Time* Magazine, November 18, 1985

Depicting President Ronald Reagan and Mr. Mikhail Gorbachev

Source: Time Magazine, "Cover Search." http://www.time.com/time/covers/0,16641,19851118,00.html

(accessed 13 March 2013)

> My mission, stated simply, is a mission for peace. It is to engage the new Soviet leader in what I hope will be a dialog for peace that endures beyond my Presidency. It is to sit down across from Mr. Gorbachev and try to map out, together, a basis for peaceful discourse even though our disagreements on fundamentals will not change. It is my fervent hope that the two of us can begin a process which our successors and our peoples can continue—facing our differences frankly and openly and beginning to narrow and resolve them; communicating effectively so that our actions and intentions are not misunderstood; and eliminating the barriers between us and cooperating wherever possible for the greater good of all.[34]

Sixth, hidden actions and incentive alignments serve as a final economic principle for review. Asymmetric information results from hidden actions as well as the hidden characteristics discussed preciously. Whereas hidden characteristics cause problems before action or commitment occurs, hidden actions produce issues after action or

[34] President Ronald Reagan, "Address to the Nation on the Upcoming Soviet-United States Summit Meeting in Geneva, November 14, 1985." http://www.reaganfoundation.org/pdf/Address_on_the_Upcoming_Soviet_US_summit_Geneva_111485.pdf (accessed 13 March 2013).

commitment has already taken place. The hidden actions here refer to those actions that do not appear transparently between the parties involved. Hidden characteristics come to light when participants tell the truth, and hidden actions dissipate when the parties act truthfully in their agreed-to actions and commitments. One way to prevent shirking and hidden actions relates to incentives and incentive alignment after a commitment has been made.[35] Contracts and agreements serve as some tools to mitigate hidden actions. "Contracts, formal or informal, need to recognize exposure to risk, for example, by including penalty clauses or payment of risk premiums."[36]

Hidden actions and incentive alignments depend upon the principal-agent relationship. President Obama highlighted the need for transparency throughout the *2010 National Security Strategy of the United States of America*. One example relates to the need to balance the imperatives of secrecy and transparency between the American people acting as the principal, and the government, acting as the agent for the people.

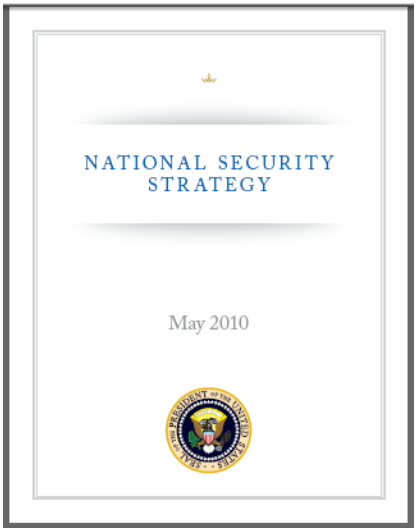

Figure 7: *The 2010 National Security Strategy of the United States of America*

Source: President Barack H. Obama, 2010 National Security Strategy of the United States of America, (Washington, DC: White House Publishing, 2010).

> For the sake of our security, some information must be protected from public disclosure—for instance, to protect our troops, our sources and methods of intelligence-gathering or confidential actions that keep the

[35] Brauer, *Castles, Battles, and Bombs*, 35.
[36] Brauer, *Castles, Battles, and Bombs*, 36.

> American people safe. Yet our democracy depends upon transparency, and whenever possible, we are making information available to the American people so that they can make informed judgments and hold their leaders accountable. For instance, when we invoke the State Secrets privilege, we will follow clear procedures so as to provide greater accountability and to ensure the privilege is invoked only when necessary and in the narrowest way possible. We will never invoke the privilege to hide a violation of law or to avoid embarrassment to the government.[37]

Principal-agent Theory

Having looked at international relations and economic theory principles, the idea of principal-agent theory now comes to bear. In considering partnership and cooperation that involves at least two parties interacting with one another, the concept of principal-agency deserves attention as well. This framework helps to explore problems of agency where political or economic actors in a superior position control or leverage the political or economic actors subordinate to them.[38] "The principal is the party giving an order or requesting a service (the patient, the client, the customer, the student, the shareholder); the agent is the party receiving the order or carrying out the service (the physician, the lawyer, the mechanic, the professor, the directors)."[39] With effective principal-agent relationships, methods for monitoring, rewarding, or punishing work accomplished, or not accomplished, need to exist.[40] "In economic relationships, the principal and the agent have a different set of incentives regarding the basic work assigned to the agent: the principal wants lots of work for little pay, and the agent wants lots of pay for little work."[41]

Research methodology

This research will be conducted using the Case-Study methodology for research. The theoretical framework outlined above serves as the basis by which to study and evaluate the chosen case study of the European Space Agency. The international

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[37] President Barack H. Obama, *2010 National Security Strategy of the United States of America,* 36.
[38] Peter D. Feaver, *Armed Servants: Agency, Oversight, and Civil-Military Relations* (Cambridge: Harvard University Press, 2003), 12.
[39] Brauer, *Castles, Battles, and Bombs*, 34.
[40] Feaver, *Armed Servants*, 56.
[41] Feaver, *Armed Servants*, 59.

relations theories, economic theories, and principal-agent theory could effectively serve an investigation into any type of cooperative effort. For purposes of this research, however, the investigation looks into whether or not cooperative relationships in space benefit those involved. Therefore, it utilizes the case study that demonstrates such relationships in the context of space partnerships. The European Space Agency was chosen as the case study since it serves as an example of well-established space partnerships. In the next chapter, an exploration into the European Space Agency will divulge evidence of the previously described theoretical frameworks at work.

Chapter 3
European Space Agency Case Study

> *It is not from the benevolence of the butcher, the brewer, or the baker, that we expect our dinner, but from the regard to their own interest. We address ourselves, not to their humanity but to their self-love, and never talk to them of our own necessities but of their advantages.*
>
> - Adam Smith
> *The Wealth of Nations*

When conducting a case study based upon an organization, such as the European Space Agency, great value comes from divulging and understanding why the organization got started in the first place. By exploring the impetus behind the creation of the European Space Agency, a more comprehensive story unfolds that can serve to explain the participants' behaviors, both past and present. Once a historical foundation comes to light, it can serve as a useful tool for comparison to the actions and behaviors of the recent past and present. This chapter begins with an exploration of the history of the European Space Agency and continues on to uncover samples of evidence that exemplify international relations theory, economic theory, and principal-agent theory in practice.

Historical Background and Significance[42]

First, why did the European Space Agency even come into existence? This question naturally occurs when considering how an organization functions in its current capacity. To answer this question, context matters. Although the European Space Agency's inauguration came in 1975, its conception began many years earlier. Contextually speaking, in the post-World War II years, a multitude of European scientists left their homelands in Western Europe to work for either the United States or the Soviet Union. Although Western European countries could still invest in research and space-

[42] Unless otherwise noted, all information in this historical section is drawn from the following two sources:
European Space Agency, "History of Europe in Space," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/History_of_Europe_in_space (accessed 20 December 2012).
Conseil Européen pour la Recherche Nucléaire, "About CERN," http://home.web.cern.ch/about (accessed 22 December 2012).

related activities, European scientists realised that solely national projects would be unable to compete with the major superpowers.

By 1958, two well-respected and well-renowned scientists from what remained of the Western European scientific community championed a cooperative space venture. Pierre Auger of France and Edoardo Amaldi of Italy proposed that the European governments combine their resources to set up a joint organization for space research. They looked to CERN to serve as a successful, multi-national, collaborative effort. "The name CERN is derived from the acronym for the French 'Conseil Européen pour la Recherche Nucléaire', or European Council for Nuclear Research, a provisional body founded in 1952 with the mandate of establishing a world-class fundamental physics research organization in Europe."

The cooperative vision of Pierre Auger and Edoardo Amaldi came to fruition when, in December of 1960, a European Preparatory Commission for Space Research (COPERS) began as a result of an intergovernmental conference held in Meyrin, Switzerland. The concept of cooperation in space continued to gain momentum, resulting in the creation of both the European Launcher Development Organisation (ELDO) and the European Space Research Organisation (ESRO) in 1962. Original members of ELDO include Belgium, France, Germany, Italy, the Netherlands, and the United Kingdom, with Australia serving as an associate member. A few months later, the six main members from ELDO joined to form an additional cooperative endeavour with ESRO, which also included Denmark, Spain, Sweden, and Switzerland.

The first successful ESRO satellite launch came in 1968, just shy of six years after its inception. In pursuit of increasing cooperation in space, the European Space Conference meeting in 1973 resulted in the decision to create the European Space Agency. Almost two years later, in 1975, the European Space Agency officially came into existence. Eleven states created the European Space Agency "to replace the European Launcher Development Organisation (ELDO) and European Space Research Organisation (ESRO): Belgium, Denmark, France, West Germany, Ireland, Italy, Netherlands, Spain, Sweden, Switzerland, and the UK. Austria and Norway, with Finland as an associate member (full member from January 1995) and Canada as a co-

operating state, subsequently joined the charter members."[43] The mandatory and general science program budgets receive funding from the Member States relative to their Gross National Product. The optional program budgets acquire financial support from those Member States choosing to enter them.

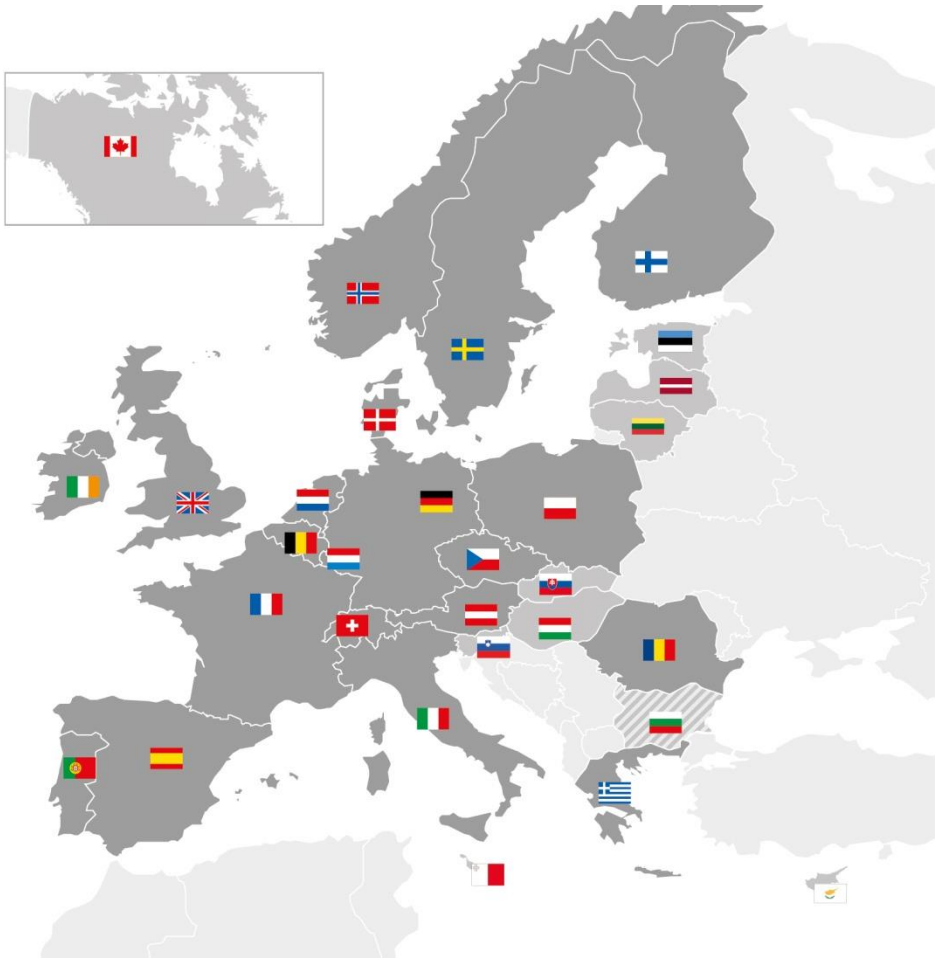

Figure 8: European Space Agency Member States and Cooperating States as of March 2013

Source: European Space Agency, "New Member States," http://www.esa.int/About_Us/Welcome_to_ESA/New_Member_States (accessed 29 March 2013). Dark grey states represent Member States, lighter grey states represent Cooperating States, and multi-striped states, as seen currently over Bulgaria, represent states in the process of negotiating a Cooperative Agreement with the European Space AgencyEuropean Space Agency.

[43] David Baker, ed., *Jane's Space Directory, 2004-2005* (Alexandria: Jane's Information Group, 2004), 13.

Today, "the Member States are: 18 states of the EU (Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Poland, Portugal, Romania, Spain, Sweden and the United Kingdom) plus Norway and Switzerland. Eight other EU states have Cooperation Agreements with ESA: Estonia, Slovenia, Hungary, Cyprus, Latvia, Lithuania, Malta and the Slovak Republic. Bulgaria is negotiating a Cooperation Agreement. Canada takes part in some programmes under a Cooperation Agreement."[44] For key important dates during the evolution of the European Space Agency, refer to Appendix A.

The remainder of this research views the European Space Agency with two ongoing assumptions. First, the expectation follows that all members involved behave in accordance with some level of rationality and that they all seek to maximize value and utility through the act of partnering. The second assumption presupposes that all members realize and conceive of themselves as either principals or agents, depending upon the situation. Next, evidence from the European Space Agency demonstrating the various international relations lenses will come to light.

Evidence of International Relations Theory in Practice

The nation-state serves as the primary actor in international relations for the realist. Gains for one state equate to losses by another since the world arena is viewed as a zero-sum game. The pinnacle dilemma comes from ensuring national interests in a world that has no centralized, legitimate authority.[45] States do not operate with equality since interactions result from relative power and security. The immutable and self-interested nature of the individual leads to strategic opportunism where everyone seeks to advance only interests that line up with their desires. The European Space Agency demonstrates tendencies toward realism.

Members of the European Space Agency can participate in optional programs according to their national interests. Ariane and Spacelab serve as examples of two

[44] European Space Agency, "ESA Presentation April 2013", http://esamultimedia.esa.int/multimedia/publications/ESA-Presentation/offline/download.pdf , 4 (accessed 1 April 2013).
[45] Robert Gilpin, *War and Change in World Politics* (New York: Cambridge University Press, 1981), 29.

optional programs Member States can partake of on a voluntary basis. Additionally, the following comprise optional program areas: human spaceflight, telecommunications and integrated applications, earth observation, launchers, navigation, robotic exploration, and space situational awareness. Joan Johnson-Freese eloquently captures optional programs:

> Generally speaking, optional programs are funded by a system called *juste retour*. In theory, the distribution of ESA contracts for a program (read: jobs and industrial growth) is awarded based on financial investment in the program. If a country contributes 20 percent of the required program funding, it should receive 20 percent of the industrial contracts awarded in association with that program. In reality, however, things have not always worked that way. Initially, contracts were not awarded based on individual investment, but on a cumulative basis. That meant the larger countries with more developed industrial bases got the lion's share of contracts. For a while, there was even an unwritten rule that some countries could get contracts only for equipment used on the ground, because it was felt that their industries were not mature enough to be trusted to build equipment for use in space. Needless to say, such a system thwarted the entire investment rationale of the smaller contributing countries. Consequently, member states began insisting that distribution of contracts be on a program-by-program basis. That system, however, creates problems of its own, such as when a small country makes a large contribution, but does not have the industrial infrastructure or capabilities to handle an equal proportion of the often highly technical work.[46]

The above narrative effectively demonstrates how the optional programs within the European Space Agency can derive from a realist perspective on international relations. States serve as the main focal point as strategic opportunists. They seek to increase their relative power. In this case, decisions occur in effort to seek, and increase, economic power, which leads to an increase in the overall appearance of general power. The European Space Agency does not fall neatly into the realist paradigm, however.

The liberal believes that benefits for one can benefit all, albeit not necessarily in the same way. Regardless, in the world of the liberal, even with unequal gains the actors still arrive in a better situation than they would have without any cooperative efforts.[47] Institutions provide critical negotiation nodes for governments while serving as a

[46] Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 173.
[47] Daniel W. Drezner, *Theories of International Politics and Zombies* (Princeton: Princeton University Press, 2011), 47.

platform for seeking out mutually beneficial relationships. All states, regardless of size, have equal importance in international relations according to liberals. In these cooperative institutions, people rise above self-interest and take on a more community-minded approach to meeting their needs. The European Space Agency also demonstrates propensities toward liberalism.

The keystone to the liberal view of the European Space Agency comes from its stated purpose as indicated in *Convention for the Establishment of a European Space Agency & ESA Council Rules of Procedure*:

> The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among European States in space research and technology and their space applications, with a view to their being used for scientific purposes and for operational space applications systems:
>
> *a.* by elaborating and implementing a long-term European space policy, by recommending space objectives to the Member States, and by concerting the policies of the Member States with respect to other national and international organisations and institutions;
>
> *b.* by elaborating and implementing activities and programmes in the space field;
>
> *c.* by coordinating the European space programme and national programmes, and by integrating the latter progressively and as completely as possible into the European space programme, in particular as regards the development of applications satellites;
>
> *d.* by elaborating and implementing the industrial policy appropriate to its programme and by recommending a coherent industrial policy to the Member States.[48]

The all-for-one and one-for-all sense of liberalism appears in the ante contributed by each Member State. Entrance fees and continuing contributions of Member States into the European Space Agency are assessed relative to the state's Gross National Product (GNP). The GNP determines the relative share of the budget each state provides for mandatory programs, as a percentage of the whole. These include: general budget,

[48] European Space Agency, *Convention for the Establishment of a European Space Agency & ESA Council Rules of Procedure* (Noordwijk: ESA Publications Division, 2003), 10.

future studies, technological research, education, common investments (facilities, laboratories, basic infrastructure), and science (Solar System science, astronomy, and fundamental physics). Although the contribution for each state is relative to economic power, each state gets a single, equal vote in the council, making it appear that liberal notions are also at work within the European Space Agency. Ultimately, everyone can benefit as well, in the long-run, from the optional programs. The trickle-down effect of the optional programs comes not from getting contracts, but from the observation of the multitude of benefits bestowed upon all of society with their resultant discoveries.[49] Finally, the European Space Agency also represents ideals associated with constructivism.

Human ideas serve as the foundation for the constructivist. If you believe it, you will see it. The key to international relations stems from socially-created processes, practices, and interactions. Group and collective meanings determine how the participants will behave under certain situations. As more and more players engage in similar behaviors, norms develop as a result of consistently reinforced actions agreeable to the group writ large. The European Space Agency displays attributes of constructivism as well.

Just as anarchy is what states make of it, so too is space cooperation.[50] "The Council is the governing body of ESA. It provides the basic policy guidelines for ESA's activities. Each Member State is represented on the Council and has one vote. About every three years, the Council meets at ministerial level ('Ministerial Council') to make key decisions on new and continuing programmes and financial commitment. The ESA Council at ministerial level also meets together with the EU Council to form the European 'Space Council.'"[51] The fact that each member gets a vote indicates that the institution can change as a result of the beliefs and ideas associated with its component parts. The lenses of realism, liberalism, and constructivism help to explain why the

[49] Quiggin, John. *Zombie Economics : How Dead Ideas Still Walk Among Us* (Princeton: Princeton University Press, 2010), 146.
[50] Alexander Wendt, *Social Theory of International Politics* (New York: Cambridge University Press, 1999).
[51] European Space Agency, "ESA Presentation April 2013", http://esamultimedia.esa.int/multimedia/publications/ESA-Presentation/offline/download.pdf, 12 (accessed 1 April 2013).

European Space Agency behaves the way it does. Next, the study provides evidence of economic principles at work.

Figure 9: Strengthening Cooperation in Space

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2007/03/Strengthening_cooperation_in_space (accessed 18 April 2013). From left to right: ESA Director General, Jean-Jacques Dordain, the Head of the Federal Space Agency of the Russian Federation (Roscosmos), Anatoly Perminov, and European Commission Director General Heinz Zourek met 21 March 2007 at Roscosmos in Moscow within the framework of the Tripartite Space Dialogue between the European Commission, European Space Agency and Roscosmos.

Evidence of Economic Theory in Practice

First, opportunity costs represent the sacrifices made by actors when they make one choice over another. When the decision-maker chooses to favor one option over another, it comes at a cost. The cost can go beyond financial costs and can include costs of time, convenience, prestige, et cetera. "The real price of every thing, what every thing really costs to the man who wants to acquire it, is the toil and trouble of acquiring it. What every thing is really worth to the man who has acquired it, and who wants to dispose of it or exchange it for something else, is the toil and trouble which it can save to

himself, and which it can impose upon other people."[52] The Hermes serves as a sample of evidence for opportunity costs in action in the case of the European Space Agency.

In 1987, the European Space Agency approved plans for the Hermes, a spaceplane.[53] A highly technical program, the Hermes demanded a large budget. As such, the European Space Agency had to consider the opportunity costs of continuing to pursue the program. Ultimately, the European Space Agency's need to reduce financial obligations to the program resulted in a decision to reduce the Hermes to a technology program. Part of this change incorporated the study, and consideration, of three strategic options. The three scenarios up for consideration included: Russian cooperation, United States cooperation, or an autonomous European solution.[54]

Figure 10: Concept Drawing of the Hermes, a European Manned Spaceplane

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2011/03/Hermes_1987_concept_for_a_European_manned_spaceplane (accessed 18 April 2013). Hermes, 1987: Hermes was to have been part of a manned spaceflight program providing independent European manned access to space. Designed to take three astronauts to orbits of up to 800 km altitude on missions of 30 to 90 days, the Hermes spaceplane would have been launched using the Ariane 5 rocket.European Space Agency.

[52] Adam Smith, *The Wealth of Nations* (New York: Random House, Inc., 1937), 31.
[53] European Space Agency, "History-Hermes Spaceplane 1987," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/History_Hermes_spaceplane_1987 (accessed 13 April 2013).
[54] Baker, David, ed. *Jane's Space Directory, 2004-2005* (Alexandria: Jane's Information Group, 2004), 13.

The Hermes case illustrates the economic principle of opportunity cost since the European Space Agency faced the challenge of managing its limited financial resources as efficiently as possible. From the plethora of valuable things it had to choose from, ultimately the Hermes came at too high of a cost and was therefore terminated.[55] Other less-costly options appeared more important to the decision makers within the European Space Agency.[56] Many times financial obligations influence the choices actors make and become part of their cost-benefit analysis.

Second, cost-benefit analysis aids decision-makers in their thought processes. When decision-makers conduct their analysis, if it appears as though the benefits of taking one particular action over another will outweigh the costs associated with that same decision, then the choice will favor the direction associated with the greatest benefit.[57] What an actor considers a cost appears relative and subjective since not all costs come in the form of financial burdens. Respect, friendship, prestige, and time provide some examples of costs and benefits that do not stem from money.[58] The ultimate and final price an individual willingly pays for any good or service will have a basis on the value placed upon the expected outcome and benefit.[59] The European Space Agency's 2013 Budget by Domain serves as a sample of evidence for expected marginal costs and benefits in action.

By looking at the budget of an organization, one can glean important details about the values of that organization in its cost-benefit analysis. Upon review of the European Space Agency's Budget by Domain for 2013, two interesting thoughts come to mind. One, a preponderance of the budget slices appears to support dual-use technologies. These can support civilian as well as military purposes and include: earth observation, navigation, human spaceflight, telecommunications, launchers, robotic exploration, and

[55] European Space Agency, "History-Hermes Spaceplane 1987," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/History_Hermes_spaceplane_1987 (accessed 13 April 2013).
[56] Jurgen Brauer, and Hubert P. Van Tuyll, *Castles, Battles, and Bombs: How Economics Explains Military History* (Chicago: University of Chicago Press, 2008), 12.
[57] Brauer, *Castles, Battles, and Bombs*, 17.
[58] Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge: Harvard University Press, 1971), 60.
[59] Brauer, *Castles, Battles, and Bombs*, 17.

space situational awareness. "That space technology is largely dual-use technology creates a plethora of difficulties that permeate political and economic issues."[60]

Two, the largest budget slices happen to occur in earth observation (22.9 percent), navigation (16.6 percent), and launchers (16.0 percent). Those amount to tremendous ability to fund programs, considering the overall budget accounts for four billion Euro.[61] Since these represent optional programs, it stands to reason that each contributing member conducted its own cost-benefit analysis to determine its interest in such activities. Next, the European Space Agency shows evidence in support of the economic principle of substitution.

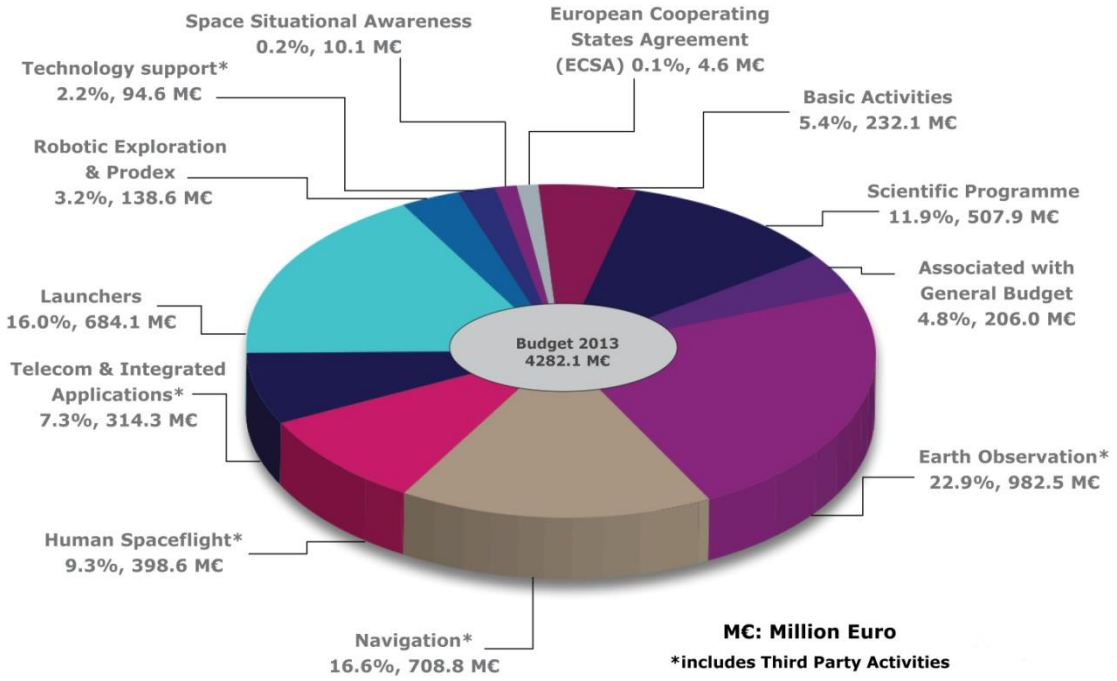

Figure 11: European Space Agency Budget by Domain for 2013

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2013/01/ESA_budget_by_domain_for_2013_M_Million_Euro (accessed 31 March 2012)

[60] Johnson-Freese, *Space as a Strategic Asset*, 49.
[61] European Space Agency, "ESA Presentation April 2013", http://esamultimedia.esa.int/multimedia/publications/ESA-Presentation/offline/download.pdf , 3 (accessed 1 April 2013).

Third, through the act of substitution, alternatives serve to satisfy the needs, wants, or desires of the decision-maker. Generally speaking, when faced with a choice of options, the populace will opt for the opportunity that affords the most comparable benefit when balanced against those of relatively lower price. When a series of options yield largely the same benefit, the choice will favor the one that costs the least. Similarly, if several options come in at a relatively similar price, the verdict will favor the one that provides the most benefits, relative to the subject making the decision. Perfect substitutions completely meet the needs of consumers whereas imperfect substitutions only partially satisfy them. Incentives associated with the economic principle of substitution also play a central role in whether or not the actor partakes in substitution.[62] The European Space Agency's involvement in the Hubble Space Telescope program serves as a sample of evidence for the economic principle of substitution.

After World War Two, scientists seriously began considering space-based optical observation for the advantages it could provide to the scientific community. In his 1946 paper, *Astronomical Advantages of an Extra-Terrestrial Observatory*, Yale professor and researcher Lyman Spitzer explained how the earth's atmosphere does not offer the best opportunity to observe space due to atmospheric distortion. For the concept to transition into reality, the telescope needed to garner support from the National Aeronautics and Space Administration and obtain federal funding. According to the history of the Hubble Space Telescope as told by the National Aeronautics and Space Administration:

> Unfortunately for the program, the large space telescope's total cost was roughly estimated at $400 to $500 million, making it a tough sell. Funding for the telescope was originally denied by the House Appropriations Subcommittee in 1975, but this prompted a large-scale lobbying effort by NASA and leading astronomers, led by Spitzer and John Bahcall, another Princeton astronomer who was also an original proponent of the telescope. The European Space Research Organization (ESRO), later to become the European Space Agency (ESA), was also invited to participate in the project by producing inexpensive solar panels and taking part in observations and research. NASA wanted to take advantage of international cooperation to reduce the overall cost of the program, making it more likely to receive Congressional support. The ESRO accepted the offer in 1975. A mirror reduction from 3 to 2.4 meters helped bring the project down to about $200 million, approximately half the originally expected price tag. The proposal was

[62] Brauer, *Castles, Battles, and Bombs*, 23.

accepted by Congress, which granted the Large Space Telescope program funding in 1977.

The following year, design of the telescope began in earnest, with the award of contracts to the Perkin-Elmer Corporation to construct the mirror and optical assembly and the Lockheed Missiles and Space Company to construct the spacecraft and its support systems. The Europeans were mainly responsible for the solar array that would power Hubble while in orbit.[63]

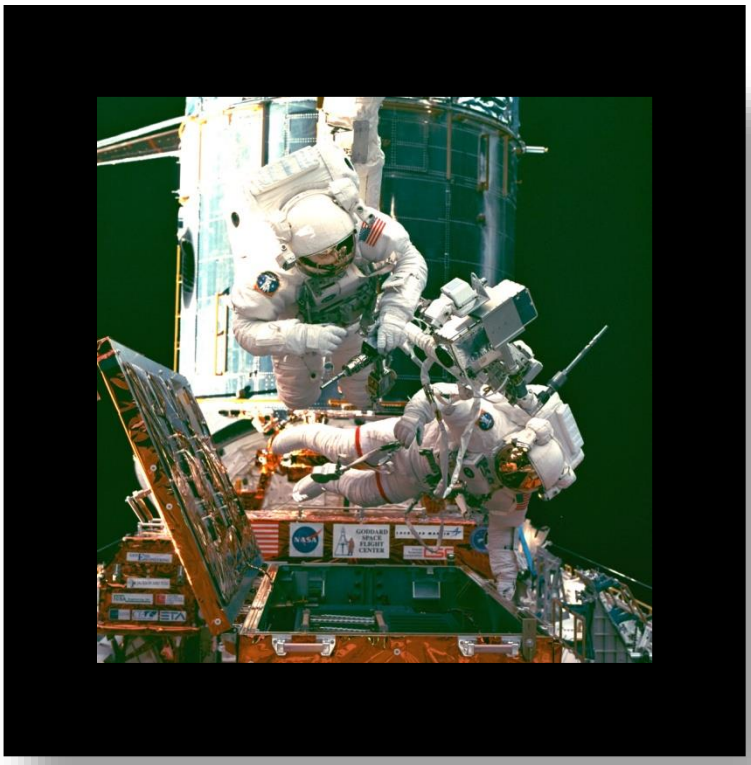

Figure 12: An Extravehicular Activity (EVA) During Space Transportation System (STS)-82, a Servicing Mission for the Hubble Space Telescope (HST)

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2003/07/An_EVA_during_STS-82_a_servicing_mission_for_the_Hubble_Space_Telescope_HST (accessed 13 April 2013). A view of one the Extravehicular Activities (EVA) performed during Space Transportation System (STS)-82, a Space Shuttle mission (Discovery) to service the Hubble Space Telescope (HST). The six-member crew completed servicing and upgrading of the Hubble Space Telescope during four planned EVAs and then performed a fifth unscheduled space walk to repair insulation on the telescope. (11-21 February 1997).

[63] National Aeronautics and Space Administration, "NASA History Division," http://history.nasa.gov/hubble/index.html (accessed 18 March 2013).

As seen from the brief history above, the European Space Agency came into consideration for the Hubble Space Telescope for largely financial reasons, and resulted in the substitution of European participation, contributions, and labor for a portion of the American ones. The division of labor is a form of substitution. "The division of labor arises from a propensity in human nature to exchange. This propensity is found in man alone."[64] The Hubble Space Telescope, launched in April 1990 as a joint, cooperative European Space Agency and National Aeronautics and Space Administration venture to observe the universe in visible, infrared, and ultraviolet light.[65] Still today, these cooperative efforts continue as one nation substitutes labor for the other during continued work on the Hubble when it periodically docks with the International Space Station. The Hubble Space Telescope serves as evidence for substitution in action in the case of the European Space Agency. Next, diminishing marginal returns are considered.

Fourth, with the economic principle of diminishing marginal returns, as an agent increases its total investment, the total return on that investment, as a proportion of the total investment, decreases. The concept of diminishing marginal returns applies to both production and consumption. The Hermes also serves as a sample of evidence for diminishing marginal returns in action.

The fact that the Hermes never physically existed demonstrates the economic principle of diminishing marginal returns in action. This shows in the European Space Agency in both consumption and production. As a consumer, the Hermes drove specifications for the European Space Agency's Ariane 5 launcher, which, in turn, led to an increase in development costs. More specifications and requirements added to the program as it progressed led to increased weight and even more costs. The *Challenger* disaster drove some of the modifications that ran the program into cost overruns.[66] Ultimately, the Hermes faded into oblivion in 1992 when the project was cancelled. No vehicles were ever even built due to the diminishing marginal returns in cost, performance, and time. Next, the research reveals evidence of asymmetric information and hidden characteristics within the European Space Agency.

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[64] Smith, *The Wealth of Nations*, 13.

[65] Baker, *Jane's Space Directory, 2004-2005*, 14.

[66] European Space Agency, "History-Hermes Spaceplane 1987," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/History_Hermes_spaceplane_1987 (accessed 13 April 2013).

Fifth, asymmetric information and hidden characteristics contribute to the decision making process. When one actor has more knowledge about a particular good, service, or situation than another actor, asymmetric information results. Hidden characteristics create information asymmetry as well. On the grand scale, asymmetric information and hidden characteristics can manifest themselves when participants have limited information about the capabilities, limitations, and intentions of others. Regardless of this, decision makers do their utmost to use the best, most accurate information available to shape the expectations they have of others. If decisions occur with too little information or inaccurate information, actors may have a propensity to inefficiently allocate their resources and may have expectations that do not fall in line with the realm of the possible.

Figure 13: Mr. Jean-Jacques Dordain, the Current Director General for the European Space Agency.

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2007/01/ESA_s_Director_General_Mr._J.-J._Dordain_during_the_ESA_Awards_Programme_2005 (accessed 25 March 2013). The European Space Agency's Director General, Mr. Jean-Jacques Dordain during the European Space Agency Awards Program 2005.

Decision-makers do not always process the same information in the same manner as others, and the same decision-maker may not make the same choices in a given scenario if she faces a different contextual situation. "Prejudices, preconceptions, and personal experience cause similarly situated commanders to read the same information differently. No fact exists independent of interpretation."[67] In his *Agenda 2015*, the Director General for the European Space Agency, Jean-Jacques Dordain, touches upon the importance of information-sharing to benefit all.

> **The use of resources between ESA and national agencies and their national programmes must become more systematic**
> ESA is the agency of its Member States and builds on their capabilities in space-related knowhow and technologies. However, Member States' delegations and the Executive do not always work closely together as ONE ESA to reach the strategic goals of Member States. While there are good examples of successful cooperation between national and ESA programmes (such as in scientific missions, the Vega development, EGNOS and Alphabus) these are still far from being systematic and optimal; and substantial difficulties remain in other areas to bring together the objectives of national and ESA programmes. This may be due to a certain lack of dialogue, a lack of trust among the different actors around the ESA table, and the unbalance among national programmes.
>
> However, especially now, the competitiveness of Europe requires using all existing competences, starting with those from ESA and national agencies. The consequences of the economic crisis on public budgets make current inefficiencies unaffordable and should therefore be taken as an opportunity to make such cooperation systematic.[68]

From the above guidance, it seems apparent that the Director General understands the importance of uncovering asymmetric information and hidden characteristics so that the institution can function more effectively as one, united, European Space Agency, fostering trust, faith, and confidence among its members. This, as he highlights, becomes ever more imperative when put into the context of competition, economic crisis, and inefficiencies. As such, the Director General's vision up through 2015 captures the essence of asymmetric information and hidden characteristics. Next, another form of asymmetric information comes to bear with hidden actions and incentive alignments.

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[67] Brauer, *Castles, Battles, and Bombs*, 195.
[68] Jean-Jacques Dordain, *Agenda 2015* (Noordwijk: ESA Publications Division, 2011), 10.

Sixth, hidden actions and incentive alignments serve as a final economic principle as evidence. When parties enter into agreements, they become subject to hidden actions if a lack of transparency exists after they have already entered into agreements, as noted in Chapter Two. In order to minimize hidden actions, participants must engage in their activities with integrity when accomplishing their agreed-upon actions and commitments so that all parties involved can adjust their efforts or incentives accordingly. In effort to maintain honesty in action, incentives can help encourage working rather than shirking. Actors may choose to shirk, or evade, work if they do not feel that the incentives from other actors line up appropriately, or do not provide compensation commensurate with their efforts. A decision maker may opt for the use of contracts and agreements to help mitigate hidden actions. In his book, *Freedomnomics : Why the Free Market Works and Other Half-baked Theories Don't,* John Lott reinforces this idea when discussing the ideas posed by Adam Smith in *The Wealth of Nations.*

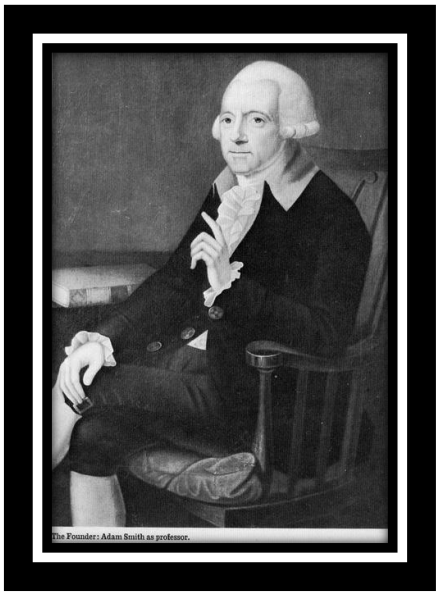

Figure 14: Adam Smith

Source: Google Images, "Adams Smith Image Search", http://www.google.com/search?q=adam+smith&hl=en&source=lnms&tbm=isch&sa=X&ei=az5vUf_SIpTs8gTwm4HwCw&ved=0CAoQ_AUoAQ&biw=1440&bih=732 (accessed 15 April 2013)

> Altruism is a noble quality-but in a large economy, it only goes so far. Adam Smith had it right: individuals, by pursuing their own self-interest, enrich society. Smith understood the fundamental principle of economics: when you make something more costly, people will do less of it. In other words, incentives matter.

> Studying the incentives that underlie our everyday decisions shows us that economic, criminal, and political policies work best when they direct individuals' natural motivations toward a common good. These are policies that allow people the freedom to profit from their own work, that create meaningful and fair disincentives to committing crimes, and that carefully consider what factors encourage people to participate in our democracy by voting.[69]

With reference to the European Space Agency, participation in the International Space Station serves as an example of hidden actions and incentive alignment. As a mammoth partnership and cooperative effort, the International Space Station relies upon the unity and collaboration of the United States, Russia, Japan, Canada, and Europe. "Europe's two key contributions are the Columbus laboratory and the Automated Transfer Vehicle (ATV). Columbus provides a substantial part of the ISS's research capability, specialising in fluid physics, materials science and life sciences. Europe has also provided almost 50% of the pressurised part of the ISS, including Cupola, Node-2 and Node-3."[70] Clearly, when the lives of astronauts are at stake along with other national treasures, no members can afford to be anything less than forthright in their actions. There is little room for hidden actions and everyone ought to act as an honest broker. As an incentive to acting with transparency, the nations earn more contracts for additional work as well as continued benefit from the research, applications, and human discoveries made by the international team of astronauts and ground personnel. The European Space Agency's involvement in the International Space Station serves as evidence of the last economic principle of hidden action and incentive alignment. Next, evidence of the principal-agent theory in practice comes for consideration.

Evidence of Principal-agent Theory in Practice

Finally, when pondering events that occur in relationships based upon cooperation and partnership, it is prudent to consider how the principal-agent theory comes into practice. The principal gives an order, or makes a request, that the agent thereafter receives or carries out. This framework helps to explore problems of agency where

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[69] John R. Lott, *Freedomnomics: Why the Free Market Works and Other Half-baked Theories Don't* (Washington, DC: National Book Network, 2007), 193.

[70] European Space Agency, "ESA Presentation April 2013", http://esamultimedia.esa.int/multimedia/publications/ESA-Presentation/offline/download.pdf , 30 (accessed 1 April 2013).

political or economic actors in a superior position control or leverage the political or economic actors subordinate to them.[71] For the principal-agent relationship to work most effectively and efficiently, methods to monitor, reward, and punish the agent for working or shirking ought to exist. In general, the incentives that motivate the principal as opposed to the agent vary.[72] In the case of the European Space Agency, the Cosmic Ray Satellite, Option B (Cos-B) project serves as an example of principal-agent theory in practice in a cooperative environment.

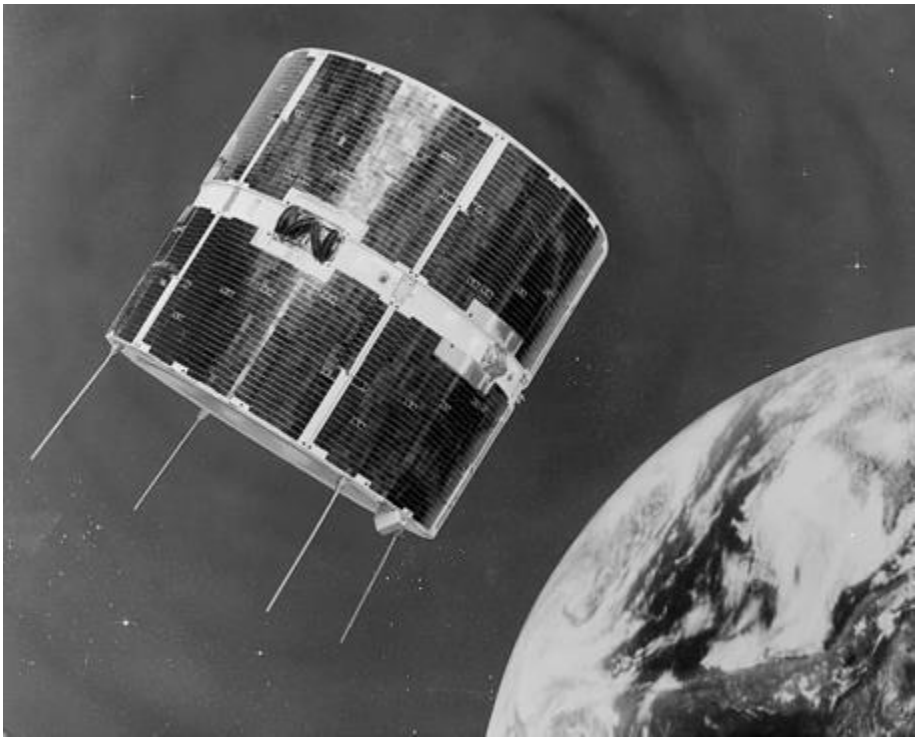

Figure 15: The COS-B Satellite

Source: J. Krige, and A. Russo, A History of the European Space Agency 1958 – 1987 (Noordwijk: ESA Publications Division, 2000), 194.

The Cos-B satellite's service life spanned 9 August 1975 to 25 April 1982. During this time, "it provided the first complete map of the Galaxy in gamma-rays" as it lived well beyond its two-year life expectancy. The satellite, along with the SAS-22 satellite of the National Aeronautics and Space Administration, provided the first detailed

[71] Peter D. Feaver, *Armed Servants: Agency, Oversight, and Civil-Military Relations* (Cambridge: Harvard University Press, 2003), 12.
[72] Feaver, *Armed Servants*, 59.

views of the Universe in Gamma-rays.[73] Additionally, the Cos-B was one of sixteen scientific satellites attributed to the European Space Agency from 1967 to 1989.[74] Unlike many satellites launched today, the Cos-B carried only one experiment, the Gamma-Ray Telescope, which it used for mapping the galaxy's gamma ray signatures. The responsibility of this satellite fell to the Caravane Collaboration, a group of European research laboratories collaborating through the European Space Agency.

Laboratory	Group leader	Hardware
Centre d'Etudes Nucléaires, Saclay, France	J. Labeyrie	Anti-coincidence counter
Max-Planck-Institut für Extra-terrestrische Physik, Garching, Germany	R. Lüst	Spark chamber
Space Science Department, ESTEC, Noordwijk, Netherlands	E. Trendelenburg	Triggering telescope
Huygens Laboratory, University of Leiden, Netherlands	H. van de Hulst	Energy calorimeter
Instituto di Fisica, Università di Milano, Italy	G. Occhialini	Experiment electronics
Istituto di Fisica, Università di Palermo, Italy	L. Scarsi	Pulsar synchronizer

Table 4: The Caravane Collaboration for the COS-B satellite

Source: Adapted from the European Space Agency. Krige, A History of the European Space Agency 1958 – 1987, 246.

The Caravane Corporation pursued science by leveraging its internal relationships amongst member nations. Oftentimes, people enter into principal-agent relationships to meet the needs of others and as a result of self-interest to compete for the benefits of

[73] National Aeronautics and Space Administration, "The Cos-B Satellite," http://heasarc.gsfc.nasa.gov/docs/cosb/cosb.html (accessed 18 February 2013).
[74] Baker, *Jane's Space Directory, 2004-2005*, 476.

money, prestige, or time.[75] In the case of Cos-B, France, Germany, the Netherlands, and Italy combined efforts and hardware to create the scientific coalition which led to the creation, launch, and success of the Cos-B satellite. In this case, each member could serve as a principal in the agreements and requirements they had with the representatives from the other hardware contributors. At the same time, they each fall into agent status relative to their contribution to the other members as well as to meeting the needs of the European Space Agency principal.

In conclusion, this chapter has scoured the evidence available for the Europeans Space Agency to provide samples of international relations theory, economic theory, and principal-agent theory in practice within the cooperative space arena. Next, Chapter Four will delve into the analysis of the evidence provided herein.

[75] Lott, *Freedomnomics*, 13.

Chapter 4

Analysis

> *Strategy, in its simplest form, is a plan for attaining continuous advantage. For the goal of strategy is not to culminate events, to establish finality in the discourse between states, but to influence states' discourse in such a way that it will go forward on favorable terms.*
>
> - Everett Dolman
> *Pure Strategy*

This research investigation began in Chapter One with posing two key questions to highlight the problem at hand. Does strategic partnering in space benefit the United States? Does it benefit America's strategic partners? Chapter Two set forth the theoretical framework used for the continued investigation. International relations theory, economic theory, and principal-agent theory serve to guide the research. The European Space Agency case study in Chapter Three serves as a body of evidence to provide examples of each of these theories in practice for international space cooperation and partnership. Now, the research comes to its most important point—analysis. The importance of discovering if strategic partnering and cooperation in space appears beneficial cannot be overemphasized in a world that continues to trend toward globalization and would appear to lend itself to such enterprise.

The continued investigation would prove remiss in its endeavors without first clarifying what actually defines a partnership, or cooperative effort, as strategic. To enable discovery of this critical delineating factor, this research proceeds using the definition offered by Dolman, as stated in the opening to this chapter. To that end, for the remainder of the investigation process, a partnership or cooperative effort will appear strategic in nature if it affords the actors a continuous advantage, or if it serves to influence the actors to proceed on favorable terms. Using the above definition for strategy, this chapter will analyze the evidence from the European Space Agency case study, discuss conclusions drawn from the data, voice implications drawn from the same, and make recommendations for the future, when appropriate.

Analysis of International Relations Theory Evidence

The idea that cooperation and partnership can even exist in a world viewed through the lens of realism seems counterintuitive. However, going beyond a superficial look, the European Space Agency demonstrates aspects of realism. Even though this agency exists as a conglomeration of nations that agree to participate for mutual benefit, the bulk of the institution appears as optional programs, which serve as evidence of realism in practice for the organization. When viewing the European Space Agency as a product of its budget, the true realist nature of the organization comes to light. Recall that the optional programs fall into these seven categories: human spaceflight, telecommunications and integrated applications, earth observation, launchers, navigation, robotic exploration, and space situational awareness. With these categories in mind, and looking at the budget pie of the European Space Agency, the most intriguing information comes to light. Analysis of the budget shows that a whopping 75.5 percent of the budget relates to optional programs.

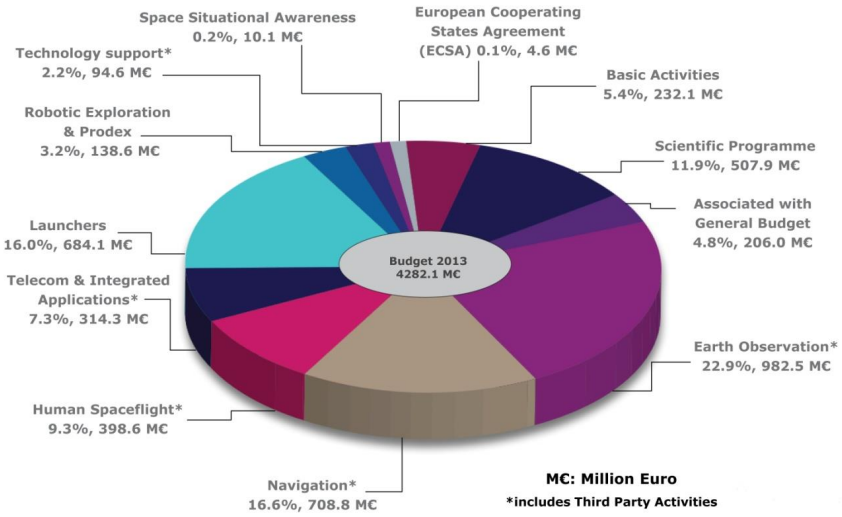

Figure 16: European Space Agency Budget by Domain for 2013

Source: European Space Agency, "Space in Images," http://spaceinimages.esa.int/Images/2013/01/ESA_budget_by_domain_for_2013_M_Million_Euro (accessed 31 March 2012)

With that evidence at hand, why does strategic partnering in space benefit the United States? From the point of view of a realist, strategic partnering in space would benefit the United States because it has the potential to put the nation in an advantageous position, gaining economic influence, political sway, power, and security relative to other nations if it followed the same model as the European Space Agency's optional programs. Currently, the top enduring interest of the United States, as outlined in the *2010 National Security Strategy of the United States of America*, appears with a realist bent: "The security of the United States, its citizens, and U.S. allies and partners."[76]

From the same vantage point of realism, however, strategic partnering in space could not benefit the United States. This perspective appears when considering the dual-use nature of space technology.

> Whether recognized and appreciated or not, space and space-related technology is a part of everyday life for people in the United States, and increasingly for others around the world as well. Because space technology is dual use, however, other countries' craving for the benefits to be yielded from space creates great concern for the United States. Most recently, those concerns have been dealt with by trying to deny technology to others, while developing more and more technology ourselves, especially in the military realm. Attempts at such a denial in a globalized world, however, are increasingly fruitless. And in attempting to hoard technology while simultaneously expanding its own military space capability, the United States only increases others' desire and determination to acquire the technology that the United States clearly values. Technology denial and hoarding is also seen as part of a pattern by the United States to hold back the development of other countries.[77]

So, the realist would ultimately conclude that while the United States should engage in building alliances in space for its continuous advantage, it should proceed with caution so as to never do so at the risk of national defense. Adam Smith noted that the state ultimately has superiority over private enterprise when it comes to the defense of the nation.[78] Given this postulate, in combination with consideration of the dual-use nature of space technology, any actor engaging in partnerships or cooperation in space, in an effort to seek advantage, needs to do so in a well-informed manner.

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[76] President Barack H. Obama, *2010 National Security Strategy of the United States of America*, (Washington, DC: White House Publishing, 2010), 7.
[77] Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 49, 50.
[78] Davis S. Landes, *The Wealth and Poverty of Nations: Why Some Are So Rich and Some So Poor* (New York: W.W. Norton, 1999), 520.

How does strategic space cooperation benefit America's strategic partners given the realist view? Again, referring back to the idea of the European Space Agency's optional program model, partners really only engage in optional programs for their personal benefit. "The natural effort of every individual to better his own condition, when suffered to exert itself with freedom and security, is so powerful a principle, that it is alone, and without any assistance, not only capable of carrying on the society to wealth and prosperity, but of surmounting a hundred impertinent obstructions with which the folly of human laws too often encumbers its operations; though the effect of these obstructions is always more or less either to encroach upon its freedom, or to diminish insecurity."[79] Next, the analysis moves on, taking a liberal perspective to strategic space partnership.

As one would expect of an international institution, the European Space Agency's mere existence stems from liberal ideals. The *Convention for the Establishment of a European Space Agency & ESA Council Rules of Procedure* rings with themes that hail from the lens of liberalism. "The purpose of the Agency shall be to provide for and to promote, for exclusively peaceful purposes, cooperation among the European States ... by concerting the policies of the Member States with respect to other national and international organizations and institutions."[80] As averred in Chapter Two, liberalism's themes and concepts include the idea that institutions will alleviate the tendency to go to war, making war obsolete, and that cooperation will advance all members' positions.

Liberal notions of complex interdependence and cooperation appear in the general membership of the European Space Agency as well. States that wish to attain member status need to contribute the same percentage of their Gross National Product as others. This money funds mandatory programs including the general budget, future studies, technological research, education, common investments, and science. The general budget funds the sustainment of internal functioning as well as research and development, and

[79] Adam Smith, *The Wealth of Nations* (New York: Random House, 1937), 508.
[80] European Space Agency, *Convention for the Establishment of a European Space Agency & ESA Council Rules of Procedure* (Noordwijk: ESA Publications Division, 2003), 10.

others serve to foster basic technology, explore new avenues, and to achieve excellence.[81] These programs, funded by all, benefit all.

From the liberal view, why would the United States benefit from strategic partnerships in space? The President has already directed the nation to engage in cooperative efforts by expanding international science partnerships. Since space technology's survival depends upon science, a fair connection emerges between the President's direction and the need to engage in these partnerships. Therefore, asking why the nation would benefit appears less important than figuring out how to make it beneficial since the nation will participate in this way. "America's scientific leadership has always been widely admired around the world, and we must continue to expand cooperation and partnership in science and technology. We have launched a number of Science Envoys around the globe and are promoting stronger relationships between American scientists, universities, and researchers and their counterparts abroad. We will reestablish a commitment to science and technology in our foreign assistance efforts and develop a strategy for international science and national security."[82]

Additionally, in consideration of the liberal view, the nation has already benefitted from building alliances within space to achieve an advantage. The birth of the National Aeronautics and Space Administration originated from the Space Act of 1958, whose purpose stems from highly liberal views to engage in cooperation with other nations and groups for peaceful purposes.[83]

> International cooperation has been a fundamental part of NASA since the agency was formed in 1958. Over the years, NASA has signed more than 1,200 agreements with more than 135 countries and international organizations. This cooperation ranges from shared scientific data and joint research to construction of space hardware and orbital rendezvous, like the Apollo-Soyuz docking in 1975 and visits of Space Shuttles to the Russian Mir space station, which began in 1995.
>
> The International Space Station is one of the largest high-tech cooperative ventures ever, with formal participation by the United States, Russia, Canada, Japan and 11 nations of the European Space Agency and Brazil.

[81] European Space Agency, Industrial Matters Department – PFL-I, "Principles of Industrial Policy, Practices, Procurement Rules and Procedures." Bratislava, Slovak Republic, January 6, 2012.
[82] President Obama, *2010 National Security Strategy of the United States of America,* 31.
[83] National Aeronautics and Space Administration, "National Aeronautics and Space Act of 1958 (Unamended)," http://history.nasa.gov/spaceact.html (accessed 18 April 2013).

> Joint programs allow each country to contribute its individual expertise. They also foster an increased understanding of different cultures, leading to more peaceful and productive relations between the people of the countries as a whole. In many cases, the pooled resources and shared funding inherent in most international cooperation enable missions that would be too difficult or too costly for nations to accomplish individually.[84]

From the liberal viewpoint, cooperation benefits all of those involved, although not necessarily to the same extent. Participating in space partnerships can benefit strategic partners by offering an advantageous position scientifically, politically, economically, and socially as indicated by the narrative above. The implications of engaging in such cooperation include an increased need to understand one's own capabilities and limitations so that participants can seek to maximize the intent of the cooperative institution for their continued advantage. Next, the concept of space partnering will appear through the world view of the constructivist.

The world we live in results from the beliefs, perceptions, and actions taken by humankind. Whatever condition the world appears results from the decisions and perceptions of the people that shape it. Their decisions and perceptions are in turn shaped by the world around them, in a continuous process. These tenets set the foundation for the constructivist world view. Within the European Space Agency, the Council serves as evidence of this theory in practice. This governing body of the European Space Agency provides the basic policy guidelines for participants' behaviors and activities. The institution can change depending upon how the Member States vote on various topics to include the pursuit of activities, and the allocation of financial resources.

Based upon the evidence above, the United States would benefit from taking a constructivist approach to strategic space partnerships because it implies that the world arena appears as a result of the collective decisions of the people within it. This means the United States could have significant influence in shaping the partnerships it engages. Again, President Obama has recognized the world according to constructivists, and he recommends taking a proactive, rather than reactive approach, accordingly.

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[84] National Aeronautics and Space Agency, "Frequently Asked Questions," http://www.nasa.gov/centers/kennedy/about/information/general_faq.html#13 (accessed 13 March 2013).

> In the past, the United States has thrived when both our nation and our national security policy have adapted to shape change instead of being shaped by it. For instance, as the industrial revolution took hold, America transformed our economy and our role in the world. When the world was confronted by fascism, America prepared itself to win a war and to shape the peace that followed. When the United States encountered an ideological, economic, and military threat from communism, we shaped our practices and institutions at home—and policies abroad—to meet this challenge. Now, we must once again position the United States to champion mutual interests among nations and peoples.[85]

On the other hand, the United States would not benefit from involvement in strategic space partnerships based upon a constructivist view if its voice was not loud enough to meet with the majority. While partnership does imply sharing in an action or endeavor, it does not indicate a required percentage of participation from members, nor an equal sharing amongst them. Referring back to the case of the European Space Agency's Council, each Member State has one vote in issues that come up at the meetings, which only occur every three years. If the United States engages in space partnerships based upon this model, its influence may fall into the minority vote, thereby putting it in a position that does not afford it the strategic advantage that it sought to begin with.

In the same vein, the strategic space partners of the United States would stand to benefit or not benefit from constructivist engagements in the same fashion as noted above. This condition results from the limitations associated with the constructivist view. As indicated in Chapter Two, this view gives individual perceptions and thoughts more power and influence than they truly deserve in the grand global scale. Actors are only capable of truly knowing themselves. Also, the socially constructed view of the world falls to the majority, and does not cover the reality that everyone perceives.

Upon reflection of the evidence and analysis, it appears that none of these international relations theories completely help explain why the United States would benefit from strategic space partnerships or cooperation by themselves. Looking at the world as an absolute from any of these three lenses has explanatory power in discovering why people behave the way they do in extremes. The most informative view, however, comes not from seeing them as binary conditions. As the European Space Agency case-

[85] President Obama, *2010 National Security Strategy of the United States of America*, 9.

study evidence has suggested, people can see what they choose to see. Assuming the world consists of rational actors engaging in government behavior and international relations, the best way to proceed comes from having the most well-informed view. [86] This comes from understanding all the views and acting, or reacting, within the partnerships in order to maximize the advantage gained by participating in such endeavors. Now, the analysis turns toward the realm of economic theory.

Analysis of Economic Theory Evidence

When rational actors engage in their decision making calculus, they consider economic principles that will result in maximizing the value they can expect from the decision they make. For the most part, this process occurs implicitly rather than explicitly. Value comes from purposely looking at specific economic principles decision-makers may factor into the calculus of the decisions they make. This section of the investigation analyzes the following six economic principles: opportunity cost, expected marginal costs and benefits, substitution, diminishing marginal returns, asymmetric information and hidden characteristics, and hidden actions and incentive alignments.

First, the European Space Agency forfeited other programs in order to fund Hermes, the spaceplane that eventually got cancelled. Although the investigation into the European Space Agency did not directly reveal programs denied or postponed as a result of the choice to fund the Hermes, one could safely infer that such cases occurred. The program's initial proposal came in 1975, followed by its approval in 1987, and eventual termination in 1992. The termination of the program meant, at least for the time being, that Europe would not have independent, manned access to space.

> The program's $530-million 'Phase 1' detailed definition lasted from March 1988 to February 1990. Crew safety and unplanned weight growth were major problems. The designers initially considered a Crew Escape Module that would have cost 400 million ESA Accounting Units (MAU), then looked at smaller 50-MAU encapsulated ejection seats derived from German 'Mikroba' capsules. ESA finally settled for ordinary ejection seats instead of an ejectable cabin, although they would not be able to save a crew above 22-29km altitude.

[86] Graham T. Allison, and Philip Zelikow, *Essence of Decision: Explaining the Cuban Missile Crisis* (New York: Longman, 1999), 26.

> By late 1990 the Germans wanted to leave the French-led Hermes program, but this was easier said than done because the primarily German MTFF program would not be feasible without its Hermes 'space taxi.' In December 1988, ESA decided to move some systems into an expendable aft-mounted docking module that would be jettisoned before returning to Earth. The new design was smaller and lighter, but the marginal cost per launch would be higher due to the expendable components.
>
> At the end of Phase 1, ESA decided to delay the formal go-ahead for the Phase 2 program to July 1991. By this time the project was estimated to cost $4.5 billion and was employing 1,500 persons. France contributed 43.5% of the funding, followed by Germany at 27% and Italy at 12.1%.[87]

Considering the facts above regarding dollars, personnel, and time invested, it seems fair to conclude that these expenditures came at a cost of other things. As indicated previously, however, investigation did not yield any specific data to verify this claim. "Anything you do involves giving up the opportunity of doing something else. That is the opportunity cost. The principle of opportunity cost is at once easy to understand and difficult to apply, in part because the values assigned to alternative courses of action vary from person to person."[88]

In light of opportunity costs as evidenced by the European Space Agency, why would the United States benefit from strategic space partnerships? Another enduring American interest appears to be, "A strong, innovative, and growing U.S. economy in an open international economic system that promotes opportunity and prosperity."[89] In order to gain and maintain economic prosperity, the United States authorized the transition of Global Positioning System from a military-only to a dual-use technology. The opportunity cost associated with this resulted in the military giving up any asymmetric advantage it may have had. This system now serves as a collective good that does bring the United States, and others, a large economic advantage. "A collective good is, by definition, such that other individuals in the group cannot be kept from consuming it once any individual in the group has provided it for himself."[90] So, while the United

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[87] *Encyclopedia Astronautica*, "Hermes," http://www.astronautix.com/craft/hermes.htm (accessed 30 March 2013).
[88] Jurgen Brauer, and Hubert P. Van Tuyll, *Castles, Battles, and Bombs: How Economics Explains Military History* (Chicago: University of Chicago Press, 2008), 49.
[89] President Obama, *2010 National Security Strategy of the United States of America*, 7.
[90] Mancur Olson, *The Logic of Collective Action: Public Goods and the Theory of Groups* (Cambridge: Harvard University Press, 1971), 35.

States may give up opportunities so that it can provide services to its partners, it may also gain opportunities to perform other actions when its partners act as providers.

Those who choose to engage in strategic space partnership with the United States, as well as those who do not, can ultimately benefit. The Department of Defense, in an effort to meet with the enduring interests of the nation, seeks to assure access of the global commons and globally connected domains, to include space.[91] Since the United States has committed to this mission, others will benefit from the freedom of maneuver afforded by such commitments since their opportunity costs to protect the same environment will be less than if they had to secure it themselves. Next, analysis will move to expected marginal costs and benefits.

When rational people make decisions, they consistently seek to maximize the value associated with their choices.[92] Performing cost-benefit analysis enables actors to predict the outcome that will have the largest benefit at the lowest cost. In the case of the European Space Agency, its Budget by Domain for 2013 reflects cost-benefit calculations for fiscal expenditures. As noted previously, optional programs account for 75.5 percent of the budget. This proves important because it shows a limitation of this study. It only shows the costs and benefits to those Member States that can afford and opt to participate in those optional programs. It does not reflect the cost-benefit of the European Space Agency as a whole institution. Additionally, it relates only to fiscal cost, benefit, and economic incentives. Other non-tangible costs and benefits include things such as respect, friendship, prestige, and time.[93]

Using this evidence, the United States would either benefit or not benefit from strategic space partnerships based upon the cost-benefit analysis of its leaders. When actors marshal resources for a particular project, program, or situation, they have a level of dissonance that corresponds to the investment they made. This, consequently, increases their level of commitment to those events.[94] A large investment of resources equates to an increased expectation and value. Recalling that space technology largely

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[91] Michael G. Mullen, *2011 National Military Strategy of the United States of America* (Washington DC: Department of Defense, 2011), 33.
[92] Allison, *Essence of Decision*, 18.
[93] Olson, *The Logic of Collective Action*, 60.
[94] Robert Jervis, *Perception and Misperception in International Politics* (Princeton: Princeton University Press, 1976), 393.

appears as dual-use, "What technology should the United States attempt to control? There are two basic answers: either everything that has potential military value should be controlled, or the United States must accept that it cannot control everything and should build high fences around small areas of especially critical technology over which it retains a monopoly (such as stealth technology)."[95] In performing cost-benefit analysis with regard to strategic space partnership, the United States ought to promote cooperation, so long as its benefit does not come at the cost of national security.

How can strategic space partners of the United States benefit? President Obama declared, "We will promote appropriate cost-sharing and risk-sharing partnerships to develop and share capabilities. Decisions on partnering will be consistent with U.S. policy and international commitments and consider cost, protection of sources and methods, and effects on the U.S. industrial base."[96] This means that partners may share in common interests, objectives, and opportunities, which in itself may prove beneficial. Contrarily, it also means that they need to prepare themselves to share in the challenges, and risks that may flow from the second-and third-order effects of cooperation. Next, the principle of substitution receives analysis.

In substitution, a person or thing can act or serve in the place of another. Generally speaking, any partnership or cooperative endeavor benefits the individual because the partner, or partners, serves as a substitute for individuals having to accomplish all of their desired tasks themselves. The European Space Research Organization, the precursor to European Space Agency served in the role of substitution for the development, procurement, and operations of the Hubble Space Telescope. This cooperative endeavor benefitted nations involved since it allowed their scientists to gain experience and conduct research, as well as giving jobs to bolster member's economies.

This evidence, by its very nature, demonstrates direct strategic advantage gained by the United States in space cooperation. Why did the nation benefit from this arrangement? With an estimated cost of $400 million to $500 million, The House Appropriations Subcommittee denied Hubble's funding in 1975. In an effort to ensure

[95] Johnson-Freese, *Space as a Strategic Asset*, 47.
[96] Robert M. Gates, and James R. Clapper. *2011 National Security Space Strategy of the United States of America*. (Washington DC: Department of Defense and the Office of the Director of National Intelligence, 2011), 9.

the survival of the program, suitable substitutes for some of the associated costs of attaining the program were sought. The European Space Research Organization emerged as an appropriate substitute, leading to Congressional approval in 1977 to proceed with the project.

This evidence shows how strategic partners benefit from space cooperation as well. As a result of the substitution principle, Europeans gained, and continue to gain, through participation, contributions, research, education, and division of labor that brought, and brings, wealth to their nations. The Hubble Space Telescope continues to serve as a stellar example of successful substitution. For partners that decide to engage with the United States via substitution, benefits will result. "The Department, through the implementation of priorities from the Space Posture Review, will explore opportunities to leverage growing international and commercial expertise to enhance U.S. capabilities and reduce the vulnerability of space systems and their supporting ground infrastructure. The Department will broaden and deepen relationships with other nations and private firms to create mutually beneficial partnerships to share capabilities, systems, technology, and personnel, while ensuring that we also protect sensitive sources and methods."[97] The idea of sharing capabilities, systems, technologies, and personnel reflects the economic principle of substitution. Next, the study considers diminishing marginal returns.

Initially, the investment an actor puts into something yields a significant return. Diminishing marginal returns suggests that the more and more an actor invests the smaller and smaller the yield from that investment becomes as time goes on. The Hermes spaceplane project pursued by the European Space Agency serves as evidence of this principle in action. In 1985, the initial total program cost estimate came in at $1.9 billion. By 1990, this cost had inflated to $4.5 billion. Still, by November of 1991, estimates ballooned to $7.7 billion plus $4.6 billion for its Ariane-5 launch vehicle.[98] The new total of $12.3 billion resulting from requirements creep no longer seemed worthy of the investment. Consequently, due to decisions based upon the economic principle of diminishing returns, the program got the axe.

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[97] Robert M. Gates, *2010 Quadrennial Defense Review Report* (Washington DC: Department of Defense, 2010), 33.
[98] *Encyclopedia Astronautica*, "Hermes," http://www.astronautix.com/craft/hermes.htm (accessed 30 March 2013).

Considering the evidence of diminishing marginal returns, why would the United States benefit from strategic space partnerships? Acting as a rational actor, the nation would benefit because cooperative behavior proves appropriate to the goals specified by national leadership given the current global context.[99]

> Our economic institutions are crucial components of our national capacity and our economic instruments are the bedrock of sustainable national growth, prosperity and influence. The Office of Management and Budget, Departments of the Treasury, State, Commerce, Energy, and Agriculture, United States Trade Representative, Federal Reserve Board, and other institutions help manage our currency, trade, foreign investment, deficit, inflation, productivity, and national competitiveness. Remaining a vibrant 21st century economic power also requires close cooperation between and among developed nations and emerging markets because of the interdependent nature of the global economy. America—like other nations—is dependent upon overseas markets to sell its exports and maintain access to scarce commodities and resources. Thus, finding overlapping mutual economic interests with other nations and maintaining those economic relationships are key elements of our national security strategy.[100]

Space contributes greatly to national capacity and economic instruments, so it is therefore important to engage in cooperative space partnerships that do not lead to diminishing marginal returns to the extent as evidenced in the case of Hermes. In order to safeguard against this, the United States ought to continuously assess the amount of effort it invests into the cooperative efforts and review the returns to look for continued advantage. If diminishing marginal returns begin to appear, the United States needs to reposture to put itself back into a position that offers a continuous advantage. "It is frequently argued that values and the resulting goals are treated as constraints in complex decision-making. Rather than engaging in trade-offs, an actor strives to insure that he does not fall below some minimum level on any of his goals."[101]

Having an awareness of diminishing marginal returns will benefit strategic partners of the United States as well. According to national guidance, economic power requires close cooperation between and among developed nations and emerging markets

[99] Allison, *Essence of Decision*, 17.
[100] President Obama, *2010 National Security Strategy of the United States of America*, 15.
[101] Jervis, *Perception and Misperception in International Politics*, 129.

because of the interdependent nature of the global economy. Assuming that part of the global economy stems from space, partners working with the United States can be assured that the nation pays particular attention to these considerations since they serve as key elements of its national security strategy. Next, asymmetric information and hidden characteristics provide an element of cooperation.

The world presents us with great uncertainties. When two or more actors engage with one another, asymmetric information and hidden characteristics naturally result. In order to put oneself into a position of continuous advantage in a world of unknowns, people must seek information, communicate, and question their perceptions, and assumptions. By doing so, they will see the world with more accuracy, thereby enabling better decision-making. Director General Jean-Jacques Dordain of the European Space Agency recognized this and set out guidance accordingly. Realizing his organization lacks synergy, he attributes inefficiencies essentially with asymmetric information and hidden characteristics by recognizing a "lack of dialogue, and lack of trust among the different actors around the ESA table, and the unbalance among national programmes."[102] He continues to identify these behaviors as a threat to Europe's competitiveness, economic status, and efficiency if they do not get addressed.

The United States would benefit by figuring asymmetric information and hidden characteristics into its calculus for engaging in strategic space partnerships. However, "by sharing or exchanging capabilities, data, services, personnel, operations, and technology, we can ensure access to information and services from a more diverse set of systems – an advantage in a contested space environment."[103] To reap the maximum advantage, the United States needs to minimize asymmetric information and unveil the hidden characteristics of its partners. On the other hand, the United States needs to measure the advantage lost by divulging its own information and presenting hidden characteristics forthright for the sake of transparency.

Addressing asymmetric information and hidden characteristics benefits strategic partners of the United States as well as the United States itself. "Expectations or perceptual sets represent standing estimates of what the world is like and therefore, of

[102] Jean-Jacques Dordain, *Agenda 2015* (Noordwijk: ESA Publications Division, 2011), 10.
[103] Gates, *2011 National Security Space Strategy of the United States of America*, 8.

what the person is likely to be confronted with. In everyday life, in the interpretation of other states' behavior, and in the scientific laboratory, expectations create predispositions that lead actors to notice certain things and to neglect others, to immediately and often unconsciously draw certain inferences from what is noticed, and to find it difficult to consider alternatives."[104] By reducing the amount of inference and guessing a partner needs to do, the cooperative effort can move forward unhindered and without delay that may result from misunderstandings or misperceptions. Finally, the hidden actions and incentive alignments serve as evidence for strategic space partnering.

If a partnership lacks transparency, hidden actions may result. Participants acting with integrity perform actions based upon their agreements. By aligning incentives to match the required performance, the actors reduce the likelihood of hidden actions and increase the likelihood of honest effort and action to accomplishing the mission rather than shirking. The European Space Agency's cooperative effort in the International Space Station serves as an example of hidden actions and incentive alignments. The agency's collaborative efforts with the United States, Russia, Japan, and Canada led to the successful construction, operation, and maintenance of the station. The specifics associated with the incentives provided to the participants are not revealed. Based upon the European Space Agency's contributions of the Columbus laboratory and the Automated Transfer Vehicle, the assumption follows that they acted in an honest manner since the life of astronauts relies upon people performing the actions agreed upon, to the standards required for the sustainment of human life. Also, my research did not explicitly indicate what incentives result from these cooperative efforts. Even so, one could infer that the following incentives come from this unique strategic space partnership: award of contracts, research authorizations, use of applications, sharing of human discoveries, and diplomatic alliance.

Why would the United States benefit from strategic space partnerships when considering hidden actions and incentive alignments? International cooperation "is inherently competition-driven ... Cooperation breeds cooperation, and however it is

[104] Jervis, *Perception and Misperception in International Politics,* 145.

achieved, it is valuable." [105] International cooperation itself can serve as an incentive to try to mold the behavior of other nations. As outlined in the *2010 National Security Strategy of the United States of America,* "respect for universal values at home and around the world" appears as an enduring interest for the nation.[106] Consequently, this allows for the United States and other nations to deny China an opportunity to participate in the International Space Station based upon the Chinese tendency to violate human rights.[107] From a more global scale, the President has reiterated the need to leverage and grow the nation's space capabilities.

> For over 50 years, our space community has been a catalyst for innovation and a hallmark of U.S. technological leadership. Our space capabilities underpin global commerce and scientific advancements and bolster our national security strengths and those of our allies and partners. To promote security and stability in space, we will pursue activities consistent with the inherent right of self-defense, deepen cooperation with allies and friends, and work with all nations toward the responsible and peaceful use of space. To maintain the advantages afforded to the United States by space, we must also take several actions. We must continue to encourage cutting-edge space technology by investing in the people and industrial base that develops them. We will invest in the research and development of next-generation space technologies and capabilities that benefit our commercial, civil, scientific exploration, and national security communities, in order to maintain the viability of space for future generations. And we will promote a unified effort to strengthen our space industrial base and work with universities to encourage students to pursue space-related careers.[108]

By pursuing the policy outlined above, the United States serves as a beneficial partner for the peaceful pursuit of space activities. Ultimately the action called for above boils down to security and stability in space along with bolstering national security strengths and those of its allies and partners. The incentives offered appear as assured global commerce, scientific advancement, and investments in the people and industries that develop space capabilities. The cooperative efforts and partnerships that offer the greatest chance of synergy and success base themselves on honest agents and a realistic

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[105] Everett C. Dolman, *Astropolitik: Classical Geopolitics in the Space Age* (London: Frank Cass, 2002), 172.
[106] President Obama, *2010 National Security Strategy of the United States of America,* 7.
[107] Johnson-Freese, *Space as a Strategic Asset*, 227.
[108] President Obama, *2010 National Security Strategy of the United States of America,* 31.

alignment of incentives. A system of awards and penalties needs to exist for clarity purposes. The partners need to set forth expectations that reward people for recognizing system failures. "The domestic or bureaucratic costs of policy change are usually high. The realization of the costs of change makes subordinates hesitant to call attention to the failure of current practices or to the potential of alternatives."[109] Having incentives will encourage more honest work and participation in the organization. Finally, the analysis looks at principal-agent theory.

Analysis of Principal-agent Theory Evidence

The principal-agent theory revolves around the central tenet that someone requests a service or product, and another provides that service or product. To maximize the benefits of this relationship, methods need to exist for monitoring, rewarding, and penalizing the agent. "The principle-agent framework is designed to explore problems of agency, how political or economic actors in a superior position (principals) control the behavior of political or economic actors in a subordinate position (agents)."[110] For purposes of this study, the European Space Agency's pursuit of Cos-B serves as evidence for this theory at work. Ultimately, the Caravane Collaboration worked through the European Space Agency to complete the project. Interestingly, it appears superficially as though all members involved served as both a principal and as an agent in at least one situation. The combined efforts of France, Germany, the Netherlands, and Italy proved highly contingent upon one another. If any nation failed as an agent, the satellite project would have failed.

Does this help explain why the United States would benefit from strategic space partnerships? Yes. Particularly when viewed from the vantage point offered from President Obama in his address to the United Nations General Assembly. "In an era when our destiny is shared, power is no longer a zero-sum game. No one nation can or should try to dominate another nation. No world order that elevates one nation or group of people over another will succeed. No balance of power among nations will hold. The traditional divisions between nations of the South and the North make no sense in an

[109] Jervis, *Perception and Misperception in International Politics*, 387.
[110] Peter D. Feaver, *Armed Servants: Agency, Oversight, and Civil-Military Relations* (Cambridge: Harvard University Press, 2003), 12.

interconnected world; nor do alignments of nations rooted in the cleavages of a long-gone Cold War."[111]

Cooperation appears as a recurring theme from his perspective. That being said, to maximize principal-agent theory to secure the most advantageous position, the interaction needs to follow a well-established process and a hierarchy needs to be developed to serve as a reference for clarification.[112] Clear definition of these will lead the participants to act in a more well-informed manner, and will ideally lead to fewer misunderstandings and less work effort, time, or resources lost. "Resolution of the principal-agent and other difficulties revolves around the writing, monitoring, and enforcing of contracts that reduce the number and severity of contract disputes, minimize opportunism, enable better observation (policing) at low cost, share risk-taking, and generally align incentives between principal and agent. The overall objective is to prevent shirking."[113]

In the same way that clear principal-agent relationships would benefit the United States, it would benefit the partners acting with the United States. Part of this relationship will have its basis on the actor's individual cost-benefit analysis as well. "International policies often involve commitments that cannot be broken without damaging the state's reputation for living up to its word. Decision-makers may calculate that the value of this reputation outweighs the loss entailed by continuing an unwise policy."[114] In relationships, interactions, or cooperation, someone acts as the principal while another acts as the agent. Understanding these roles and the dynamics associated with them prove critical to continuously position oneself for advantage.

In conclusion, this chapter analyzed the evidence gleaned from the European Space Agency case study to show why strategic space cooperation would benefit the United States and how strategic space partnerships would benefit those engaging in said alliances with the United States. The chapter explored international relations theory, economic theory, and principal-agent theory evidence. The overall conclusion, given the

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[111] President Barack H. Obama, "Remarks by the President to the United Nations General Assembly," http://www.whitehouse.gov/the_press_office/Remarks-by-the-President-to-the-United-Nations-General-Assembly/ (accessed 16 February 2013).
[112] Feaver, *Armed Servants*, 55.
[113] Brauer and Van Tuyll, *Castles, Battles, and Bombs*, 84.
[114] Jervis, *Perception and Misperception in International Politics*, 387.

current context as stated by national leadership, is that the United States would benefit greatly from strategic space partnerships such as those demonstrated within the European Space Agency, as seen in this investigation, and the Asia-Pacific Space Coordination Organization, which extends beyond the bounds of this research. Notably, however, the nation needs to proceed with caution and due diligence to ensure that it does not cooperate at the expense of national security.

Briefly, the Asia-Pacific Space Coordination Organization also seeks international cooperation in space in order to further the interests of the Member States. "The needs of all Member States in space cooperation in the areas of space science, space technology and space applications are the priorities of the work of APSCO. The APSCO Secretariat works very closely and intimately with Member States to understand their requirements."[115] Currently, this organization includes the following eight Member States: Bangladesh, China, Iran, Mongolia, Pakistan, Peru, Thailand, and Turkey.[116] The alphabetical list does not indicate levels of relative influence among the Member States. From this, it appears that the United States could very well benefit by continued cooperative partnering within both the Asia-Pacific Space Coordination Organization and the European Space Agency. However, in effort to maximize its benefits and to continue to position itself in a position of continuous advantage, the nation should lead an effort to create a similar venture in the Western Hemisphere.

Having studied the European Space Agency, and understanding that there exists an Asia-Pacific Space Coordination Organization, this research recommends the United States engage in like fashion. The United States would benefit from shaping an organization that consisted of nations from Canada down to Chile and Argentina. Canada and Brazil already have well-established space industries with significant space capabilities. Canada has the following government and non-government institutional organizations: the Alliance for Marine Remote Sensing, Canada Centre for Remote Sensing, Canadian Space Agency, Provincial Remote Sensing Office, Teleglobe Canada,

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[115] Asia-Pacific Space Coordination Organization, "Member States Relations," http://www.apsco.int/sitesearchOne.asp?ID=244 (accessed 4 May 2013).
[116] Asia-Pacific Space Coordination Organization, "APSCO Member States," http://www.apsco.int/AboutApsco.asp?LinkNameW1=APSCO_Member_States&LinkCodeN=11 (accessed 4 May 2013).

and Telesat Canada.[117] The government and non-government institutional organizations of Brazil include: the Agencia Espacial Brasileira, Andrade Gutierrez Quimica Ltda, Centro Tecnico Aerospacial, Empresa Brasileira de Telecomunicacões, Instituto de Aeronautica e Espaco, and Instituto Nacional de Pesquisas Espacias.[118] The United States might benefit by leveraging some of the capabilities afforded through partnering with these nations.

This organization would also allow the United States to leverage key launch points in South America.[119] Additionally, it could mold fledgling space-power nations to fit its strategic vision. Mexico, Argentina, and Chile have emerging space industries that would make them good partners.[120] This would also allow the United States to bolster its consumer base for American-made space technologies or American launch services. The organization, the Space Agency of the Americas, could include the Dominican Republic as well as Haiti, and perhaps even Cuba, if the political climate ever changes to accommodate such a relationship. Ultimately, this would allow the United States to maintain a dominant position as well as avoid many of the problems with entering in as an equal partner in some of the more established programs such as the European Space Agency.

Essentially, actors act for reasons. They engage in relationships, cooperation, and partnerships in pursuit of advantageous positions. In doing so, to maximize value, one needs to embark in self-reflection and truly understand the various world views and the factors that go into their decision-making process. Oftentimes misperceptions keep people from effectively pursuing their interests. With an understanding of the world, and by challenging one's own thought processes, the chances of success increase. Next, and finally, Chapter Five concludes the research and offers other areas for continued investigation.

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[117] David Baker, ed., *Jane's Space Directory, 2004-2005* (Alexandria: Jane's Information Group, 2004), 40.
[118] Baker, *Jane's Space Directory, 2004-2005*, 39.
[119] Dolman, *Astropolitik*, 79.
[120] Baker, *Jane's Space Directory, 2004-2005*, 6, 37, 56, 365, 396, 471, 472.

Chapter Five

Conclusion

> *As our understanding of the history of technology increases, it becomes clear that a new device merely opens a door; it does not compel one to enter.*
>
> *The acceptance or rejection of an invention, or the extent to which its implications are realized if it is accepted, depends quite as much upon the condition of a society, and upon the imagination of its leaders, as upon the nature of the technological item itself.*
>
> - Lynn White, Jr.
>
> *Medieval Technology & Social Change*

Technology has only as much power as humankind delegates unto it. Throughout history, civilizations have made use of technology to enable the acquisition of food, clothing, shelter, defense and transportation.[121] Militaries have also deputized technology in efforts to make them more capable to meet their missions to provide defense, win battles, and provide deterrence. The paradigm of technology as an enabler to other things continues today. Assuming Lynn White's quote as noted above holds true, acceptance or rejection of a technology relates to the condition of society, the imagination of the society's leaders, and the nature of the technology.[122] As previously stated, humankind gives technology its power. Thinking in a strategic context, people produce and utilize technologies to maximize their capabilities and to position themselves for continuous advantage. The technology of space holds to these postulates. This chapter concludes the investigation into strategic space partnerships and cooperation with discussions of society's condition, leaders' imagination, and technology's nature followed by recommended areas for further research.

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[121] Arnold Pacey, *The Maze of Ingenuity: Ideas and Idealism in the Development of Technology* (Cambridge: MIT Press, 1992), vii.
[122] Lynn T. White, *Medieval Technology and Social Change* (London: Oxford University Press, 1964), 28.

Condition of Society

Human beings serve as the catalyst for technological advancement and for military innovation. "The history of technology is a history of human actions. To understand the origin of a particular kind of technological power, we must first learn about the actors. Who were they? What were their circumstances?"[123] The condition of society today demonstrates the extent to which the interests of nations and people of the globe overlap. Taking this into account, people decide how to leverage technology in order to help, or hinder, this environment.[124]

Society today has embraced technological advances that have essentially shrunk the world in such a way that events on one side of the globe can affect actors on the other side. Considering this, value comes from understanding that the people interacting within the society will operate from different world views. This research discussed the various lenses of realism, liberalism, and constructivism while concluding that the world and society do not, in reality, adhere to such stringent world views. Instead, actors have tendencies toward one with inklings of the others.

American society today can no longer afford a national policy of isolationalism. The current strategic guidance from the leadership portends a national policy of globalization and cooperation. Even in space, innovation and the changes that occur as a result come from relationships and interactions at the global and local network levels. "We have considered the way in which an actor attempts to mobilize and stabilize what we call a *global network* in order to obtain resources with which to build a project."[125] The nation, for its continued pursuit of its national interests and security, needs to build its local network of space experts while at the same time looking to global network development.

"International cooperation in space from the outset has been motivated by foreign policy objectives. Cooperation has historically been a useful tool for the United States to shape other countries' space programs in accordance with U.S. interests, as the United

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[123] Merritt R. Smith, and Leo Marx, eds., *Does Technology Drive History?: The Dilemma of Technological Determinism* (Cambridge: MIT Press, 1994), xiii.
[124] President Barack H. Obama, *2010 National Security Strategy of the United States of America,* (Washington, DC: White House Publishing, 2010), 7.
[125] Wiebe E. Bijker, Trevor Pinch, and Thomas P. Hughes, eds., *The Social Construction of Technological Systems: New Directions in the Sociology and History of Technology* (Cambridge: The MIT Press, 1994), 21.

States co-opts both other countries' program directions and their limited resources."[126] By embracing globalization as a society, the United States can accept and leverage space technology and partnerships to advance national interests while maintaining its security. Next, the imagination of a society's leaders has a marked influence on whether or not a technology flourishes.

Imagination of Societal Leaders

In order for technologies to advance, leaders must use their imagination to shape the progress of the innovation. They must find ways to organize support for their technological systems. In doing so, leaders consider economic theory and principal-agent theory in their decision-making process. "Technological systems contain messy, complex, problem-solving components. They are both socially constructed and society shaping."[127] These systems can include the physical artifacts, natural resources, scientific and legislative components, and global and local networks as alluded to previously. The only limitation to this process comes from the lack of imagination of the leaders involved.

Currently, the United States puts its own space companies at a serious competitive disadvantage by demanding compliance with International Traffic in Arms Regulations.[128] Hoarding technology, as outlined in Chapter Four, does not bode well for a national policy that hails space cooperation and partnership. Considering the six economic principles and the principal-agent theory as indicated throughout this research, the leaders of the United States exhibit lack of imagination by hamstringing themselves in this way. Creative solutions exist that would enable partnership and cooperation so that the United States could benefit from the economic, diplomatic, and technological benefits afforded by pursuing foreign services.

Thomas Kuhn noted that no inevitable truths exist, what people believe forms the most important part of history, and the world results from the construction of people's

[126] Joan Johnson-Freese, *Space as a Strategic Asset* (New York: Columbia University Press, 2007), 62.
[127] Bijker, *The Social Construction of Technological Systems,* 51.
[128] Erik Seedhouse, *The New Space Race: China Vs. the United States* (London: Praxis, 2009), 32.

beliefs.[129] As such, the ability to move the mind and imagination through space and time proves pivotal to maintaining a position of continuous advantage. Leaders and decision-makers need to understand their history, who they are, where they have been, and have the ability to imagine the future they want so that they can properly consider economic principles and relationships that will aid them in meeting their goals.[130] Using the imagination, one can look at national guidance of the United States and extrapolate how the United States will leverage the technology of space to meet its enduring interests of security, prosperity, values, and international order.[131]

Some examples from the past already demonstrate how the imagination of leaders served to shape the acceptance of space technology in meeting national objectives.

> Space has always been a venue for both cooperation and competition. Apollo was a national program to "beat the Russians." But the Apollo-Soyuz Test Project in 1975 used one of the last Saturn 5 rockets built for travel to the moon to dock with the Soviets in LEO as a show of U.S.-Soviet cooperation and friendship: strategic communication at its finest. Many scientists saw the highly publicized handshake-in-space mission as wasteful, even though the astronauts conducted multiple scientific experiments while in orbit. Politicians got everything they wanted from the mission, specifically a well-publicized demonstration of improved U.S.-Soviet relations.[132]

The most imaginative minds will find ways to operate most efficiently using the technological tools of the time and will factor these into their images of the world, and into the economics of their decision calculus. Next, the nature of the technology itself tends to factor into whether or not a technology receives acceptance from a society.

Nature of the Technological Item Itself

When a technology works, its continuation and advancement becomes enmeshed with social and political imperatives. In the case of space technology, advancements have proven so beneficial that they now serve critical functions in nations' abilities to pursue economic growth, global communications, navigation, and exploration. In pursuit of these goals, nations come to realize that they cannot afford to go it alone in the pursuit

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[129] Thomas S. Kuhn, *The Structure of Scientific Revolutions* (Chicago: The University of Chicago Press, 1996).
[130] Ray Kurzweil, *The Age of Spiritual Machines: When Computers Exceed Human Intelligence* (London: Penguin, 2000).
[131] President Obama, *2010 National Security Strategy of the United States of America*, 7.
[132] Johnson-Freese, *Space as a Strategic Asset*, 62.

of this dual-use space technology. As a result, cooperation emerges as a more palatable option in a world where communications occur near-real time and precise navigation allows for enhanced global commerce in a space-enabled world.

> Cooperation, however, does not necessarily lower the cost of space programs; the overall cost of a cooperative program is likely to be higher that it would be if the program were the sole responsibility of one country. A rule of thumb is that overall cost increases by about one-third, due to management and interface expenses. Communication channels must be established; technical and legal teams assembled and exchanged, often for prolonged periods of time (all of the ISS partners have long had offices at Johnson Space Center); and hardware built to specifications compatible with other hardware, and transported. However, cooperative programs should also have greater capabilities, because more partners are contributing and the cost to individual countries to access those capabilities will be proportionately less. The technical rationale for cooperative programs is to make one plus one yield more than two.[133]

The expensive nature of space technology tends to lend itself well to fostering cooperative endeavors that have the added advantage of promoting diplomacy and economic prosperity as well. Finally, this research concludes with suggested areas of additional study.

Areas for Further Research

Due to the short time span with which to conduct the investigation for this research, only one case study received scrutiny. The discoveries served valuable to understanding the broader question of why the United States would benefit from strategic space partnerships and cooperation. However, studying the European Space Agency alone does not give the most comprehensive world view to maximize the decision-maker's calculus for maintaining a position of continuous advantage.

For future study, I propose research beyond the European Space Agency case study. A bounty of research material resides in divulging international cooperation and partnerships, and intra-national cooperation and partnerships. One international study ought to include space partnerships and cooperation in the Asia-Pacific Space Coordination Organization. This organization relies upon a conglomeration of nations for the advancement of their space objectives, but it may have structures, policies, and

[133] Johnson-Freese, *Space as a Strategic Asset*, 64.

procedures that differ from those demonstrated by the European Space Agency. Even if this organization does not get investigated for the sole purpose of understanding how the United States would benefit from strategic space partnerships, it deserves a scrupulous eye to better inform the leadership of the United States about the intentions, desires, capabilities, and limitations of this organization in the world writ large.

Next, study could turn to the United States specifically. This investigation uncovered instances where the United States engaged in partnership with the European Space Agency for the Hubble Telescope, and the International Space Station. As indicated in the history of the European Space Agency in Appendix A, the United States has also had occasion to provide launch services for a fee to the European Space Agency. A more thorough investigation into other cooperative efforts the United States has engaged in outside of formal institutions and organizations could prove helpful to understanding the dynamics of space cooperation.

Finally, the space cooperation and partnerships that occur within the United States justify further inquiry. Study of these relationships proves instrumental because discovery of what advantages truly result from partnerships and what disadvantages come from the same prove critical in a resource-constrained environment. As such, this research proposes delving into the following intra-national space partnerships: military-military (ex: United States Air Force - to - United States Navy), military-intelligence community (ex: United States Air Force - to - National reconnaissance Office), military-corporation (ex: United States Air Force - to - SpaceX). Specifically, investigation into Operation BURNT FROST where the United States shot down an errant NRO satellite on 20 February 2008, a combined effort of the NRO, USN, and USAF would yield much intellectual fruit for consideration. Of course, opportunities to explore non-military intra-national space cooperation must exist as well.

Overall, the whole point of research comes to fruition when humankind can better answer the following questions: Who are we? What do we want? How are we going to get it? By looking to the past, the pathways to the future result in more deliberatively planned efforts. This puts actors in a position of advantage. "Strategy, like art, is about

exploration and the development of new ways of seeing, thinking, and being."[134] The shape of the future depends upon the mold set forth by the minds of humanity. In order to continue to evolve, the curious human mind need not receive satisfaction from finding the one answer that answers all questions. The best position for continuous advantage relies upon the never-ending thoughtful exploration and discovery of human existence.

[134] Everett C. Dolman, *Pure Strategy: Power and Principle in the Space and Information Age* (London: Frank Cass, 2005), 188.

Appendix A

Key Historical Dates for the European Space Agency from 1958-2013

ELDO/ESRO/ESA:

Key dates 1958-2013

1958

Pierre Auger of France and Edoardo Amaldi of Italy propose that the European governments combine their resources to set up a joint organization for space research. They looked to CERN to serve as a successful, multi-national, collaborative effort.[135]

1960

1 December - Intergovernmental conference at Meyrin, Switzerland, setting up a European Preparatory Commission for Space Research (COPERS)

1962

29 March - Belgium, France, Germany, Italy, the Netherlands, the United Kingdom and Australia (associate member) sign in London the Convention creating the European Launcher Development Organisation (ELDO)

14 June - Belgium, Denmark, France, Germany, Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom sign in Paris the Convention creating the European Space Research Organisation (ESRO)

1968

17 May - Launch of ESRO 2B intended to study cosmic rays and solar X-rays, the first successful satellite launch by ESRO

1971

[135] European Space Agency, "History of Europe in Space," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/History_of_Europe_in_space (accessed 20 December 2012).

20 December - First Package Deal which permits ESRO to pursue application programmes comes into effect

1973

12 and 31 July - Second Package Deal: The European Space Conference (ESC) meeting in Brussels decides the start of three new programmes: Spacelab, L3S (Ariane) and MAROTS and the creation of the European Space Agency (ESA)

1975

30 May - Belgium, Denmark, France, Germany (Federal Republic), Italy, the Netherlands, Spain, Sweden, Switzerland and the United Kingdom sign the Convention on the establishment of ESA

9 August - Launch of COS-B, first ESA mission to study gamma-ray sources

31 December - Ireland signs the ESA Convention and becomes ESA's 11th Member State

1977

13 May - Establishment of the Eutelsat (European Telecommunications Satellite Organization), an intergovernmental organisation by PTT administrations in Europe

23 November - Meteosat-1 is launched on a Thor Delta rocket from Cape Canaveral

1978

11 May - Launch of OTS-2 (Orbital Test Satellite-2), ESA's first comsat

1979

1 January - The first five-year Cooperation Agreement between Canada and ESA comes into effect

24 December - The first Ariane is launched from the Guiana Space Centre

1980

26 March - Arianespace, the world's first commercial space transportation company is created

3 July - Decision to upgrade Ariane to Ariane 3 designed to launch two satellites into GTO

1983

28 November - First Spacelab launch with Ulf Merbold, ESA's first astronaut on board the US Space Shuttle

1985

30-31 January - ESA Ministerial Council in Rome: ministers approve the start of preparatory work on the Ariane 5 launch vehicle

1986

13-14 March - Successful historic encounter of Giotto with Comet Halley

June - The Eumetsat Convention enters into force

1987

1 January - Austria and Norway become ESA's 12th and 13th Member States

9-10 November - ESA Ministerial Council in The Hague: ministers approve the development of Ariane 5

1988

29 September - Memorandum of Understanding on cooperation in the design, and development of the Space Station Freedom signed by ESA and NASA in Washington

15 June - Ariane 4 launched for the first time

1991

17 July - Launch of ERS-1

1995

1 January - Finland becomes ESA's 14th Member State

20 April - Launch of ERS-2

18-20 October - ESA Ministerial Council in Toulouse, France: ministers agree on the funding of Europe's contribution to the ISS

1996

4 June - Ariane 5's first test flight (Flight 501) fails and causes the loss of four Cluster spacecraft

1997

15 October - Cassini-Huygens launched from Cape Canaveral

1999

11-12 May - ESA Ministerial Council in Brussels which approved investments in major new programmes in the areas of telecommunications, navigation including the definition phase for the Galileo programme (in partnership with the European Union), and Earth observation

10 December - Launch of XMM-Newton by Ariane 5

2000

1 January - Portugal becomes ESA's 15th Member State

15 December - Approval of the development of the small launcher Vega

2002

1 March - Launch of Envisat by Ariane 5

11 March - Argentina signs Cooperation Agreement with ESA

28 August - Launch of MSG-1 by Ariane 5

11 December - First launch of Ariane 5 ECA (failure)

2003

15 February - Last flight of an Ariane 4 after 116 flights

7 April - Hungary becomes first ESA European Cooperating State

2 June - Mars Express, Europe's first mission to the 'Red Planet', launched from Baikonur

27 September - SMART-1, Europe's first mission to the Moon, launched by Ariane 5

25 November - Signature of the Framework Agreement between ESA and the European Community in Brussels

2004

4 February - Approval of the programme to build a complex at the Guiana Space Centre for commercial Soyuz launches

2 March - Launch of Rosetta from Kourou

24 November - Czech Republic becomes second ESA European Cooperating State

25 November - First ESA/EU 'Space Council' in Brussels

2005

14 January - Historic landing of Huygens probe on Titan

12 February - First successful launch of Ariane 5 ECA

16 March - Greece becomes ESA's 16th Member State

30 June - Luxembourg becomes ESA’s 17th Member State

9 November - Venus Express launched from Baikonur on a Starsem Soyuz-Fregat launcher

5/6 December - ESA Ministerial Council meeting in Berlin

28 December - Launch of first Galileo test satellite (GIOVE-A)

2006

27 February - Romania becomes third ESA European Cooperating State

19 October - Launch of MetOp-A from Baikonur

2007

26 February - Inauguration of Soyuz launch pad in Kourou. BepiColombo, the mission to explore planet Mercury, definitively 'adopted' by ESA's Science Programme Committee

4 May - Poland becomes fourth ESA European Cooperating State

22 May - A consensus of 29 ESA/EU countries adopt a Resolution on European Space Policy

23 October - ESA astronaut Paolo Nespoli and Node-2 module launched to ISS

2008

11 February - Columbus installed on ISS

9 March - ESA launches first ATV resupply spacecraft to ISS

27 April - Launch of ESA's second Galileo In-Orbit Validation Element satellite GIOVE-B

28 April - Poland becomes fourth European Cooperating State

9 June - Slovenia signs Cooperation Agreement with ESA

12 November - Czech Republic becomes 18th ESA Member State

25/26 November - ESA Ministerial Council in The Hague

2009

20 May - Six new ESA astronauts selected: two Italian, one French, one Dane, one German and one British

29 May - Sixth 'Space Council', Brussels

24 July - Latvia signs Cooperation Agreement with ESA

27 August - Cyprus signs Cooperation Agreement with ESA

10 November - Estonia becomes fifth European Cooperating State

2010

22 January - Slovenia becomes sixth European Cooperating State

12 February - European-built Node-3 and Cupola modules installed on ISS

8 April - ESA's 'ice mission', CryoSat-2, launched

28 April - Slovak Republic signs Cooperation Agreement with ESA

3 June - Mars500, 520-day simulated mission to Mars begins

7 October - Lithuania signs Cooperation Agreement with ESA

25 November - Seventh 'Space Council', Brussels

26 November - Hylas-1, ESA's first PPP satellite launched

22 December - Romania becomes 19th ESA Member State

2011

31 January - Israel signs Cooperation Agreement with ESA

16 February - ESA's second ATV, ATV *Johannes Kepler*, launched to ISS

21 October - Soyuz lifts off for first time from Europe's Spaceport in French Guiana, carrying two Galileo IOV satellites

21 November - ESA's Council grants observer status to 10 states that are members of the EU but not ESA: Bulgaria, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic and Slovenia.

2012

20 February - Malta signs a Cooperation Agreement with ESA

23 March - ESA's third ATV, ATV *Edoardo Amaldi* launched to ISS

19 November - Poland formally becomes ESA's 20th Member State

20-21 November - Ministerial Council in Naples, ministers approve new launcher Ariane 6 and adapted Ariane 5 ME, and Europe will provide service module for NASA's new Orion Multipurpose Crew Vehicle

18 December - New Deep Space Antenna station inaugurated at Malargüe, Argentina

Last update: 19 February 2013

Source: Adapted from European Space Agency[136]

[136] European Space Agency, "ELDO/ESRO/ESA: Key Dates 1960 - 2013," http://www.esa.int/About_Us/Welcome_to_ESA/ESA_history/ELDO_ESRO_ESA_br_Key_dates_1960-2013 (accessed 19 February 2013).

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