DISSERTATION

DYNAMICS OF INTERNATIONAL SPACE COOPERATION: EVALUATING MISSIONS FOR EXPLORING SPACE AND PROTECTING THE EARTH

Submitted by

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In partial fulfillment of the requirements for the

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ABSTRACT OF DISSERTATION

DYNAMICS OF INTERNATIONAL SPACE COOPERATION: EVALUATING MISSIONS FOR EXPLORING SPACE AND PROTECTING THE EARTH

The goal of this study is to promote an enhanced understanding of international space cooperation to ensure the prospects of (a) Missions for Exploring Space and Protecting the Earth; and (b) cooperative relations in the international system. Research objectives to meet this goal are twofold. First, space cooperation case studies related to Missions for Exploring Space and Protecting the Earth are evaluated. Case studies evaluated include the Space Station and the International Earth Observing System as examples of exploring space and protecting the Earth respectively. Evaluation is conducted according to a framework of analysis that incorporates four space cooperation outcome-types and associated dynamics of cooperation. The outcome-types are comprised of (1) coordination involving technical and scientific collaboration (mission design and plans) of independent projects; (2) augmentation signifying functional enhancements of capabilities through discrete contributions to a project; (3) interdependence entailing cooperation that is functionally enabling (i.e., necessary) for a project; and (4) integration denoting joint research and development with the aggregation of financial resources. And, the dynamics of cooperation encompass (a) technological and scientific resources; (b) authority and decision-making patterns; and (c) policy

preferences over outcomes.

Second, the case study evaluations are assessed to make substantive and theoretical contributions towards understanding international space cooperation and contributing to extant theories of international cooperation. Results indicate that space cooperation outcomes are described by terms of exchange as it relates to things of value affecting technological capabilities and scientific resources and by the functional and political (authority and decision-making) risks that cooperating partners are willing to assume. The principal policy-relevant implication reveals that the viability of space cooperation is dependent upon the extent to which functional and political conditions of a particular cooperative endeavor are congruent with the outcome-type which is preferred. Incongruent circumstances can lead to points of contention and the possible dissolution of cooperation. Theoretically, there are several "crucial" variables worthy of consideration for theories of international cooperation and cooperative relations in the international system. These variables include (a) the distribution of power resources as expressed in terms of exchange among cooperating partners; (b) perception of risks; (c) compatibility of policy preferences; and (d) functional and political arrangements that are present in international relations.

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DEDICATION

This Dissertation is dedicated to my late father, Dr. Willy Z. Sadeh, who inspired me to achieve excellence and to my son, Yinon, whom I hope to inspire in the same way.

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Advanced Microwave Scanning Radiometer (AMSR)

Advanced Microwave Sounding Unit (AMSU)

Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER)

American Geophysical Union (AGU)

American Meteorological Society (AMS)

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Assured Crew Return Vehicle (ACRV)

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Chemistry (CHEM)

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Memorandum of Understanding (MOU)

Meteorological Operational Platform (METOP)

Mini-Pressurized Logistics Module (MPLM)

Missile Technology and Control Regime (MTCR)

Mission to Planet Earth (MTPE)

Multifrequency Imaging Microwave Radiometer (MIMR)

Multilateral Coordination Board (MCB)

Multilateral Program Coordination Committee (MPCC)

National Academy of Sciences (NAS)

National Aeronautics and Space Administration (NASA)

National Center for Atmospheric Research (NCAR)

National Climatic Data Center (NCDC)

National Institute for Environmental Health Sciences (NIH)

National Oceanic and Atmospheric Administration (NOAA)

National Science Foundation (NSF)

National Security Council (NSC)

National Security Decision Directive (NSDD)

National Space Development Agency of Japan (NASDA)

Natural Resources Defense Council (NRDC)

Physicians for Social Responsibility (PSR)

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Polar-Orbiting Operational Environmental Satellites (POES)

Program Coordination Committee (PCC)

Research and Development (R&D)

Russian Scientific Production Association (NPO)

Russian Space Agency (RSA)

Satellite Aided Search and Rescue Project (COSPAS-SARSAT)

Service Module (SM)

Science Program Committee (SPC)

Smithsonian Institution (SI)

Space Science (SS)

Space Shuttle Transportation System (STS)

Space Station Control Board (SSCB)

Space Station Freedom (SSF)

Subcommittee on Global Change Research (SGCR)

Systems Operations Panel (SOP)

Total Ozone Mapping Spectrometer (TOMS)

Tracking and Data Relay Satellite System (TDRSS)

Tropical Rainfall Measuring Mission (TRMM)

Union of Concerned Scientists (UCS)

United Nations (UN)

United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS)

United Nations Conference on Environment and Development (UNCED)

United Nations Education, Scientific and Cultural Organization (UNESCO)

United Nations Environmental Program (UNEP)

United Nations Framework Convention on Climate Change (UNFCCC)

United Nations World Commission on the Environment and Development (UNWCED)

United States (US)

United States Department of Agriculture (USDA)

United States Geological Survey (USGS)

United States Global Change Research Program (USGCRP)

User Operations Panel (UOP)

Working Group on Data (WGD)

World Climate Research Program (WCRP)

World Meteorological Organization (WMO)

World Resources Institute (WRI)

CHAPTER ONE: INTRODUCTION—

MISSIONS FOR EXPLORING SPACE AND PROTECTING THE EARTH

> **"...the inescapable recognition of the unity and fragility of the Earth is its clear and luminous dividend, the unexpected final gift of Apollo. What began in deadly competition has helped us to see that global cooperation is the essential precondition for our survival."**
>
> **—Carl Sagan (1994)**

The genesis of this study emanates from the observation that the international system is increasingly characterized by cooperative relationships. One important aspect of these cooperative relationships is reflected in international space cooperation between the United States (US) and other countries. Moreover, the present and future prospects of Missions for Exploring Space and Protecting the Earth are justified and made possible through international cooperation.[1]

International space cooperation is feasible given changes that have occurred in international relations since the end of World War II. Noteworthy changes include Cold War politics, détente, post-Cold War relations and enhanced interdependencies between states. These events promoted space cooperation as a vehicle to realize US foreign policy interests in international leadership and national security as well as cooperative relations with other states in science and technology.

International space cooperation advanced the strategic interests of the US, Europe and Japan vis-à-vis Soviet/Russia during the Cold War. Relations between the US and Soviet/Russia, such as détente in the 1970s and post-Cold War politics, are symbolized by space cooperation. The end of the Cold War, marked by the dissolution of the Soviet Union, has led to cooperative relations between the US and Russia. These cooperative relations are symbolized by the International Space Station (ISS).

The development and growth of interdependencies between states due to globalization has engendered international space cooperation. One example is Europe's political and economic integration that spawned formation of the multinational European Space Agency (ESA). This enhanced Europe's space capabilities and potential areas of cooperation with the National Aeronautics and Space Administration (NASA). Further, the ESA case shows that cooperative functional arrangements are a political response to interdependencies. This response allows for political, organizational, managerial and technical risks to be shared between states and for financial resources and technological capabilities to be aggregated among them.

An additional manifestation of functional arrangements exists in Earth observations from space. International space cooperation is viewed as essential to deal with global environmental problems that have threatened the habitability of Earth.[2] Policies that can mitigate against potential global environmental catastrophes, such as greenhouse warming and global climate change, depend on cooperative functional relations that allow for accessibility and availability of Earth remote sensed data.[3]

MISSION FOR EXPLORING SPACE

A Mission for Exploring Space is rooted in a synthesis of public imagination, technological innovation and the international imperatives of the Cold War including the "space race" between the US and Soviet/Russia.[4] Science fiction, such as Jules Verne's *From the Earth to the Moon* (1865), Edward E. Hale's *The Brick Moon* (1869) and H. G. Wells' *First Men on the Moon* (1901), sparked public imagination about space exploration. The visions of these writers evolved from fiction to fact with the pioneering development in rocketry that was led by the efforts of Robert H. Goddard in the US, Herman Oberth in Germany and K. E. Tsiolkovskiy in Soviet/Russia during the first half of the twentieth century.[5]

The space age was earmarked by Cold War confrontation that resulted in a space race between the US and Soviet/Russia. This race was sparked by the Soviet launching of Sputnik in 1957 and orbiting of cosmonaut Yuri Gargarin in 1961. The US responded to these events with the establishment of NASA in 1958 and Apollo missions to the Moon from 1969 to 1972. Governmental support of these endeavors implied that dreams of scientists and engineers were in synergy with policy imperatives of the power-state. Scientists and engineers had at their disposal the resources of the state to implement their concepts.[6] Visions of the former and political needs of the latter combined, and once political decisions were made, the spread of a space age technological infrastructure followed.[7]

Within this context, NASA adopted a Mission for Exploring Space based on ideas put forward by Wernher von Braun. Largely acknowledged as a foremost rocket scientist and public advocate for space in the 1950s and 1960s,[8] von Braun wrote about the possibilities of spaceflight in a series of articles published from 1952 to 1954 in *Colliers*.[9] These articles described technological developments for space exploration such as orbital space stations and human-tended lunar and Martian bases. This vision underlies a Mission for Exploring Space.[10]

NASA's initial post-Apollo plans called for resources to implement a space shuttle, orbital space station, nuclear space tug, lunar base and human expeditions to Mars.[11] Similar scenarios were advanced in the 1980s and 1990s with a series of reports and policy initiatives.[12] To date, in addition to the Apollo missions to the Moon, NASA developed and operates a reusable Space Shuttle and is currently assembling in cooperation with international partners an orbital space station designated ISS. Concomitantly, an active program of robotic exploration of Mars with an intent to proceed later with human expeditions is currently underway within NASA.[13]

International cooperation in robotic scientific exploration of space has been the norm since the beginnings of the space age. Although human space exploration was initially a byproduct of confrontation between the US and Soviet/Russia, it has come to symbolize international space cooperation. Today, it is in the development, assembly, operations and utilization of ISS that cooperation is directed at advancing a Mission for Exploring Space. Chapter Two discusses the historical evolution of international cooperation in relation to space exploration and Chapter Four evaluates cooperation with regard to ISS.

MISSION FOR PROTECTING THE EARTH

Anthropogenic alteration of the Earth's biosphere has contributed to an environmental problematic that is demarcated by concern about global commons and a collective action problem.[14] Commons are commonly-held physical or biological resource domains that lie outside the jurisdiction of any individual state.[15] These resources are in joint supply and nationally nonappropriable. Joint supply denotes equal potential availability to commons by all states. Nonappropriability indicates that it is impossible to exclude states from sharing in benefits of commons resources or from suffering consequences caused by damage to them. As a result, any user may exploit commons resources since exclusion is impractical. This explains why global environmental degradation is so difficult to prevent or reverse. A Mission for Protecting the Earth through Earth observations by satellite concerns commons resources pertaining to global environmental change phenomena.

A collective action problem results from a "tragedy of the commons."[16] This tragedy is rooted in self-interested behavior in relation to commons resources. A "tragedy" occurs when the value of commons resources diminishes as a result of exploitation. This reflects a complex and dynamic problem set that sits at the juncture of politics, science and technology.[17] An important political challenge to realize a Mission for Protecting the Earth is to bring about international collaboration in the creation, production and dissemination of knowledge— Earth remote sensed data— about global environmental change. Coping with and adapting to global change depends upon science and technology. Political actors cannot exercise control over environmental problems without recourse to scientific findings. Science relies on technology for assessing environmental degradation (e.g., Earth remote sensing satellites) and on technological innovations for preventing further damage and bringing forth solutions.

Scientific awareness about global change led to formulation of the US Global Change Research Program (USGCRP) in 1990. The goal of USGCRP is to "provide for the development and coordination of a comprehensive and integrated United States research program which will assist the Nation and the world, to understand, assess, predict and respond to human-induced and natural processes of global change."[18] This program is cognizant that scientific knowledge is crucial to informed decision-making on environmental issues related to management of commons resources.[19] The primary component of USGCRP is NASA's Earth Sciences (ES) Enterprise.[20] This enterprise involves a constellation of Earth observing satellites (e.g., Earth Observing System) to assess global change. The ES Enterprise is inherently international involving cooperation among eighty-eight states as of 1998.[21]

Chapter Two surveys historical aspects of cooperation in Earth observations from space and Chapter Five evaluates cooperation related to NASA's Earth Observing System which dealt with an International Earth Observing System (IEOS). Unlike a Mission for Exploring Space— where cooperation is a matter of purposeful choice directed at functional and political ends— the realization of mission goals for protecting the Earth depends upon cooperation. Explaining and managing global change based on the use of Earth remote sensed data can only be achieved by international space cooperation.

RESEARCH DESIGN

Goal and Objectives

The goal of this study is to promote an enhanced understanding of international space cooperation to ensure the prospects of (a) Missions for Exploring Space and Protecting the Earth; and (b) cooperative relations in the international system. Research objectives to meet this goal are twofold. First, space cooperation case studies related to Missions for Exploring Space and Protecting the Earth are evaluated. Second, results of these evaluations are assessed to (a) determine how cooperative policy patterns are manifested in international space cooperation; and (b) proffer theoretical contributions to extant theories that address cooperation in international relations.

Research Questions

This investigation focuses on several research questions with respect to evaluation of case studies and assessment of results. Evaluation of case studies examines the historical and political conditions under which international space cooperation is initiated and sustained and over what issues political actors (e.g., national space agencies) bargain and negotiate in realizing cooperative outcomes (i.e., dynamics of cooperation). In turn, results are assessed by considering substantive policy implications and what this research effort can add to the study of space cooperation and international cooperation that was not known before (i.e., theoretical implications).

Methodology

This research effort employs a process-tracing case study methodology.[22] Process-tracing uncovers systematic patterns of historical phenomena. To this end, the historical record of international space cooperation is reviewed, synthesized and assessed in Chapters Two and Three. This forms the foundation for establishing a framework of analysis in Chapter Three that incorporates four international space cooperation outcome-types and associated dynamics of cooperation. The framework serves as a process-tracing guideline for evaluating distinctive and systematic policy patterns (i.e., dynamics) of international space cooperation.

The four outcome-types include (1) coordination; (2) augmentation; (3) interdependence; and (4) integration. Coordination involves scientific and technical (e.g., mission design and plans) collaboration of independent projects that does not meet the standards of the other three outcome-types. Augmentation is signified by functional enhancements of capabilities through discrete contributions to a project. Interdependence entails cooperation that is functionally enabling (i.e., necessary) for a project. Integration denotes joint and shared research and development with the aggregation of financial resources. The dynamics of cooperation associated with these outcome-types encompass (a) technological and scientific resources; (b) authority and decision-making patterns; and (c) policy preferences over outcomes.

Case Study Selection

Case studies selected for investigation include the Space Station and IEOS. These selections are justified according to three criteria that were put forward and satisfied.[23] One, case studies should relate to Missions for Exploring Space and Protecting the Earth. This introductory chapter discussed how Space Station (e.g., ISS) and IEOS are important examples of these missions. Two, cases should exhibit characteristics that can be specified in terms of the framework of analysis to make certain that process-tracing is systematic. This is demonstrated by the case study evaluations conducted in Chapter Four for Space Station and Chapter Five for IEOS. Three, cases must vary within the range of outcome-types. This avoids case study selection on one particular outcome-type and provides the basis for characterizing dynamics associated with different outcomes. The Space Station involved changes in outcomes that ranged from coordination to augmentation and interdependence, whereas IEOS corresponded to coordination of multinational projects.

Research Implications

The case study method endeavors to promote the cumulative progression of knowledge. To accomplish this task, policy and theoretical implications inferred from the case study evaluations are considered in the concluding Chapter Six. Policy results and findings of the evaluations are summarized, interpreted and assessed to determine the validity of the framework of analysis. Validation is undertaken by ascertaining the relationships between outcome-types and dynamics. These relationships are specified by proposing variable dimensions underlying each cooperation outcome-type. Theoretical implications are explored by appraising how the results and findings contribute to extant theories of international cooperation. Contributions are identified through a set of "crucial" variables that influence cooperation in the international system. Finally, suggestions for future research directed at ensuring cooperative efforts in Missions for Exploring Space and Protecting the Earth are offered.

NOTES TO CHAPTER ONE

[1]Missions for Exploring Space and Protecting the Earth are reflected in NASA's Human Exploration and Development of Space (HEDS), Space Sciences (SS) and Earth Sciences (ES) Enterprises. See *NASA Strategic Plan* (Washington, DC: Government Printing Office, 1998).

[2]The perspective of a transnational vision manifested by the image of Earth from space, engendered by spaceflight, may have been found just in time, just as technology threatens the habitability of the world. In this regard, space exploration is an imperative for species survival and human evolution. See Carl Sagan, *Pale Blue Dot: A Vision of the Human Future in Space* (New York, New York: Random House, 1994), 203-208, 215 and 218-229.

[3]See Eligar Sadeh, "Modeling International Collaboration for Global Environmental Problem Solving," in W. D. Kay and Vicki L. Golich, eds., *International Collaboration in Science and Technology in Advanced Industrial Societies* (New York, New York: Routledge, forthcoming).

[4]See Walter A. McDougall, *...The Heavens and the Earth: A Political History of the Space Age* (Baltimore, Maryland: John Hopkins University Press, paperback edition, 1997), 3-13; Howard E. McCurdy, *Space and the American Imagination* (Washington, DC: Smithsonian Institution Press, 1997), 1-52; John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: Government Printing Office, 1995), 1-207; and Roger D. Launius, *NASA: History of the Civil Space Program* (Malabar, Florida: Krieger Publishing Company, 1994), 3-16.

[5]See works by Goddard, Oberth and Tsiolkovskiy in *Exploring the Unknown*, 59-139.

[6]For a discussion about state-government mobilization of large-scale space technology programs as it applies to NASA, see Eligar Sadeh, *Democracy and the Public Administration of Large-Scale Space Technology: Apollo to the Space Shuttle Challenger* (Working Paper Series, Policy Studies Institute, Colorado State University, Fort Collins, Colorado, April 1997).

[7]See McDougall, *...The Heavens and the Earth*, 12.

[8]In addition to Wernher von Braun, his contemporary, Sergei Korolev of Soviet/Russia, was also considered a foremost rocket scientist. See James Harford, *Korolev, How One Man Masterminded the Soviet Drive to Beat America to the Moon* (New York, New York: John Wiley and Sons, 1997).

[9]See Wernher von Braun, "Can We Get to Mars," *Colliers*, April 30, 1954, 22-29; "Man on the Moon the Journey," *Colliers*, October 18, 1952, 52-59; and "Crossing the Last Frontier," *Colliers*, March 22, 1952, 23-29 and 72-73. *Colliers* was a popular news magazine and these articles were directed at the layperson.

[10]A vision of space exploration has persisted in public policy because it is wedded to an American ideology and mythology of pioneerism and frontierism. See Dale M. Gray, "Current Space Development as a Manifestation of Historic Frontier Processes" (paper presented at the 49th International Astronautical Congress, Melbourne, Australia, September 28-October 2, 1998); McCurdy, *Space and the American Imagination*; Robert Zubrin, *The Case for Mars, The Plan to Settle the Red Planet and Why We Must* (New York, New York: Free Press, 1996); and James L. Kauffman, *Selling Outer Space, Kennedy, the Media and Funding for Project Apollo, 1961-1963* (Tuscaloosa, Alabama: University of Alabama Press, 1994).

[11]Space Task Group, *The Post-Apollo Space Program: Directions for the Future*, September 1969, in *Exploring the Unknown*, 522-543.

[12]See Stephen J. Hoffman and David I. Kaplan, eds., *Human Exploration of Mars: The Reference Mission of the NASA Mars Exploration Study Team*, NASA SP-6107 (Houston, Texas: NASA Lyndon B. Johnson Space Center, July 1997); George W. Morganthaler and Gerald J. Smith, eds., *International Exploration of Mars* (Paris, France: International Academy of Astronautics, 1996); Valerie Neal, ed., *Where Next, Columbus? The Future of Space Exploration* (New York, New, York: Oxford University Press, 1994); Mary Fae McKay, David S. McKay and Michael B. Duke, eds., *Space Resources*, NASA SP-509 (Washington, DC: NASA, 1992); Frederick I. Ordway and Randy Liebermann, eds., *Blueprint for Space, Science Fiction to Science Fact* (Washington, DC: Smithsonian Press, 1992); *Mission to the Moon, Europe's Priority for the Scientific Exploration and Utilization of the Moon*, ESA SP-1150 (Noordwijk, The Netherlands: ESA Publications Division, ESTEC, June 1992); *America at the Threshold: America's Space Exploration Initiative, Report of the Synthesis Group on America's Space Exploration Initiative*, by Thomas P. Stafford, Chairman (Washington, DC: Government Printing Office, 1991); *Exploring the Moon and Mars: Choices for the Nation*, Office of Technology Assessment, United States Congress, OTA-ISC-502 (Washington, DC: Government Printing Office, 1991); *Report of the Advisory Committee on the Future of the US Space Program*, by Norman R. Augustine, Chairman (Washington, DC: Government Printing Office, 1990); *The Case for an International Lunar Base* (Paris, France: International Academy of Astronautics, 1990); A. F. Chicarro, G. E. N. Scoon and M. Coradini, eds., *Mission to Mars, Report of the Mars Exploration Study Team*, ESA SP-1117 (Noordwijk, The Netherlands: ESA Publications Division, ESTEC, January 1990); *Report of the 90-Day Study on Human Exploration of the Moon and Mars, NASA Report Prepared for the NASA Administrator* (Washington, DC: NASA, November 20, 1989); *Leadership and America's Future in Space, A Report to the NASA Administrator*, by Sally K. Ride (Washington, DC: Government Printing Office, August

1987); and *Pioneering the Space Frontier, Report of the National Commission on Space* (New York, New York: Bantam Books, 1986).

[13]This involves the use of robotic probes to survey and assess the characteristics of Mars as well as to testbed critical technologies for possible future human missions. NASA is also engaged in research directed at long-term human habitation in space involving human physiological adaptation to microgravity and bioregenerative life support systems. The International Space Station will be utilized as a platform to further these research activities. For NASA's current planning on human missions to Mars, see Hoffman and Kaplan, *Human Exploration of Mars.*

[14]See Sadeh, "Modeling International Collaboration."

[15]Environmental commons include Antarctica, deep seabed minerals, electromagnetic spectrum, geostationary orbit, global climate system, high seas, outer space and stratospheric ozone layer.

[16]See G. Hardin and J. Boden, *Managing the Commons* (San Francisco, California: W. H. Freeman, 1977).

[17]For characterizations of this problem set, see Nazli Choucri, ed., *Global Accord: Environmental Challenges and International Responses* (Cambridge, Massachusetts: MIT Press, 1993); Paul C. Stern, Oran R. Young and Daniel Druckman, eds., *Global Environmental Change: Understanding the Human Dimensions* (Washington, DC: National Academy of Science Press, 1992); K. Kondratyev, J. Ortner and O. Preining, "Priorities for Global Ecology Now and in the Next Century," *Space Policy* 8, 1 (1992): 39-48; Harold K. Jacobson and Martin F. Price, *A Framework for Research on the Human Dimensions of Global Environmental Change* (New York, New York: International Social Science Council and UNESCO, United Nations, 1991); "Special Issue: Managing Planet Earth," *Scientific American* 261, 3, (1989): entire issue; and World Commission on Environment and Development, *The Brundtland Report, Our Common Future* (London, England: Oxford University Press, 1987).

[18]See United States Global Change Research Act of 1990, United States Public Law 101-606.

[19]See *Our Changing Planet: The FY 1995 US Global Change Research Program*, Report by the Subcommittee on Global Change Research, Committee on Environmental and Natural Resources of the National Science and Technology Council, Executive Office of the President (Washington, DC: United States Global Change Research Information Office, 1994); and *Our Changing Planet* reports for fiscal years 1996, 1997, 1998 and 1999.

[20]The Mission for Protecting the Earth has been commonly known since 1989 as Mission to Planet Earth (MTPE). This name designation was changed to Earth Sciences (ES) in 1998.

[21]Lisa Shaffer, Former Director, Mission to Planet Earth Division, Office of External Relations, NASA Headquarters, Washington, DC, interview by author, August 12, 1997.

[22]For case study and process-tracing methodologies applied herein, see Ronald Mitchell and Thomas Bernauer, "Empirical Research on International Environmental Policy: Designing Qualitative Case Studies," *Journal of Environment and Development* 7, 1 (1998): 4-31; Andrew Bennett and Alexander L. George, "Process Tracing in Case Study Research" (paper presented at the MacArthur Foundation Workshop on Case Study Methods, Belfer Center for Science and International Affairs, Harvard University, October 17-19, 1997); Andrew Bennett and Alexander L. George, "Research Design Tasks in Case Study Methods" (paper presented at the MacArthur Foundation Workshop on Case Study Methods, Belfer Center for Science and International Affairs, Harvard University, October 17-19, 1997); Andrew Bennett and Alexander L. George, "Developing and Using Typological Theories in Case Study Research" (paper presented at the 38th Annual International Studies Association Convention, Toronto, Canada, March 18-22, 1997); Gary King, Robert O. Keohane and Sidney Verba, *Designing Social Inquiry: Scientific Inference in Qualitative Research* (Princeton, New Jersey: Princeton University Press, 1994); Robert K. Yin, *Case Study Research: Design and Methods* (Thousand Oaks, California: Sage Publications, second edition, 1994); Alexander L. George, "The Method of Structured, Focused Comparison," in Paul G. Lauren, ed., *Diplomacy: New Approaches in History, Theory and Policy* (New York, New York: Free Press, 1979), 43-68; Harry Eckstein, "Case Study and Theory in Political Science," in Fred Greenstein, and Nelson Polsby, eds., *Handbook of Political Science* (Reading, Massachusetts: Addison-Wesley, 1975), 79-123; and Arend Lijphart, "The Comparable Cases Strategy in Comparative Research," *Comparative Political Studies* 8, 2 (1975): 158-172.

[23]These criteria were established with the intent to minimize case study selection bias. See Bennett and George, "Developing and Using Typological Theories"; and King, Keohane and Verba, *Designing Social Inquiry*, 115-149.

CHAPTER TWO: HISTORICAL BACKGROUND—
EVOLUTION OF INTERNATIONAL SPACE COOPERATION

The onset of the Space Age is characterized by international cooperation directed at sharing knowledge among space scientists. This was exemplified by the 1957-58 International Geophysical Year (IGY). The IGY coordinated transnational scientific collaboration between sixty-thousand scientists and technicians from sixty-six states under the auspices of the International Council of Scientific Unions (ICSU) to study and assess the Earth's spatial environment from low Earth orbit (LEO).[1]

Because of the IGY experience, a belief in "openly" sharing scientific knowledge[2] and Cold War foreign policy interests, the National Aeronautics and Space Act of 1958, which led to the establishment of NASA, incorporated international cooperation in its declaration of policy and purpose:

> ...cooperation by the United States with other nations and groups of nations in work done pursuant to this Act and in the peaceful application of the results thereof should be conducted and are pursuant to the agreements made by the President with the advise and consent of the Senate.[3]

Work done pursuant to the Space Act includes the expansion of human knowledge related to space, improvements in safety and efficiency of aeronautical and space vehicles, development of space vehicles capable of carrying supplies and living organisms into space and long-range scientific studies about the cosmos and Earth.[4]

The Space Act established possibilities for a comprehensive agenda of international cooperation. In 1959, NASA put into practice this agenda with the intent of sharing scientific knowledge. This was accomplished by announcing to the ICSU's Committee on Space Research (COSPAR) that it would assist its members "by undertaking the launching of suitable and worthy experiments proposed by scientists of other countries."[5] This led to US-European space cooperation through exchanges of letters of understanding whereby NASA provided launch services in exchange for scientific data gathered by European satellites and instruments.[6]

At the same time, the Space Act seemed to restrict possibilities of cooperation by calling for treaties that require presidential approval and Senate ratification.[7] Upon signing the Act into law, President Eisenhower clarified this provision by stating "that international treaties may be made in this field, and as not precluding, in appropriate cases, less formal arrangements for cooperation."[8] Less formal arrangements, including letters of understanding, intergovernmental agreements (IGAs) and memoranda of understanding (MOUs), requiring only presidential or Agency-level approval, represent the means by which NASA facilitates international space cooperation.

NASA's international cooperative agreements are not science and technology agreements in the traditional sense. Rather, they are cooperative agreements entered into under NASA's statutory authority for international cooperation provided by the Space Act of 1958. On account of the unique goals and practices of NASA's cooperative agreements, they provide for open and free exchanges of science, transfers of technical data and goods and other features, such as broad mutual wavers for liability, that are not normally part of science and technology agreements. In most cases, aspects of these features are incorporated into the IGAs and MOUs through which NASA commits itself to cooperative space endeavors.

In contrast to the use of IGAs and MOUs, formal institution building in space involving regimes, treaties and conventions is an exception. Only in the cases of an International Space Law regime established by the Outer Space Treaty, operating agreements of the International Telecommunications Satellite Consortium (INTELSAT), convention leading to the formation of the European Space Agency (ESA) and an international treaty that instituted the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT) is such institution building present. There are, nonetheless, a number of case studies that constitute institutional arrangements based on agreements reached on terms of reference or principles. This has primarily occurred in the effort to coordinate space science missions (e.g., InterAgency Consultative Group) and data policies for Earth observations by satellites (e.g., Committee on Earth Observation Satellites).

HISTORICAL PATTERNS OF COOPERATION

Historical patterns of international space cooperation are reflected in NASA's policy preferences. NASA was willing to cooperate, but only if potential partners accepted certain policy guidelines.[9] These guidelines are listed below.

•**Clearly defined and independent managerial interfaces** that ensure NASA's dominance in political authority and decision-making.

•**No exchange of funds** in which each partner is financially responsible for project elements it develops.

•**Distinct technical responsibilities** that retain NASA's control of critical path items and overall system integration.

•**Protection of sensitive technology** where arrangements for cooperative projects protect against the unwarranted transfer of technology abroad and maintain technologies critical to NASA to ensure the industrial and economic competitiveness of the US.[10]

International space cooperation is a reflection of foreign policy and functional policy preferences related to economics, technology and science.[11] The period of détente between the US and Soviet/Russia was an outcome of symbolic foreign policy preferences directed a reducing Cold War tensions. Détente resulted in IGA umbrella agreements on space cooperation. IGAs between the US and Soviet/Russia, concluded in 1972 and 1977, led to cooperation on the Apollo-Soyuz Test Project (ASTP). In a similar way, the functional interdependence between US and Russian Space Station programs, formalized in a 1998 IGA for the International Space Station (ISS),[12] reflects US foreign policy preferences in the post-Cold War era.

Functional preferences directed at furthering European industrial autonomy played a central role in the formation of ESA.[13] This drive for autonomy, directed at space-based technologies and large-scale systems engineering management, spawned cooperative projects such as the European Spacelab (ESL), utilized in NASA's Space Shuttle Transportation System (STS), and European participation in ISS.

Cooperation based on functional preferences is an important part of NASA's STS and ISS programs. For STS, Canadian development of the robotic arm remote manipulator servicer plays a critical role in the ability of STS to retrieve and deploy payloads in LEO. With ISS, the functional energy block and service module provided by the Russian Space Agency (RSA) and the mini-pressurized logistics modules provided by the Italian Space Agency (ASI) are necessary— in the technological critical path— to the proper functioning of ISS.

In space and Earth sciences, cooperation on a functional basis, such as sharing of scientific knowledge through mission coordination, data exchange and analysis and hardware development, has been the norm since IGY.[14] The first decade of cooperation, 1959-1969, between NASA and Europe, for example, was based on science.[15] Other noteworthy examples include the International Solar Polar Mission (ISPM), renamed Ulysses in 1984, involving a joint NASA-ESA space science mission to study the polar regions of the Sun; the Inter-Agency Consultative Group (IACG) begun to coordinate national missions that studied Halley's Comet and continued for coordinating International Solar Terrestrial Physics (ISTP) missions; and the Committee on Earth Observation Satellites (CEOS) created to harmonize data acquisition, exchange and policies for Earth observation by satellites.

PRESENT STATE OF KNOWLEDGE

The body of literature that deals with international space cooperation is largely historical in character. This literature describes the histories of intergovernmental relations, specific projects and international institutions. Intergovernmental space relations focus on US-European, US-Japanese and US-Russian cooperation; specific projects encompass ESL, ISPM/Ulysses, ASTP and NASA's Space Station program (i.e., Space Station Freedom and ISS);[16] and international institutions concern INTELSAT, regime of International Space Law, ESA, IACG and institutions that have been formed to coordinate missions on Earth observations from space such as CEOS.

The literature review of international space cooperation that follows is first organized according to intergovernmental space cooperation patterns and then on institutional ones. Specific projects that are scrutinized relate to US-European, US-Japanese and US-Russian space cooperation. The evolution of international space cooperation and the years when cooperation was initiated are tabulated in Table 1.

Table 1. Historical evolution of international space cooperation.*

Cases of International Space Cooperation	Year of Initiation
US-European Cooperation	1958
European Spacelab (ESL)	1973
International Solar Polar Mission (ISPM)/Ulysses	1979
US-Japanese Cooperation	1969
US-Soviet/Russia Cooperation	1957
Apollo-Soyuz Test Project (ASTP)	1972
Multilateral Case Studies	
Space Station Freedom (SSF)/International Space Station (ISS)	1982
Institutional Cases:	
International Telecommunications Satellite Consortium (INTELSAT)	1964
International Space Law Regime	1967
European Space Agency (ESA)	1975
Inter-Agency Consultative Group (IACG)	1981
Committee on Earth Observation Satellites (CEOS)	1984

*Note: Cases of cooperation listed in this table are ones that are present in the space policy literature reviewed herein. It should be noted that this list is not inclusive of all cases in the history of international space cooperation.

United States-European Space Cooperation

US-European intergovernmental space relations have historically reflected power asymmetries in NASA's favor. This pattern of cooperation realized NASA's functional policy preferences. In essence, NASA capitalized on a structure of European dependence on the US. This pattern of cooperation eroded over time as ESA became more capable due in large part to the cooperation with NASA that dependence first caused. As a result, US-European space relations concerning ISS, for instance, compare to more equitable forms of cooperation in technological hardware contributions and decision-making dynamics.

The US initially promoted international space cooperation with Europe as part of a strategy to recover the loss of prestige linked to the 1957 "Sputnik" crisis.[17] This strategy involved the demonstration of political leadership among its Western allies by engaging them in cooperative space ventures in which the US served as a provider of launch services for European scientific satellites. Space leadership implied that institutional and resource asymmetries in NASA's favor would allow it to insist upon its preferences— "clearly defined and distinct managerial interfaces," "no exchange of funds," "distinct technical responsibilities" and "protection of sensitive technology"— as preconditions for US-European cooperation. Europe was willing to accept these preferences, very often as a dependent and junior partner, to realize its specific functional preferences aimed at fostering a space sciences program, acquiring large-scale systems management and administrative know-how and developing applied space technology capabilities.[18]

US-European space relations have passed through four distinct phases: (1) 1958 to 1968; (2) 1969 to 1973; (3) 1974 to 1988; and (4) 1989 to the present. The first phase is characterized by US "tutorship" of Europe that was put into practice by limiting the scope of cooperation to a project-by-project basis. US policy preferences were to avoid large-scale sharing or joining of major research and development (R&D) programs. Instead, NASA focused its cooperative efforts on specific technical and scientific packages that could be exchanged to functionally enhance its space projects.[19]

These initial years of cooperation took the form of bilateral arrangements involving launch services provided by the US in exchange for some form of payload sharing on European scientific satellites. Agreements were reached between NASA and the United Kingdom, Italian, French and German national space programs.[20] With the institutionalization of a unified European effort in space sciences in 1964, represented by the European Space Research Organization (ESRO),[21] a series of MOUs were reached between NASA and ESRO. These MOUs facilitated NASA's launch services for a series of ESRO satellites in exchange for scientific results obtained from these missions.[22]

The first phase, 1958-1968, also involved technology transfer. This policy, which was endorsed by US President Johnson in 1966-67, was directed at the development of a European based expendable launch vehicle (ELV) named Europa.[23] The European Community began these efforts in 1962 with the creation of the European Launch and Development Organization (ELDO).[24] The willingness of the US to allow for some technology transfer, such as in flight hardware and technical information, was driven by foreign policy preferences. These preferences were to remedy the "technology gap" between the US and Europe and to stimulate economic and industrial growth in Europe to enhance the Western strategic alliance.[25]

The second phase, 1969-1973, is represented by a transition from US tutorship to the emergence of Europe as a "junior" partner in cooperative space activities. A junior partnership implied some degree of autonomy in science and hardware development for the Europeans. This type of partnership is best articulated by the 1969 Space Task Group Report on NASA's post-Apollo space program:

> ...a substantial raising of sights, interest and investment in space activity by the other nations able to do so in order to establish a base of major contributions by them: and creation of an attractive international institutional arrangements to take full advantage of new technologies and new applications. The form of cooperation most sought after by advanced countries is technical assistance to enable them to develop their own capabilities. We should move toward a liberalization of our policies affecting cooperation in space activities, should stand ready to provide launch services and share technology wherever possible, and should make arrangements to involve foreign experts in the detailed definition of the future United States space programs and in the conceptual and design studies required to achieve them.[26]

Despite this report, the European space program remained asymmetrical in resources and dependent on the US in several respects. First, NASA dominated in its financial contributions to cooperative projects.[27] Second, NASA was able, if necessary, to functionally continue their proposed cooperative projects and missions without a European contribution. Third, Europeans joining the partnership became dependent on NASA for an important aspect of their future activities in space. To compound matters, US President Nixon never endorsed this Space Task Group Report and reversed Johnson's policy of technology transfer to Europe.

Nixon linked technology transfer to national security policy; technology represented a form of "knowledge" to be closely regulated and controlled. Further, Nixon's preferences progressively shifted towards spectacular US-Soviet cooperative achievements in support of détente, while European importance in the US foreign policy agenda was reduced accordingly.[28] This policy undermined the "technology gap" rationale for technology transfer to Europe. Consequently, a shift in gratuitous launch services to one based on the utilization of US launchers, purchased initially by ESRO and then by ESA, took place.[29]

Notwithstanding, ESRO and ELDO responded to the call from NASA for post-Apollo cooperation by establishing working groups to analyze the technical implications of European participation in the American space program. European objectives were to redevelop patterns of technology transfer, which previously existed in the 1960s, and to realize a more equitable distribution of responsibilities.[30] Technology transfer was to be brought about through access to all post-Apollo systems and by developing elements technologically critical to STS. An equitable distribution of responsibilities was to be achieved by shared operations and decision-making in systems and technical management. In addition, Europe sought to secure commitments by the US to procure European developed hardware on a permanent basis.

US objectives in this second phase differed markedly from the European ones and resembled NASA's traditional policy preferences for cooperation. They were directed to avoid a reliance on Europe for the success of STS; maintain systems management and decision-making control; provide for detailed access only to technologies necessary for specific European contributions to post-Apollo programs; retain freedom from any formal political commitment to cooperation given possible financial constraints from Congressional appropriators; allow for nominal access to post-Apollo systems on a commercial basis; and uphold the principle of "no exchange of funds."[31]

After presidential and congressional approval of STS in 1972, Europe pursued cooperation with NASA on ESL, albeit within the confines of a junior partnership. From a US viewpoint, ESL was a good candidate for cooperation since it satisfied NASA's policy preferences for cooperation. Though Europe failed to realize any of its post-Apollo policy preferences, there existed a willingness to cooperate on ESL because of a lack of confidence in their own capabilities, especially in large-scale systems management know-how, and the belief that their technological and managerial capabilities could only be improved through cooperation with NASA.[32]

The transition of US-European space relations from a dependent junior partnership to a "genuine" partnership began in the 1974 to 1988 period and fully took hold in the fourth phase from 1989 to the present. A genuine partnership implies that all partners are "free" and "equal" actors in both authority and decision-making.[33] In practice, this meant that Europe could exercise a certain degree of technological and managerial autonomy in its cooperative dealings. The ability for Europe to function in such a way was reinforced by the development of a more autonomous European space program. This included (a) the successful implementation of ESRO and High Eccentric Orbiting Satellites (HEOS) satellite missions begun in 1964; (b) the 1973 initiation of an indigenous ELV development program (Ariane) as a replacement for the failed attempts by ELDO to develop a Europa ELV;[34] (c) ESL; (d) the development of space science, telecommunications and Earth observing satellite programs in the 1970s and 1980s; and (e) the formation of ESA in 1975.[35] Europe's enhanced space capabilities broadened the potential areas of cooperation with NASA and diminished European dependence on the

US space program.

Cooperation in the third phase, 1974-1988, encompassed both space sciences and human spaceflight and involved undertakings with NASA, Soviet/Russia and Japan. In space sciences, cooperation included (a) the International Ultraviolet Explorer (IUE) for the study of distant galactic phenomena; (b) the International Sun-Earth Explorer (ISEE) to study the solar terrestrial magnetosphere; (c) Hubble Space Telescope (HST) for astronomical observation; and (d) ISPM/Ulysses.[36] ESA's contribution to these programs involved scientific instruments and the development of scientific probes. In human spaceflight, ESA successfully developed ESL and is a major foreign participant in NASA's ongoing Space Station program.

Cooperation patterns evident in NASA's Space Station Freedom (SSF)[37] exemplified Europe's genuine partnership status.[38] The driving impulse for cooperation, from an American standpoint, was a fusion between NASA's long-standing plans for permanent expansion into space and President Reagan's policy of technological resurgence as a superpower summed up in a doctrine of "leadership" of the Western strategic alliance.[39] Leadership was physically manifested in a "core" US space station to which partner elements would be added. ESA successfully countered this doctrine of "leadership" with one of "autonomy."[40] Autonomy was manifested in a European Hermes space plane (this was to serve as an autonomous orbital transfer vehicle), a functionally autonomous Manned Tethered Free-Flyer (MTFF) scientific facility and ESA's portion of the Space Station polar platforms for Earth observations. In all of these cases, ESA was to have full management and technical authority. Although a major redesign of SSF in 1992-1993 in tandem with ESA budget cutbacks during the same period led to the elimination of these programs,[41] ESA's policy preference of autonomy carried over to ISS and other cooperative project areas.

Lastly, cooperation from 1989 to the present deals with the emergence of Europe as an "equal" partner in its cooperative relationships with NASA. An equal partnership indicates symmetry in European technological capabilities, interdependent cooperation outcomes in terms of contributions to critical path technologies and infrastructural components, participation in systems and technical management and project leadership roles. By the late 1980s, Europe's capabilities in ELV and space science, telecommunications and remote sensing satellites were not only comparable to that of NASA and the US, but in some cases were more successful.[42] In its relations with Europe, the US was faced with prospects of both cooperation and economic competition. This shifted the balance of power between the US and European space programs to one more characterized by mutual interdependence.

The realization of interdependent relations is exemplified by US-European cooperation on both ISS and the Cassini mission to Saturn and its moon Titan. In the ISS case, ASI's mini-pressurized logistics modules and ESA's planned support for propellant resupply and orbital reboost are critical to the program. ESA also became more of an equal partner with respect to the management and decision-making structures of ISS.[43] One example of this surrounds the 1993 redesign of SSF that led to the current ISS. Europe participated in the review process for redesign through a Multilateral Program Coordination Committee and in the decision that led to the inclusion of the Russians into the program. For Cassini, ESA developed the robotic probe and instrumentation which are critical to this mission currently in flight to explore Saturn and Titan.

Additionally, ESA played a role as lead agency within IACG. The mission concept put forward by IACG to study Halley's Comet revolved around complimenting ESA's Giotto probe encounter with the comet. In similar fashion, ESA plays a project leadership role in IACG's coordination of ISTP. ESA's ability to take such a leading role in cooperative space ventures speaks for the degree of mutual interdependence that has developed between ESA and NASA.

European Spacelab

Cooperation between NASA and the European space program was an outgrowth of international and domestic policy preferences. Internationally, the US sought to assert leadership by addressing the "technology gap" between the US and Europe. Domestically, international space cooperation enhanced the versatility and political support of NASA's programs and strengthened its precarious budgetary support particularly in the post-Apollo era. Europe, on the other hand, viewed cooperation as essential in developing autonomous technological capabilities in space and furthering industrial policies.

Given these political incentives, NASA and ESRO began discussing possibilities for cooperation in the post-Apollo era. These discussions examined three possible cooperative options: (1) Space Shuttle development through subcontracting to European aerospace industry; (2) European space tug with subcontracting to US aerospace industry; and (3) European scientific sortie module for use in the Space Shuttle.[44] NASA's conditions for European consideration of these options were established to ensure that no sensitive or economically valuable US technologies would be transferred to Europe.

These conditions included technical items that should not be scheduled as critical nor involve high technical risk, simple technological interfaces and cooperation for which there would not be a high probability of frequent design changes.[45] These restrictions, in addition to NASA's doubts on Europe's technical and managerial capabilities, precluded the first and second options.[46] On this account, the third option of a scientific sortie module that represented noncritical path (i.e., functionally enhancing and not functionally enabling) Space Shuttle hardware, was pursued.

Cooperation on the sortie module, which became known as ESL, was formalized in a 1973 MOU between NASA and ESRO for a "Cooperative Program Concerning Development, Procurement and Use of a Space Laboratory in Conjunction with the Space Shuttle System." Albeit this MOU largely reflected NASA's preferences for cooperation and the structural nature of European dependence on the US, it allowed ESA to acquire critical know-how in large-scale systems management and organizational practices.[47]

NASA received full control of ESL through the transfer of ownership and the first unit was delivered free of charge with a provision in the MOU that NASA would purchase a second unit. At the time, future spacelabs beyond the first two were envisioned. Their construction would have provided a substantial profit to ESA. NASA, due to fiscal constraints and a reduced STS launch schedule, only purchased the second unit as obligated in the MOU.[48] However, the purchase of this ESL unit for $128 million, finalized in a 1980 contract between NASA and ESA, was the largest financial transaction to that date between NASA and a foreign entity.[49] It also denoted the first departure from NASA's preference for "no exchange of funds."

ESL raised important constraints to cooperation regarding the legality of a MOU in relation to US domestic law.[50] In 1973, the US Air Force planned to build a space laboratory of a similar nature to the European one. It was argued that since the US Senate had not ratified the MOU it was not legally binding. In the US, domestic law takes precedence over executive empowered IGAs. The Defense Appropriations Act of 1973 precluded R&D contracts to foreign entities when indigenous capabilities of a similar nature existed. Despite the fact that this constraint never blocked provisions set forth in the 1973 ESL MOU, the controversy spilled over into other cooperative ventures, as exemplified by ISPM/Ulysses, and weakened European resolve to partake in cooperation with the US as a dependent junior partnership.

International Solar Polar Mission/Ulysses

ISPM/Ulysses was characterized by a number of features that made it favorable for international cooperation. First, ISPM was relatively inexpensive, possessed short R&D and operations life cycles and utilized known technologies. Second, the mission abided by NASA's preferences involving "no exchange of funds" and "protection against unwanted technology transfer." Third, it focused on a specific aspect of transnational collaboration among scientific communities to explore and study the third dimension of the heliosphere (i.e., solar environment in Sun polar orbit). Fourth, ISPM was considered the first cooperative venture where Europe was viewed as a genuine partner.[51]

Despite these favorable conditions for international cooperation, the political dynamics of ISPM were problematic. In 1980, one year after NASA signed an ISPM MOU with ESA, NASA announced, due to budgetary restrictions and delays in the STS program, that the ISPM launch would be moved back from 1983 to 1985. This was followed by further US budget cutbacks effectively canceling NASA's promised ISPM probe.[52] The political repercussions of this decision were far reaching to the extent that ESA considered this cancellation as a loss of confidence in NASA as a partner in international space activities. This outcome raised questions within ESA on the viability of international cooperation between the US and Europe and on the legal utility of IGAs and MOUs.

ISPM cooperation was undermined by US institutional constraints exacerbated by different legal and budgetary systems in the US and Europe.[53] These constraints are both procedural— abrupt policy changes and short-term budget cycles— and structural— no system for forcing compliance with IGA/MOU based agreements and the exclusion of ESA and foreign partners from critical funding decisions.[54] Ironically, NASA, which insisted upon noncompletion contingencies in its cooperative agreements with Europe due to concerns on their abilities to follow through with their commitments, was unable to honor its 1979 ISPM MOU obligation to provide one of the two planned solar polar probes. Additionally, inclusion within the MOU of an "availability of funds clause" that allows domestic law, when in conflict, to supersede international obligations played an important factor in NASA's termination of its planned solar polar probe.

An annual authorizations and appropriations process domestically restricted NASA. In budget requests to Congress in 1980, the House Appropriations Committee, with responsibility for funding NASA, recommended termination of ISPM. These funding constraints were compounded by NASA priorities on other space science missions, such as Galileo and the HST, and the growing costs of STS development.[55]

This led to a budget compromise in 1981 with the Reagan Presidential administration that reduced ISPM funding to a level that forced the abrogation of NASA's planned probe.

Though NASA fulfilled other parts of the MOU (i.e., power units, launching and telemetry tracking), ESA interpreted the cancellation as a fundamental legal breach of NASA's international obligations. ESA was excluded from decision-making process in the US in what was supposed to be an international program between equal partners.[56] This is exemplified by the fact that ESA's Director General was informed about the abrogation only hours before it was made public.

In the US, IGAs and MOUs are not legally binding in domestic law. They are executive agreements that cannot legally bind Congress and in particular, cannot take precedence over statutory requirements for annual budget legislation related to NASA's authorization and appropriation bills. In Europe, IGAs and MOUs are equivalent to international treaties that prevail over domestic laws in that they are systematically ratified by national parliamentary systems. For ESA, these type of agreements are binding international agreements sanctioned by all its member states pursuant to ESA's Convention.[57]

Linked to these legal interpretations are differences in budgetary politics. In contrast to the annual authorization and appropriations budget cycles in the US, ESA's mandatory programs— space science programs[58]— enjoy five year budget cycles.[59] Clashing legal interpretations and funding procedures have established an imbalance in the level of political commitment to cooperation between the US and Europe.[60] Paradoxically, it is this imbalance that sparked the emergence of mutually interdependent US-European cooperative space relations.

Given the funds and time committed to ISPM/Ulysses, ESA had no choice but to acquiesce (i.e., proceed with a one probe mission renamed Ulysses).[61] While ISPM/Ulysses questioned US-European space cooperation, it also reinforced European drives for autonomy in space. This is exhibited by ESA's Giotto space science mission to Halley's Comet and a planned all-European Space Observatory. In light of ISPM/Ulysses, both of these missions, which at first were seen as candidates for cooperation with NASA, were implemented independently by ESA.

The political fall out over ISPM/Ulysses resulted in a decade passing— 1979 to 1989— before the next MOU between ESA and NASA was concluded in space sciences (e.g., ISTP). One striking feature of the ISTP MOU is the degree of detail it enters as compared to past MOU agreements. This denotes not only a sign of caution being exercised, but also a measure of European autonomy in authority and decision-making.[62] The ISTP MOU addresses funding difficulties, obliges the parties to consult with each other before making any decisions that could affect the project and allows for joint contingency planning that is "for the benefit of the program as a whole."[63]

United States -Japanese Space Cooperation

Space relations between the US and Japan are typified by a "leader-follow" approach. The US was willing to take the lead on cooperative space relations for foreign policy reasons directed at assisting in Japan's postwar reconstruction and integration into the Western strategic alliance.[64] Japan, as is the case with ESA, promoted and participated in space projects involving international cooperation with NASA in order to attain indigenous capabilities in space. This was accomplished by following the lead of the US. Japan identified the leader in technological capability (i.e., NASA) and then sought to learn as much as possible from its accomplishments to develop a strong indigenous technological base. Japan has developed its space program by importing off-the-shelf space technology and know-how from the US.[65]

These US and Japanese preferences led to a 1969 agreement between the governments that allowed Japan to work with US industry to transfer selected launch vehicle and satellite technologies. For foreign policy reasons, the US departed from one of its cornerstones of cooperation based on protecting the transfer of important space-based technologies.[66] Even though technology transfer ended by 1978-1979, Japan was able to indigenously develop and build launch vehicles and communications and Earth observation satellites.

As with US-European space relations, Japan's more symmetrical space capabilities spawned additional avenues of cooperation with the US in scientific, Earth observation, public service communications and human spaceflight missions. For example, Japan cooperates with NASA's Earth Sciences (ES) enterprise and actively participates in the worldwide global change research effort. Japanese experiments and astronauts have flown on STS and Japan is an integral part of ISS. Regarding ISS, Japan has agreed to develop an experimental laboratory module and to utilize its H-2 ELV for assembly and operations support. Japan is also active in promoting vis-à-vis international fora space cooperation for lunar exploration and development.[67]

United States-Soviet/Russia Space Cooperation

Relations in space between the US and Soviet/Russia are characterized by an intergovernmental paradigm involving both competition and cooperation.[68] Competition was reflected by Cold War politics where the US sought global preeminence and the preservation of national security in space. Cooperation exists among US and Soviet/Russian scientific communities.[69] Even in the absence of direct governmental cooperation and in periods of Cold War competition, as both IGY and IACG exhibit, transnational scientific collaboration has been sustained. Operationally, this implied Cold War competition in human spaceflight, space technology and engineering and cooperation in space sciences.[70] US-Soviet/Russian cooperation in space has never existed merely for the sake of cooperation itself rather, it is a product of compatible policy preferences symbolic of stable and friendly overall political relations.[71]

Cooperative relations in space between the US and Soviet/Russia have evolved over five distinct historical periods: (1) 1957 to 1971; (2) 1971 to 1979; (3) 1980 to 1987; (4) 1987 to 1991; and (5) 1992 to the present. The first period, 1957 to 1971, is characterized by scientific collaboration and the space race. Cooperation was initially limited to international nongovernmental scientific forums such as the IGY and its parent groups the ICSU and COSPAR.[72] These scientific venues led to a 1962 MOU between NASA and the Soviet Academy of Sciences to implement cooperative programs through joint working groups in satellite-based meteorology, geomagnetism and communications.[73] Cooperation also existed in the codification of international space law as represented by the 1967 Outer Space Treaty. The US and Soviet/Russia sought to ensure peaceful scientific cooperation in space that could benefit all humankind as well as to establish a legal precedent of unfettered access to space and "freedom of passage" in space to allow for satellite reconnaissance.[74]

Stable and friendly relations symbolized by a policy of détente earmarked the second period— 1971 to 1979. President Nixon's policy of détente, implemented through the Partial Test Ban, Outer Space, Nuclear Non-Proliferation and Strategic Arms Limitation (SALT-I) treaties, included US-Soviet/Russian cooperation in science, technology and space. The US and Soviet/Russia signed an umbrella IGA for "Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes" in 1972 and 1977.[75] Cooperation involved exchanges of information through the establishment of joint scientific working groups between American and Soviet space scientists with respect to projects each carried on independently.

These projects included satellite meteorology, meteorological sounding rockets, research on the Earth's environment, robotic exploration of the Earth space, the Moon and other planets and space biology and medicine.[76] Only in the field of compatible rendezvous and docking capabilities, represented by the ASTP mission, was there any joining of human and technological resources on a common endeavor.[77] Of note is that the 1972 and 1977 IGA agreements sanctioned the sharing of scientific knowledge, but forbid technology transfer.

The collapse of détente and the resumption of a Cold War rivalry and US-Soviet/Russian antagonistic competition demarcated the third period— 1980 to 1987. Nonetheless, space cooperation persisted.[78] Examples include the satellite aided search and rescue project (COSPAS-SARSAT) involving cooperation between Soviet/Russia and the US, Canada and France, bilateral cooperation with the US in planetary data exchanges and joint US-Soviet biomedical experiments. Cooperation also took place among the superpowers with respect to IACG.

The scientific and technical coordination that took place under the auspices of the IACG needed for implementation of Halley's Comet rendezvous mission resulted in cooperation that leapfrogged political arrangements at the time. A permanent hot line was established between ESA's European Space Operations Center and the Soviet Institute for Space Research along with a computer-to-computer link between the ESA center and NASA's Jet Propulsion Laboratory (JPL). Due to political considerations, all data transmitted between the Soviet Institute for Space Research and JPL had to be run through the European Space Operations Center since the US and former Soviet Union had no formal state-to-state agreement sanctioning cooperation in space at that time.

The fourth period, 1987 to 1991, is distinguished by a resurrection of formal cooperative intergovernmental relations. With the ascendance of Gorbachev to the position of Soviet Premiere and the policies of Glasnost and Peristrokia, US-Soviet/Russian relations in space resumed the formal cooperative arrangements realized during détente in the 1970s. This entailed a 1987 IGA for cooperation in space that brought back the joint working group structures of the 1972 and 1977 IGAs. Joint working groups were established in space biology, space medicine, solar system exploration, astronomy, astrophysics, space physics and Earth sciences.

The final period, 1992 to the present, witnessed the dissolution of the Soviet Union and the end of the Cold War. This led to a greater degree of cooperation between the US and Russia than ever before. In 1992, an IGA was signed to continue with and expand the space cooperation that was established in the 1972, 1977 and 1987 IGAs. The 1992 IGA sought to expand space cooperation in such areas as robotic exploration of Mars (e.g., Mars Together 98)[79] and Earth science flight projects.[80]

The pinnacle of US-Russian space cooperation was reached in the invitation to include Russia in ISS. This invitation initially led to cooperation in human spaceflight involving rendezvous, docking and exchange of astronauts/cosmonauts between STS and the Russian Mir space station and a contract with the Russian Scientific Production Association (NPO Energia) to study the potential use of the Soyuz spacecraft as an interim crew return rescue vehicle for ISS.[81] The NASA-NPO Energia contract, the first between NASA and a Russian company, was a significant departure from Cold War politics. Suddenly, the American civil space program was directly funding its historical competitor.[82]

US-Russian cooperation on ISS was consummated in a 1998 IGA "Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station."[83] This agreement functionally integrated Russia into the infrastructure and critical path of the Space Station program of NASA and its Western allies— Europe, Japan and Canada.

Apollo-Soyuz Test Project

ASTP was the first cooperative human spaceflight mission. Cooperation was a result of political symbolism and functional concerns. Apollo-Soyuz was driven by a convergence of political symbolic norms centered on détente.[84] The project was seen as a foreign policy tool aimed at relaxing Cold War tensions and future areas of potential conflict between the superpowers.

A bilateral IGA served as the vehicle for cooperation on ASTP. In 1970 and 1971, agreements were reached between NASA and the Soviet Academy of Sciences entailing organization of Apollo-Soyuz. These agreements served as the basis for the IGA "Concerning Cooperation in the Exploration and Use of Outer Space for Peaceful Purposes" signed by Soviet Premier Kosygin and President Nixon at the 1972 superpower summit in Moscow. This IGA endorsed a joint working group structure between the respective national space agencies to implement Apollo-Soyuz.[85]

Functional cooperation involved joint working groups of scientists and engineers. These working groups predated the 1972 IGA.[86] Cooperation took place in the development of an androgynous docking mechanism, coordination of mission plans, science experiments and data and telemetry tracking requirements. Both countries agreed to design and fabrication details, while hardware development was conducted independently to minimize technology transfer. The docking mechanism served to enhance the safety of human spaceflight by allowing for rescue missions and providing opportunities for conducting joint scientific experiments in LEO.

ASTP took place because both the US and Soviet/Russia decided that they could realize important policy preferences in a cooperative endeavor. For the US, ASTP enabled a firsthand look at Soviet capabilities in space, served as an important policy bridge for NASA between the ending of the Apollo era and start of the STS program[87] and allowed for the siting of Earth remote sensing photographic equipment. The former Soviet Union viewed ASTP more in symbolic terms. Foremost, ASTP implied that the Soviet/Russian space program was comparable to NASA's in its technological capabilities and know-how.

Space Station Freedom and International Space Station

NASA's Space Station program has evolved over three distinct phases of cooperation. The first phase, 1982 to 1984, dealt with coordination of mission concepts. From 1982 to 1983, NASA, European, Japanese and Canadian space agency experts discussed plans for Space Station although no respective government had approved such a program.[88]

The second phase of cooperation, 1984 to 1988, entailed agreements on a multilateral IGA and bilateral MOUs between NASA and its foreign partners. In 1984, President Reagan directed NASA to develop a Space Station and to "invite other countries to participate so we can strengthen peace, build prosperity and expand freedom for all that share our goals."[89] The European, Japanese and Canadian governments responded by publicly stating their commitments to participate. These initiatives were followed by a four-year period of negotiations— 1984 to 1988— on an IGA/MOU framework of cooperation for SSF.

Similar to ISPM/Ulysses, different interpretations regarding IGA and MOU legalities became a factor during negotiations. This led ESA to insist upon a single multilateral IGA even though NASA preferred separate MOU bilateral arrangements.[90] Eventually, a compromise was reached on both a multilateral IGA among the US, Europe, Japan and Canada and a series of bilateral MOUs between NASA and its foreign partners.[91] This combined multilateral-bilateral arrangement has served as the basis for cooperation throughout the Space Station program.

The SSF partnership was characterized by an asymmetry in NASA's favor. Foreign partners were dependent on NASA for a major aspect of their future human activities in space since their specific Space Station elements could not function without being attached to NASA's "core" station.[92] The IGA and MOU agreements abided by NASA's policy preferences with respect to no exchange of funds, clean technology interfaces, control of critical path items and protection of sensitive technologies.

Domestic policy preferences rooted in the incremental nature of congressional budgetary politics also influenced international cooperation.[93] Without involving its partners directly in the decision-making process, congressional appropriators forced NASA, from 1986 to 1993, to design and redesign the Space Station several times because of rising costs and less than expected funding. Domestic budget constraints forced NASA to cut costs by reducing redundant contributions among partners.

Ironically, this mitigated the extent to which NASA was able to remain independent of its international partners for the completion of SSF which, in turn, enhanced the program's interdependence. In addition to NASA's dependence on the Canadian mobile servicing center for assembly and operations, the program became dependent on ASI's mini-pressurized logistics modules for getting cargo to and from the core station. In the latter instance, NASA abandoned its earlier plans to develop modules for this purpose as part of a 1993 redesign.

The third phase of cooperation emerged in light of changes in international politics regarding the dissolution of the Soviet Union in 1991-1992. As a result, Space Station became symbolic of post-Cold War politics signified by enhanced US-Russian cooperation in world affairs. Through an IGA concluded in 1998 "Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station"[94] Russia became politically and functionally incorporated into the Space Station program.

In the course of incorporating Russia, NASA departed from its traditional policy preferences of cooperation.[95] First, the US authorized the transfer of NASA funds contracted out in Russian goods and services for Space Station. Second, Russian contributions are in the critical path items of what is now a NASA-Russian "core" Space Station. Russia is substantially involved in early assembly and provides critical path infrastructure elements on which the partnership depends throughout the program.

International Telecommunications Satellite Consortium

The objective of INTELSAT is to provide on a commercial basis the space segment for public telecommunications services.[96] This includes satellites and other equipment required to support the operation of spaceborne telecommunications. INTELSAT was established as an international consortium in 1964 on the basis of Interim Arrangements and in 1971 through Definitive Arrangements for the regulation of telecommunication satellite systems.[97]

Through INTELSAT the US sought to realize international and national preferences. International preferences were directed at "the American crusade on behalf of space for the benefit of all mankind."[98] National preferences were concerned with maintaining technological and commercial leadership in telecommunication satellite development. The US wished to preserve its technological advantages in this new commercial sector, while ensuring that benefits of communicating via satellites were available to all countries whatever their stage of economic development.[99]

INTELSAT was initially set-up under the auspices of a US government-owned Communications Satellite Corporation (COMSAT). From 1964 to 1980, COMSAT managed and effectively controlled INTELSAT. COMSAT was a majority shareholder initially controlling 61% of INTELSAT investment shares with the stipulation that in the future, as the Consortium inevitably would expand its membership, the US share must not fall below 50.6%. In the first generation, COMSAT had close to all INTELSAT contracts.[100]

The transformation of INTELSAT into an international organization (IO), characterized by institutional patterns of cooperation and equitable distributions of resources, occurred in the 1970s as membership expanded from 15 to 116 states and telecommunications satellite technology diffused worldwide. This institutional genesis is based on the notion that the state acting unilaterally is increasingly dysfunctional in coping with complex technology.[101] The commercialization of telecommunications throughout the world and economic competition that ensued mollified against US dominance over the Consortium.

INTELSAT was institutionalized as an IO based on an Operating Agreement reached in 1971. This agreement established INTELSAT as an economic club with private firms and state-governments as members.[102] Members pay fees according to their investment shares and utilization rights; investment shares equal a member's allocated percentage of utilization of INTELSAT's space segment. Investment shares and utilization rights are allocated through a weighted decision-making system. The terms of INTELSAT's Operating Agreement represented a power shift to multilateral authority and decision-making patterns. Accordingly, the US investment share through COMSAT, since 1988, has been at the 20-25% level. The US crafted INTELSAT to suit its policy preferences. Over time, economic and technological changes that took place in telecommunication satellites engendered a greater degree of compatible preferences that led to more equitable distributions of telecommunication resources.

International Space Law

The Soviet launching of the first Earth orbiting satellite in 1957— Sputnik— created an international legal problem related to sovereignty in outer space.[103] This problem led to evolution of an International Space Law Regime. The Regime was based on tacit acceptance of the "Sputnik precedent." This precedent is an accepted principle among states officially recognizing free access to and unfettered passage through outer space for peaceful purposes.[104] Codification of this precedent took place in the United Nations (UN) system with the establishment of the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) in 1958.

An UNCOPUOS-sponsored General Assembly resolution of 1961 recognized the applicability of international law and the UN Charter to space and was the benchmark of the first major achievement in US-Soviet space cooperation.[105] This was followed by additional resolutions that banned nuclear weapons from space and advocated principles for international cooperation and peaceful uses of outer space. These resolutions were formalized in a 1967 "Treaty on Principles Governing the Activities of States in the Exploration and Uses of Outer Space, Including the Moon and Celestial Bodies."[106]

The Outer Space Treaty is the basic framework for international space law. It incorporates a number of principles that include:

> The exploration and use of outer space shall be carried out for the **benefit and in the interests of all countries and shall be the province of all mankind.**
>
> Outer space shall be **free for exploration and use by all states.**
>
> Outer space is **not subject to national appropriation** by claim of sovereignty, by means of use or occupation or by any other means.

> States shall **not place nuclear weapons or other weapons of mass destruction** in orbit or on celestial bodies or station them in outer space in any other manner.
>
> The Moon and other celestial bodies **shall be used exclusively for peaceful purposes.**[107]

Since the ratification of the Outer Space Treaty in 1967, international cooperation on space law has resulted in the Rescue and Return of Astronauts Treaty (1968), International Liability Convention (1972), Convention on Registration of Objects (1975) and Moon Treaty (1979). This body of international space law is considered an institutional legal regime that fundamentally guarantees free and unfettered access to space.

The Moon Treaty is the last of a first generation of international space law. Concomitantly, it has proven to be the most difficult in terms of securing international acceptance; it has only been ratified by eight states and among them no major spacefaring power. The Moon Treaty seeks to address the question of private property rights on the Moon and other celestial bodies.[108] In this Treaty, the Moon is designated as the common heritage of mankind that forbids ownership of lunar resources by states or nonstate entities. Rather, it seeks to establish an international regime to govern exploitation and development of lunar resources once technically feasible. Over these issues of ownership, exploitation and development, space law between the major spacefaring powers broke down. This was due to the interpretation that the Moon Treaty represents a disincentive (because of the commons designation and international control vis-à-vis a regime) to the development of lunar resources.[109] Sovereign concerns over economic and technological development has until now prevented international acceptance of the Moon Treaty.

European Space Agency

ESA is unique in the annals of international cooperation in that it is the only multinational space agency. The origins of ESA date back to ESRO and ELDO. ESRO, in particular, fostered collaboration in space sciences among European scientists and national space agencies. Such cooperation served as basis for the formation of ESA in 1975 and ratification of its Convention in 1980. Strong political support for ESA is linked to governing principles that focus on space sciences, multilateral decision-making processes and equitable geographical and industrial distributions of space technology and development projects.

The ESA Convention establishes an institutional legal framework requiring all member states to participate and contribute funds to mandatory scientific and technological research projects.[110] This has encouraged a high degree of involvement and collaboration among European scientists. ESA manages technical and scientific aspects of mandatory programs through a Science Program Committee (SPC) composed of member state delegates with competence in scientific matters. This community provides for common facilities, such as launchers, telemetry tracking and operations and has authority over mandatory space science projects. A supranational legislative council composed of member states establishes political approval and funding levels for these projects. These projects are protected from unwanted changes by requiring a two-thirds majority in council to change decisions.[111]

The concepts of mandatory and gross domestic product (GDP) based contributions, which safeguard ESA programs from national political pressures, are important to cooperation. Programs are driven primarily by scientific merit and secondarily by political and industrial considerations. This is reinforced by the close working relationship that exists between European space science communities and the SPC.

As ESA's science policy is structured to serve the scientific community independent of political interests, ESA's industrial policy is arranged to share economic and technological resources in an equitable fashion. "Just retour" (just return) is the mechanism that governs industrial policy. This is measured through an industrial return coefficient that is calculated as the ratio of all contracts placed by ESA in the space industry of a given member state to the budget that ESA spends on projects as a whole. Just return has had a positive effect on political support for ESA activities since it has developed competencies in member states where the industrial capacity is not sufficient to meet return levels.[112]

The ESA model of international cooperation works because it coordinates and balances the policy positions of various European national space programs such as French autonomy concerns exemplified by Ariane ELV with German and Italian preferences for cooperative missions with NASA. ESA's ability to coexist with Europe's various national space programs lies with the restriction of its funding to common facilities, the preservation of independence for space science research groups where space science experiments are financially supported by national space agencies, the distribution of resources in an equitable fashion and the provision of optional programs in human spaceflight (e.g., ESL and participation in ISS), Earth sciences (e.g., CEOS) and space applications such as telecommunications and remote sensing.[113]

Inter-Agency Consultative Group

The IACG was established in 1981 as a multilateral organization involving European, Japanese, Soviet/Russian and US scientists and their respective national space institutes or national space agency representatives. Its mission goals, which were successfully realized, were to coordinate nationally approved missions to rendezvous with and scientifically study Halley's Comet. This success is attributable to several factors: concern with coordinating space science observations of Halley's Comet that were already approved by national space agencies; mission goals that were specific and well-defined scientifically; and a maximum of informality and a minimum of bureaucracy in that communities of space scientists dominated the cooperative process.[114]

Participating scientists within IACG conceptualized a "Pathfinder" mission coordination concept that allowed for the optimization of mission objectives for each national spacecraft that encountered Halley's comet.[115] This placated sovereign concerns over authority and decision-making since Pathfinder was desirable for scientific enhancement, but not functionally enabling to individual national spacecraft. The IACG focused on coordination of science to the exclusion of augmented or integrated hardware development that would necessitate some degree of technology transfer. These aspects are reflected in IACG terms of reference including no technology transfer, no exchange of funds and an advisory role to member space agencies. On this basis, the IACG was able to function as a viable multilateral organization that reinforced historical patterns of collaboration in data exchange and analysis prevalent in space science missions since IGY.

Annual meetings of the IACG were held from the group's formation in 1981 to mission implementation in 1986. These meetings were informal with delegations composed of senior scientists and managers from ESA, Japanese Institute for Space and Astronomical Science, Soviet Institute for Space Research and NASA as well as professional astronomers from the International Halley Watch.[116] Transnational alliances of space science communities dominated the IACG. The people who were involved for the duration of the Halley mission were by no means strangers, rather they were international colleagues who had collaborated and shared information on various projects through the fora of international conferences on space.[117]

The success of IACG was viewed as a compelling reason for the organization to extend its duration.[118] This took place through coordination of solar terrestrial science programs (i.e., ISTP) underway in ESA, Japan, Russia and NASA. However, this second phase of cooperation has proven to be problematic for the IACG. The expansion of the IACG, due to the size and complexity of coordinating over thirty satellites and quadrilateral (Europe, Japan, Russia and US) coordination for solar terrestrial science, caused the group to become less an informal community of scientists and more a formalized bureaucracy. In addition, the IACG lacked requisite organizational mechanisms like a formalized organizational charter specifying decision-making procedures and distributions of financial resources. This has resulted in a level of commitment that is not commensurate with the task at hand for ISTP.[119]

Earth Observations from Space

International cooperation pertaining to Earth observations by satellites directed at assessing global environmental change is a result of institutional bargaining. This collaborative bargaining milieu is more explicitly charted in Table 2 for global change R&D. Collaboration has taken place among state-governments (e.g., US Global Change Research Program) and national space agency Earth observation offices and programs, nongovernmental organizations (e.g., International Council of Scientific Unions, World Meteorological Organization), intergovernmental organizations (e.g., UN Environmental Program, Intergovernmental Oceanographic Commission) and "Earth science" communities within, for example, NASA and foreign national space agencies, International Geosphere-Biosphere Program and the UN World Climate Research Program.[120] Coordination among these organizations for spaceborne global change research has primarily taken place through CEOS.[121]

Table 2. Global change research and development collaboration.*

Activity Level	Political Actors
Subnational ***(United States)***	American Meteorological Society (AMS); American Geophysical Union (AGU); Center for Global Change; Electric Power Research Institute (EPRI); Environment Defense Fund (EDF); Federation of American Scientists (FAS); Global Tomorrow Coalition; National Academy of Sciences (NAS); Goddard Institute for Space Studies (GISS); National Center for Atmospheric Research (NCAR); Natural Resources Defense Council (NRDC); National Climatic Data Center (NCDC); Physicians for Social Responsibility (PSR); Sierra Club; Union of Concerned Scientists (UCS); World Resources Institute (WRI); Worldwatch Institute.
National ***(United States)***	US Global Change Research Program (USGCRP)-- Subcommittee on Global Change Research (SGCR)[122] Department of Agriculture (USDA); National Oceanic and Atmospheric Administration (NOAA); Department of Defense (DOD); Department of Energy (DOE); National Institute for Environmental Health Sciences (NIH); US Geological Survey (USGS); Department of State; Environmental Protection Agency (EPA); National Aeronautics and Space Administration (NASA); National Science Foundation (NSF); Smithsonian Institution (SI).
Transnational	Greenpeace; International Council of Scientific Unions (ICSU); International Geosphere Biosphere Program (IGBP).
International	UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS); UN Conference on Environment and Development (UNCED); Economic and Social Commission of Asia and the Pacific (ESCAP); UN Education, Scientific and Cultural Organization (UNESCO); UN Environmental Program (UNEP); Food and Agricultural Organization (FAO); UN Framework Convention on Climate Change (UNFCCC); Intergovernmental Oceanographic Commission (IOC); World Climate Research Program (WCRP); World Commission on the Environment and Development (UNWCED); World Meteorological Organization (WMO).
Cross-Level ***(National, Transnational & International)***	Committee on Earth Observation Satellites (CEOS) Global Climate Observing System— ICSU, UNESCO, UNEP, IOC and WMO Global Ocean Observing System— ICSU, UNEP and WMO Global Terrestrial Observing System— ICSU, UNESCO, UNEP, FAO, and WMO Intergovernmental Panel on Climate Change (IPCC)— UNEP and WMO

*Source: Eligar Sadeh, "Modeling International Collaboration for Global Environmental Problem Solving," in W. D. Kay and Vicki L. Golich, eds., *International Collaboration in Science and Technology in Advanced Industrial Societies* (New York, New York: Routledge, forthcoming).

The goal of this collaborative bargaining milieu is to advance scientific knowledge of the Earth's environment to understand and predict human-induced and natural global environmental change phenomena. Science serves as the end, while politics, a broad-based institutional structure of states, IOs and scientific communities, provide the means. One of the crucial factors in this case of international cooperation is the ability of transnational networks of Earth scientists to work together in analyzing global change data and to translate those analyses into policy relevant actions. This involves both mission coordination and addressing such issues as property rights, conditions and access to data, data pricing, periods of exclusive use and data archiving.[123] In this regard, cooperation is to ensure that observations will be available to meet scientific and operational needs as well as satisfy data access and data exchange requirements for all parties as effectively and economically as possible.

Cooperation is influenced by political considerations concerned with data policies, national sovereignty and national security issues.[124] The existence of disparate and incompatible data access polices among various satellite types and programs, for example, is reinforced in the retention of property rights by data producers, the requirement of licenses to use data and the pricing of data above marginal costs of fulfilling user requirements.[125] Harmonizing policies over these issues is one of the most difficult hurdles to surmount in fashioning international agreements. If cooperation is not to be precluded, advocates of both "all users must pay for profit" and "government development for public benefit" approaches must be reconciled.[126]

CEOS was created in 1984 to coordinate data management and policy issues for all spaceborne Earth observation missions.[127] Membership in CEOS is open to all international and national organizations responsible for Earth observation satellites currently operating or in development phases.[128] The primary objectives of CEOS are to (a) optimize the benefits of spaceborne Earth observations through cooperation of its members in mission planning and in the development of compatible data products, formats, services, applications and policies; (b) aid both its members and the international user community through international coordination of spaceborne Earth observation activities; and (c) exchange technical information to encourage compatibility among the spaceborne Earth observation systems.[129]

CEOS data exchange principles have been adopted for global environmental change research use and for operational public benefit use with the agreement to make data available to each member in these user categories with no period of exclusive use and on a nondiscriminatory basis. There is a commitment to provide data at the lowest possible cost to bona fide researchers and to harmonize and preserve all data needed for long-term global change research and monitoring.[130] Intellectual property rights, pricing policies and data archiving issues have yet to be addressed within CEOS.

The concern with sovereignty has been that Earth remote sensed data undercuts the ability of the state to control knowledge both in its creation and application.[131] One important sovereignty concern is the proliferation of commercial remote sensing systems. Both the US government and ESA currently promote commercialization of spaceborne remote sensing.[132] This gives rise to knowledge diffusion and "sovereignty bargains." Such bargains, which promote cooperation, exist when states cede on aspects of their sovereignty (i.e., allow their territories to be remotely sensed) to get the benefits of sharing in the knowledge (e.g., Earth observation data).[133]

National security issues surrounding Earth remote sensing emanate from the proliferation of high-resolution (e.g., <10 meters spatial resolution) commercial satellite imagery. Imagery at this resolution has potential security repercussions such as undermining foundations of deterrence through an increased certainty of an adversary's capabilities, engendering conflict based on misinterpretation of satellite imagery and altering balances of power. These factors are exacerbated given that an asymmetrical access to satellite imagery and processing capabilities provides substantial advantages for some states over others.[134]

Earth observed data gathered by security based reconnaissance systems have also played a role in international cooperation related to assessments of global environmental phenomena. The US Department of Defense (DOD) has identified its reconnaissance systems as useful for planetary management.[135] In 1991, DOD initiated a Strategic Environmental Research and Development Program and has since established an office for environmental security. The intent is to use military space satellite systems to deal with problems of instability, ethnic tensions and violent conflict that may have at their base environmental factors. Additionally, a group of Earth system environmental scientists have been given access to classified satellite reconnaissance data to study global change.[136]

ASSESSMENT OF LITERATURE

There are analytical shortcomings, in terms of historical substance and systemic evaluations, in the current literature of international space cooperation. First, there is a dearth of published literature that comprehensively describes cooperation for either Space Station or Earth observations from space. This study documents the evolution of cooperative dynamics in both of these cases in Chapters Four and Five respectively.

Second, very little work exists which attempts to search for distinctive and systematic patterns (i.e., dynamics) of cooperation. In the chapters that follow, this study builds upon approaches that have been put forward in the literature on international space cooperation[137] to systematically assess intergovernmental patterns of space cooperation and to consider policy and broader theoretical implications.

Finally, it is important to note that there is a gap in understanding the emerging nature of cooperative relations involving commercial sectors of space. Commercial space relations characterize current trends of space cooperation.[138] The future of international space cooperation will be based on market factors as well as policy preferences of states. Future research on international space cooperation will undoubtedly have to explicitly consider market factors and globalization processes.

NOTES TO CHAPTER TWO

[1]See Dodd L. Harvey and Linda C. Ciccoritti, "US-Soviet Cooperation in Space," *Monographs in International Affairs* (Miami, Florida: Center for Advanced International Studies, University of Miami, 1974), 1-22; Arnold Frutkin, *International Cooperation in Space* (Englewood Cliffs, New Jersey: Prentice-Hall, 1965), 17-23.

[2]Moved by an inherent "idealism" scientists in the United States thought of cooperation in space sciences as a means by which to lessen Cold War tensions. See Homer E. Nevell, *Beyond the Atmosphere: Early Years of Space Science* (Washington, DC: Government Printing Office, 1980), 299-318.

[3]"National Aeronautics and Space Act of 1958," United States Public Law 85-568, in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: Government Printing Office, 1995), 335 and 339.

[4]See "National Aeronautics and Space Act of 1958," 335.

[5]See Richard W. Porter to Professor Dr. H. C. van de Hulst, President, Committee on Space Research (COSPAR), March 14, 1959, in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume II: External Relations* (Washington, DC: Government Printing Office, 1996), 18-19.

[6]See Lorenza Sebesta, *United States-European Cooperation in Space During the Sixties*, ESA HSR-14 (Noordwijk, Netherlands: ESA Publications Division, July 1994).

[7]See "The Development of International Space Cooperation," in *Exploring the Unknown, Volume II*, 1-15.

[8]See "Office of the Press Secretary, Statement by the President," July 29, 1958, in *Exploring the Unknown, Volume II*, 16.

[9]Richard Barnes, Former Director, International Affairs Division, NASA Headquarters, interview by author, Washington, DC, January 13, 1998.

[10]See "Initiation and Development of International Cooperation in Space and Aeronautical Programs" (Washington, DC: NASA Management Instruction, NASA Office of International Relations, NASA Headquarters, December 31, 1991 to December 31, 1994); and Kenneth S. Pederson, "Thoughts on International Space Cooperation and Interests in the Post Cold War World," *Space Policy* 8, 3 (1992): 205-220.

[11]See Stephen M. Shaffer and Lisa R. Shaffer, "The Politics of International Cooperation: A Comparison of United States Experience in Space and in Security."

Monograph Series in World Affairs 17, 4 (Denver, Colorado: Graduate School of International Studies, University of Denver, 1980): 11-13.

[12]See "Agreement Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation and the Government of the United States of America Concerning Cooperation on the Civil International Space Station," January 29, 1998.

[13]For an excellent overview of the development of the European space program see Kevin Madders, *A New Force at a New Frontier: Europe's Development in the Space Field in the light of its Main Actors, Policies, Law and Activities from its Beginnings up to the Present* (Cambridge, England: Cambridge University Press, 1997).

[14]See John M. Logsdon, "US-European Cooperation in Space Science: A 25-Year Perspective," *Science* 223, 4631 (1984): 11-16.

[15]Richard Barnes, interview by author.

[16]Space Station Freedom was designated the International Space Station in 1993.

[17]See Sebesta, *United States-European Cooperation in Space During the Sixties,* 6-8.

[18]See Stephen B. Johnson, "Insuring the Future: The Development and Diffusion of Systems Management in the American and European Space Programs" (Ph.D. dissertation, University of Minnesota, 1997).

[19]See Frutkin, *International Cooperation,* 141.

[20]The one exception to these bilateral agreements was the memorandum of understanding signed with Germany in 1969 for cooperation on the Helios solar spacecraft. See Sebesta, *United States-European Cooperation in Space During the Sixties,* 11-12.

[21]The European Space and Research Organization sponsored 57 sounding rocket launches from 1964 to 1967. See John Krige, *Europe in Space: The Auger Years (1959-1967),* ESA HSR-8 (Noordwijk, Netherlands: ESA Publications Division, May 1993), 50-53.

[22]These satellite missions involved the European Space Research Organization (ESRO) and High Eccentric Orbiting Satellite (HEOS) scientific satellite programs. In both of these programs, the Europeans extensively borrowed from American systems management models. This enabled ESRO to successfully implement ESRO and HEOS

satellite programs. See Johnson, "Insuring the Future," 275-314. Also, see Arturo Russo, *The Definition of Scientific Policy: ESRO's Satellite Programme in 1969-1973*, ESA HSR-6 (Noordwijk, Netherlands: ESA Publications Division, March 1993); Arturo Russo, *Choosing ESRO's First Scientific Satellites*, ESA HSR-3 (Noordwijk, Netherlands: ESA Publications Division, November 1992); and Arturo Russo, *ESRO's First Scientific Satellite Programme, 1961-1966*, ESA HSR-2 (Noordwijk, Netherlands: ESA Publications Division, October 1992).

[23]The restraints on technology transfer, however, were still extensive. They dealt with every aspect of technology critical to development of communication satellite capabilities and production techniques as well as equipment and manufacturing processes pertaining to satellites and launch vehicles or components thereof. See Lorenza Sebesta, *The Availability of American Launchers and Europe's Decision 'To Go It Alone,'* ESA HSR-18 (Noordwijk, Netherlands: ESA Publications Division, September 1996), 21.

[24]The European Launch and Development Organization (ELDO) failed in its attempts to develop a Europa expendable launch vehicle. The Europa program failed due to the inability of ELDO to acquire and adapt to an American model of large-scale systems and engineering management. From its inception in 1962, ELDO was organized for failure. See Johnson, "Insuring the Future," 256-274.

[25]The technology gap was primarily a managerial and organizational one related to large-scale systems management capabilities. See Johnson, "Insuring the Future," 241-247. For an overview of this "technology gap" and US policy on technology transfer to Europe from 1964 to 1972, see Sebesta, *The Availability of American Launchers*, 1-32; and Lorenza Sebesta, "The Politics of Technological Cooperation in Space: US-European Negotiations on the Post-Apollo Program," *History and Technology* 11 (1994): 319-326.

[26]See Space Task Group, *The Post-Apollo Space Program: Directions for the Future*, September 1969, in *Exploring the Unknown, Volume I*, 535.

[27]See Lorenza Sebesta, *United States-European Space Cooperation in the Post-Apollo Programme*, ESA HSR-15 (Noordwijk, Netherlands: ESA Publications Division, February 1995), 31.

[28]See Sebesta, *United States-European Space Cooperation in the Post-Apollo Programme*, 48.

[29]See Sebesta, *The Availability of American Launchers*, 1-32; and Roger M. Bonnet and Vittorio Manno, *International Cooperation in Space, The Example of the European Space Agency* (Cambridge, Massachusetts: Harvard University Press, 1994), 75-81.

[30]See Sebesta, *Politics of Technological Cooperation in Space*, 330.

[31]See Ibid.

[32]Cooperation on the European Space Lab (ESL) led to an "Americanization," in terms of large-scale systems management and organizational techniques, of the European space effort. See Logsdon, "US-European Cooperation," 14; and Johnson, "Insuring the Future," 308.

[33]See Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 457.

[34]The European Launch and Development Organization (ELDO) was established in the 1960s to develop an indigenous European launch vehicle called Europa. The failure to achieve this goal due to deficiencies in large-scale systems management led to ELDO's liquidation in 1972.

[35]The European Space Agency (ESA) was formed in 1975 on the basis of the European Space and Research Organization (ESRO). See John Krige and Arturo Russo, *Reflections on Europe in Space*, ESA HSR-11 (Noordwijk, Netherlands: ESA Publications Division, January 1994).

[36]See Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 444-476.

[37]NASA's space station program, which today is known as the International Space Station (ISS), was called Space Station Freedom from 1984 to 1992.

[38]Guiseppe Giampalmo, Head, International Relations, European Space Agency Headquarters, interview by author, Paris, France, October 17, 1997.

[39]NASA described its plans for a Space Station program in 1984 to its prospective foreign partners as a "fully functional core space station" that the US will provide. This implied that NASA's part of the Station could function independently and could conceivably be built and operated without foreign participation or contributions. At that time, it was made clear that participation in NASA's core space station was excluded.

[40]See Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 456.

[41]The planned polar platforms were dropped from the Space Station program in 1996. However, the planned Earth observation activities that were to take place on the polar platforms continued on an independent basis. See Chapter Five case study of the International Earth Observing System (IEOS).

[42]The Ariane and European developed Earth remote sensing systems have captured a large percentage (in some cases more than 50%) of commercial space markets in satellite launches and remotely sensed data respectively.

[43]These management and decision-making structures are explained in detail in the Chapter Four case study of NASA's Space Station program. Also, see Lynn F. H. Cline and Graham Gibbs, "Re-Negotiation of the International Space Station Agreements—1993 to 1997" (paper presented at the 48th International Astronautical Congress, Turin, Italy, October 6-10, 1997); and Lynn F. H. Cline, "International Negotiations: The International Space Station Agreements" (paper presented at the 47th International Astronautical Congress, Beijing, China, October 7-11, 1996).

[44]See Lorenza Sebesta, *Spacelab in Context*, ESA HSR-21 (Noordwijk, Netherlands: ESA Publications Division, October 1997), 1-42; and Douglas R. Lord, *Spacelab: An International Success Story* (Washington, DC: Government Printing Office, 1987), 1-29.

[45]See Sebesta, *United States-European Space Cooperation in the Post-Apollo Programme*, 29.

[46]See Sebesta, "Politics of Technological Cooperation," 333.

[47]See Sebesta, *Spacelab in Context;* and Arturo Russo, *Big Technology, Little Science the European Use of Spacelab*, ESA HSR-19 (Noordwijk, Netherlands: ESA Publications Division, August 1997).

[48]Sebesta, *Spacelab in Context*, 36-38.

[49]The only other case of a transfer of funds from NASA to a foreign partner is that regarding Russia's participation in the International Space Station. See Chapter Four for a detailed discussion of this.

[50]See Michael Bourley, "The Legal Hazards of Transatlantic Cooperation in Space," *Space Policy* 6, 4 (1990): 323-331.

[51]See W. D. Kay, "Where No Nation Has Gone Before: Domestic Politics and the First International Space Science Mission," *Journal of Policy History* 5, 4 (1993): 437.

[52]The European Space Agency also provided a probe for the International Solar Polar Mission in what was initially intended to be a two-probe mission.

[53]See Bourley, "The Legal Hazards," 323-331.

[54]See Kay, "Where No Nation Has Gone Before," 445-449.

[55]An additional complication was the embargoing of NASA's budget. This did not allow NASA to alter line item expenses for its programs.

[56]See Kay, "Where No Nation Has Gone Before," 447-448.

[57]For a discussion of the legal asymmetry that exists between the United States and European space programs, see Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 448; and Bourley, "The Legal Hazards," 323-331.

Despite an asymmetry in the legal commitment to intergovernmental agreements and memoranda of understanding between NASA and the European Space Agency, there are a number of stable features. These features include assignment of relative technical responsibilities, designation of management structures, principles for operations, utilization and distribution of technical goods and data, liability and administrative assistance rules, dispute settlement procedures and "no exchange of funds" with the caveat that obligations are subject to domestic authorization and availability of funds.

[58]The European Space Agency programs in human spaceflight and Earth observations are optional.

[59]See Bonnet and Manno, *Example of the European Space Agency*, Chapter Two.

[60]See Ibid., 98-108.

[61]The Ulysses mission returned information in the summer of 1995 that has enabled scientists to piece together a new picture of the Sun and gain a greater understanding of the processes which power the solar system.

[62]See Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 449-450.

[63]See Ibid.

[64]See John M. Logsdon, "US-Japanese Space Relations at a Crossroads," *Science* 255, 17 (1992): 297.

[65]See Joan Johnson-Freese, *Over the Pacific: Japanese Space Policy into the Twenty-First Century* (Dubuque, Iowa: Kendall/Hunt Publishing, 1993); and Damon R. Wells and Daniel E. Hastings, "The US and Japanese Space Programs: A Comparative Study," *Space Policy* 7, 3 (1991): 239-240.

[66]This policy was advocated by the Department of State but opposed by NASA and the Department of Defense. See Logsdon, "US-Japanese Space Relations," 297.

[67]See Logsdon, "US-Japanese Space Relations," 300; and Chikako Iguchi, "International Cooperation in Lunar and Space Development: Japan's Role," *Space Policy* 8, 3 (1992): 256-268.

[68]Richard Barnes, interview by author. Also, see Matthew J. Von Bencke, *The Politics of Space: A History of US-Soviet/Russian Competition and Cooperation* (Boulder, Colorado: Westview Press, 1997), 1-7.

[69]See Harvey and Ciccoritti, *US-Soviet Cooperation*, x.

[70]Maxim Tarasenko, Research Associate, Moscow Institute of Physics and Technology, interview by author, Turin, Italy, October 9, 1997. Also, see Walter A. McDougall, *...The Heavens and the Earth, A Political History of the Space Age* (Baltimore, Maryland: Johns Hopkins University Press, paperback edition, 1997), 348-350.

[71]See Bencke, *The Politics of Space*, 193-194.

[72]See Frutkin, *International Cooperation*, 85-89.

[73]See Harvey and Ciccoritti, *US-Soviet Cooperation*, 92-103.

[74]See McDougall, *...The Heavens and the Earth*, 177-194.

[75]Given the Soviet invasion of Afghanistan in 1979, the 1977 United States-Soviet Intergovernmental Agreement on Space Cooperation was allowed to lapse without renewal in 1982.

[76]Harvey and Ciccoritti, *US-Soviet Cooperation*, 230-236.

[77]Apollo-Soyuz was widely praised as a symbol of détente. Its success led to follow-on discussions regarding possible cooperation between NASA's Space Shuttle program and Soviet Salyut space station program. This cooperative plan was suspended in 1979 amid a worsening of United States-Soviet/Russia relations and the collapse of détente in 1979-1980.

[78]See *US-Russian Cooperation in Space*, Office of Technology Assessment, United States Congress, OTA-ISS-618 (Washington, DC: Government Printing Office, 1995), 43-46.

[79]The "Mars Together '98" project envisioned a joint United States-Russian robotic orbiter/lander for the scientific study of Mars. This program was initially established in an "Implementing Agreement Between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency of the

Russian Federation on NASA Participation in the Russian Mars 94 Mission" in October of 1992 and through a report of a joint US/Russian technical working group in October of 1994. Despite the fact that the concept for "Mars Together '98" had clear scientific, technical and financial benefits to both sides, it failed to materialize. Apparently, misunderstandings, misperceptions and miscommunication as to the technical and financial arrangements emerged. In the final analysis, cooperation failed not due to a lack of willingness among the scientists involved, but due to a failure to realize important functional preferences that each respective space agency possessed. See Roger D. Bourke, "Mars Together '98" (presentation at a seminar on International Space Cooperation: Real World Examples, American Astronautical Society, Washington, DC, June 2, 1998).

[80]In 1991, the first Soviet/Russian satellite to carry a NASA instrument was launched. This involved a Soviet atmospheric monitoring satellite, Meteor 3, which carried NASA's Total Ozone Mapping Spectrometer (TOMS).

[81]For a more comprehensive account of expanded United States-Russian space cooperation since 1992, see Bencke, *The Politics of Space*, 99-108; and *US-Russian Cooperation in Space*, 46-48.

[82]See Bencke, *The Politics of Space*, 100.

[83]"Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988.

[84]Apollo-Soyuz was politically driven from the beginning. See Richard Barnes, interview by author.

[85]See Harvey and Ciccoritti, *US-Soviet Cooperation*, 223-249.

[86]See Edward Ezell and Linda Ezell, *The Partnership: A History of the Apollo-Soyuz Test Project* (Washington, DC: Government Printing Office 1978), Appendix D.

[87]NASA utilized leftover Apollo hardware for the Apollo-Soyuz Test Project.

[88]See John M., "Together in Orbit: The Origins of International Participation in the Space Station," *Monographs in Aerospace History* 11 (Washington, DC: NASA, November 1998), 3-24.

[89]*Public Papers of the Presidents of the United States: Ronald Reagan, 1984* (Washington, DC: Government Printing Office, 1986), 90.

[90]See Madders, *A New Force at a New Frontier: Europe's Development in the Space Field*, 444-476.

[91]"Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Government of Japan on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," March 14, 1989; "Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988; "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988; Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Ministry of State for Science and Technology of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988.

[92]Canada was an important exception to this in that its robotic mobile servicing center for the Space Station is a critical path element in support of overall assembly and operations.

[93]See Howard E. McCurdy, *The Space Station Decision, Incremental Politics and Technological Choice* (Baltimore, Maryland: Johns Hopkins University Press, 1990), 99-107 and 224-235.

[94]"Agreement Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation and the Government of the United States of America Concerning Cooperation on the Civil International Space Station," January 29, 1998.

[95]NASA's policy preferences for cooperation as traditionally applied were not relevant. Richard Barnes, interview by author. Also, see Cline and Gibbs, "Re-Negotiation;" and Cline, "International Negotiations."

[96]See Joan Johnson-Freese, *Changing Patterns of International Cooperation in Space* (Malabar, Florida: Orbit Book Company, 1990), 17-19. For a complete technical description of INTELSAT operations, see Barbara Edelson, "Global Satellite Communications," *Scientific American* 236, 2 (1977): 58-73.

[97]For an overview of negotiations and US space diplomacy, which led to INTELSAT, see Joseph N. Pelton, *Global Communications Satellite Policy: INTELSAT, Politics and Functionalism* (Mt. Airy, Maryland: Lomond Books, 1974); and Jonathan F.

Galloway, *The Politics and Technology of Satellite Communications* (Lexington, Massachusetts: Lexington Books, 1972).

[98]The American crusade— "space for the benefit of all mankind—" was an integral part of United States space diplomacy during the Cold War. It served as "cloaked" diplomacy; the US put forward a visible and relatively open, in terms of science, civil space program to ensure "freedom of space" and to enable intelligence gathering on Soviet/Russia through space-based reconnaissance systems. See McDougall, *...Heavens and the Earth*, 344-360; and Cargill R. Hall, "Origins of US Space Policy: Eisenhower, Open Skies, and Freedom of Space," in *Exploring the Unknown, Volume I*, 213-229.

[99]See Joseph N. Pelton, "The History of Satellite Communications," in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume III: Using Space* (Washington, DC: Government Printing Office, 1998), 1-11.

[100]See Johnson-Freese, *Changing Patterns of International Cooperation*, 18.

[101]For this idea as it relates to INTELSAT, see Pelton, *Global Communications Satellite Policy*.

[102]See Edelson, "Global Satellite Communications," 58-73.

[103]See Bencke, *The Politics of Space*, 40-78; and Glenn H. Reynolds, and Robert P. Merges, *Outer Space: Problems of Law and Policy* (Boulder, Colorado: Westview Press, second edition, 1997), 1-93.

[104]See Hall, "Origins of US Space Policy," 213-229.

[105]See Bencke, *The Politics of Space*, 48-62.

[106]The "Outer Space Treaty" is a hallmark of institutional cooperation in that it takes into account the welfare of humanity rather than the sovereign preferences of states. See Reynolds and Merges, *Outer Space*, 48-49; and Harvey and Ciccoritti, *US-Soviet Cooperation*, 161-180.

[107]See "Treaty on Principles Governing the Activities of States in the Exploration and Uses of Outer Space, Including the Moon and Celestial Bodies," in Ian Brownlie, ed., *Basic Documents in International Law* (New York, New York: Oxford University Press, third edition, 1984), 204-211.

For an insightful analyses of the "Outer Space Treaty," see Reynolds and Merges, *Outer Space*, 1-93; and Nathan C. Goldman, *American Space Law: International and Domestic* (San Diego, California: Univelt, second edition, 1996), 65-87.

[108]These issues were intentionally left open ended in the 1967 Outer Space Treaty. See Glenn H. Reynolds, "The Moon Treaty: Prospects for the Future," *Space Policy* 11, 2 (1995): 115-120.

[109]See Reynolds and Merges, *Outer Space*, 114-115.

[110]European Space Agency (ESA) member states as of 1999 include Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Norway, Spain, Sweden, Switzerland and United Kingdom. Cooperative agreements have also been signed to allow Canada to participate in certain ESA programs and to sit on the ESA council.

[111]The European Space Agency's scientific space projects from 1975 to the present have been within the policy guidelines of 20% cost capital limits (i.e., costs not to exceed the total budget of a project by more than 20%).

[112]The return coefficient allows for an equitable sharing of economic and industrial resources. For example, all member states had to have an 80% minimum return ratio from 1980 to 1985 with increases over time to 96% or better beginning in 1994.

[113]The European Space Agency's Convention states that space application systems are optional. This implies that all member states participate except those which formally declare their intentions not to do so. This concept allows for states to match their level of financial involvement to industrial economic factors.

[114]See Joan Johnson-Freese, "A Model for Multinational Space Cooperation: The Inter-Agency Consultative Group," *Space Policy* 9, 4 (1989): 288-300.

[115]The Pathfinder concept involved positioning of the comet by Japanese and Soviet probes and NASA's deep space network to enable the European Space Agency's Giotto probe to encounter Halley's Comet nucleus within a range of 40 kilometers.

[116]NASA was the only participating national space agency in the Inter-Agency Consultative Group without a dedicated spacecraft to study Halley's comet.

[117]The Inter-Agency Consultative Group demonstrated that international cooperation on scientific objectives is feasible notwithstanding political, ideological and cultural barriers. See Johnson-Freese, "A Model for Multinational Space Cooperation," 288-300.

[118]See Joan Johnson-Freese, "From Halley's Comet to Solar Terrestrial Science: The Evolution of the Inter-Agency Consultative Group," *Space Policy* 12, 3 (1992): 245.

[119]See Freese, "From Halley's Comet," 254.

[120]See *Committee on Earth Observation Satellites Toward an Integrated Global Observing Strategy, 1997 Yearbook* (Surrey, England: Smith System Engineering Limited, 1997); and H. D. Hopkins and others, "Coordination of Earth Observation Activities through the Earth Observation International Coordinating Working Group" (paper presented at the 45th Congress of the International Astronautical Federation, October 9-14, 1994, Jerusalem, Israel).

[121]See Lisa R. Shaffer, "Coordination, Cooperation, Integration: Future Models for International Earth Observations" (paper presented at the 47th Congress of the International Astronautical Federation, Beijing, China, October 7-11, 1996); and Gregory S. Wilson and Wesley T. Huntress, "Mission to Planet Earth," *Palaeoclimatol Palaeoecol, Global and Planetary Change Section*, 90 (1991): 317-328.

[122]The Subcommittee on Global Change Research is part of the Committee on Environment and Natural Resources of the National Science and Technology Council. This Subcommittee provides overall direction and executive oversight of the United States Global Change Research Program (USGCRP). The Subcommittee on Global Change Research management plan incorporates an extensive use of epistemic communities through program panels and working groups. Program panels include the interannual climate variability, climate change, changes in ozone, ultraviolet radiation and atmospheric chemistry and changes in land cover in terrestrial and aquatic ecosystems; and working groups exist for integrated global observing and monitoring systems, global change data products and information services, Earth system science and human contributions and responses to global change.

[123]See Ray Harris and Roman Krawec, "Some Current International and National Earth Observation Data Policies," *Space Policy* 9, 4 (1993): 273.

[124]See Gerald B Thomas, James P. Lester and Willy Z. Sadeh, "International Cooperation in Remote Sensing for Global Change Research: Political and Economic Considerations," *Space Policy* 1, 2 (1995): 131.

[125]See Harris and Krawec, "Some Current International and National Earth Observation Data Policies," 285.

[126]See Lisa R Shaffer, "International Cooperation in Earth Observation from Space," *Acta Astronautica* 22 (1990): 347-353.

[127]The Committee on Earth Observation Satellites evolved out of scientific collaboration among national space agencies in Europe, France, India, Japan and the United States that took place through several Multilateral Meetings on Remote Sensing held in 1980 and 1982 and through Coordination on Land Observation Satellites and Coordination on Ocean Remote Sensing Satellites. See "Minutes Committee on Earth Observations Satellites," September 24-25, 1984.

[128]The membership of the Committee on Earth Observation Satellites includes national space agencies and space-based research organizations of Australia, Brazil, Canada, China, Europe, France, Germany, India, Italy, Japan, Russia, Sweden, Ukraine, United Kingdom and United States; Belgium, Canada, New Zealand and Norway are observers; and the Economic and Social Commission of Asia and Pacific, Food and Agricultural Organization, Global Climate Observing System, Global Ocean Observing System, Intergovernmental Oceanographic Commission, International Council of Scientific Unions, International Geosphere-Biosphere Program, United Nations Environmental Program, United Nations Office of Outer Space Affairs, World Climate Program and World Meteorological Organization are affiliates.

[129]See *Committee on Earth Observation Satellites Toward an Integrated Global Observing Strategy, 1997 Yearbook* (Surrey, England: Smith System Engineering Limited, 1997).

[130]As part of this commitment to long-term global environmental research and monitoring, the Committee on Earth Observation Satellites, beginning in 1996, initiated an Integrated Global Observing Strategy aimed at coordinating missions and data policies for all spaceborne and Earth-based observations of global environmental change. See *Committee on Earth Observation Satellites.*

[131]Earth remote sensed data have the potential to engender sovereignty transparency and the "unbundling of territoriality." See John G. Ruggie, "Territoriality and Beyond: Problematizing Modernity in International Relations," *International Organization* 47, 1 (1993): 139-171; and Karen T. Litfin, *Ozone Discourses: Science and Politics in Global Environmental Cooperation* (New York, New York, Columbia University Press: 1994).

[132]The European Space Agency has put forward a dual mission strategy whereby one set of Earth observation missions, "Earth Explorer," emphasizes cooperation for Earth sciences, whereas, a second set of missions, "Earth Watch," accentuate Earth observation applications related to well identified user communities and commercial operational entities within Europe. Harald Arend, Earth Observation Strategy Manager, European Space Agency Headquarters, interview by author, Paris, France, October 16, 1997. Also, see R. Bonnefoy and H. Arend, "ESA's Earth-Observation Strategy," *ESA Bulletin*, no. 85 (February 1996), 7-11.

[133]Cooperation can take place when a particular state (or commercial entity) producing Earth observation data extends it to other states (e.g., open and free data transfer) or when knowledge diffusion is characterized as a collective good that is in joint supply. For a discussion of collective goods and international cooperation, see John G. Ruggie, "Collective Goods and Future International Cooperation," *American Political Science Review* 66, 3 (1972): 874-893.

[134]See Louis J. Levy and Susan B. Chadokewitz, "The Commercialization of Satellite Imagery," *Space Policy* 6, 3 (1990): 220.

[135]See Tom Cremins, "The New World Order, Global Change, and Space," *Acta Astronautica* 28 (1992): 327-334.

[136]See Jeffrey T. Richelson, "Scientists in Black," *Scientific American* 278, 2 (1998), 48-55.

[137]These studies include: Eligar Sadeh, James P. Lester and Willy Z. Sadeh, "Models of International Cooperation in Human Space Exploration for the Twenty-First Century," *Acta Astronautica* 34, 7-8 (1998): 427-435; Eligar Sadeh, James P. Lester and Willy Z. Sadeh, "Modeling International Cooperation for Space Exploration," *Space Policy* 12, 3 (1996): 207-224; Lynn F. H. Cline and Jeffrey D. Rosendahl, "An Assessment of Prospects for International Cooperation on the Space Exploration Initiative," *Acta Astronautica* 28 (1992): 391-399; and Shaffer and Shaffer, *The Politics of International Cooperation*.

[138]See Bencke, *Politics of Space*, 159-183.

CHAPTER THREE: FRAMEWORK OF ANALYSIS—
OUTCOMES AND DYNAMICS OF SPACE COOPERATION

PRESENT STATE OF KNOWLEDGE

There are several approaches present in the space policy literature that attempt to understand distinctive policy patterns of international space cooperation. One approach considers how political actors cooperate to realize their policy preferences.[1] International space cooperation is a reflection of both symbolic and functional preferences. Symbolic preferences are political in character encompassing a range of domestic and foreign policy concerns such as prestige, propaganda, policy legitimization, enhanced policy influence over other actors, international accountability, world leadership and national security. Functional preferences pertain to economics, technology and science. Economic interests include maximizing national economic benefits, promoting industrial autonomy, enhancing economic competitiveness and realizing economic savings through cost burden sharing with other political actors. Technological and scientific interests deal with enhanced capabilities and knowledge gains that can be realized through cooperation.

The political actors that act upon these preferences range from state-governments, primarily their respective national space agencies, and international organizations (IOs) which include nongovernmental groups like epistemic (i.e., knowledge-based) communities of scientists or engineers. There are three responses for political action: (1) national response where states (i.e., national space agencies) seek to conclude bilateral or multilateral cooperative arrangements outside any institutional or organizational framework; (2) institutional response where IOs are formed on the basis of some type of multilateral agreement; and (3) mixed response involving both national and institutional responses.

A second approach characterizes four types of space cooperation outcomes.[2] These types include (1) coordination; (2) augmentation; (3) interdependence; and (4) integration. Coordination involves separate but shared programs. Shared programs imply that separate projects with independent capabilities are coordinated technically and scientifically in some complementary manner. Augmentation is signified by functional enhancements of capabilities through contributions to a national project which are not on the technological critical path for the mission as a whole. Interdependence entails cooperation that is functionally enabling for a particular project. This implies cooperation on technological critical path and infrastructural systems. Integration denotes joint and shared research and development (R&D) with pooling of financial resources.

A third approach specifies how political actors bargain and negotiate (i.e., strategically interact) to realize international space cooperation.[3] Strategic interactions are described by structural conditioning, convergence of norms, institutional bargaining and epistemic community models. "Structural conditioning" happens when a powerful state-government entity (e.g., national space agency) extends cooperative benefits to others. This process is "structurally" generated because a dominant national space agency influences others, on the basis of an asymmetric distribution of resources (institutional capabilities) and knowledge (science and technology) in its favor, to adopt cooperative policies that are congruent with its preferences. "Convergence of norms" represents an emergence of compatible preferences between political actors as a result of changes that take place in national or international policy milieus. "Institutional bargaining" is a factor of functional interdependence between state-governments. This interdependence is managed through institutions that establish principles, rules or conventions. An "epistemic community" model focuses on collaboration between groups of scientists. Space science and Earth science missions are uniquely suited to such cooperative patterns due to their powerful scientific context. This can result in the acquiescence of national decision-makers to epistemic communities in the cooperative policy process.

OUTCOMES AND DYNAMICS

The framework of analysis developed and specified herein synthesizes and adds to the three approaches of international space cooperation present in the literature. Four types of cooperation outcomes identified earlier— coordination, augmentation, interdependence and integration— are incorporated within this framework. These types serve as a classification scheme for cooperation outcomes. This approach, however, falls short in specifying a range of variables that influence and differentiate the cooperation outcome-types. In other words, over what issues do political actors bargain and negotiate in realizing international space cooperation? This research question is addressed by specifying dynamics of cooperation that are associated with outcome-types for inclusion in the framework of analysis.

Dynamics of cooperation can be determined by considering functional and political arrangements that exist in space cooperation. It is assumed that these arrangements are framed by an interplay between interdependence— reliance upon others for performance of specific tasks— and the desire to keep such interdependent relations to a minimum.[4] States seek to minimize interdependencies by maintaining control of cooperative missions. This pattern of cooperation is reflected in NASA's policy preferences for international cooperation involving distinct technical responsibilities, protection of sensitive technologies and clearly defined and independent managerial interfaces.

Given NASA's concern about technical responsibilities and protection of sensitive technologies, technological and scientific resources are relevant dynamics of cooperation. There are two distinct dimensions to these dynamics: (1) transfer of technology including systems management and engineering know-how; and (2) control of scientific knowledge dealing with intellectual property rights. Policy preferences regarding technical and managerial interfaces suggest that authority and decision-making patterns are of consequence as dynamics of cooperation as well. Authority deals with who has control over decision-making, while decision-making pertains to the structure of managerial interfaces.

An exploration of how the range of actors, preferences and political responses relate to specific outcomes identifies additional dynamics of cooperation. This link between what can be termed process— interactions among political actors, preferences and responses— and outcomes can be conceptualized by considering how the four models of strategic interactions present in the literature relate to cooperation outcome-types.

The coordination outcome is characterized by a number of interactions encompassing convergence of norms, institutional bargaining and epistemic community processes. This implies that coordination is based on a dynamic of compatible functional preferences between national space agencies that are realized through either institutional arrangements or epistemic collaboration. The augmentation outcome is a factor of structural conditioning. This suggests that a powerful national space agency, such as NASA, brings about cooperation through resource and knowledge asymmetries in its favor. Cooperation of such a nature is influenced by the dynamic of NASA's functional policy preferences. The interdependence outcome is a function of convergence of norms. In this instance, compatible symbolic and functional policy preferences create a dynamic of an interdependent multilateral relationship.

The integration outcome is indicative of institutional bargaining. This denotes that joint R&D and the pooling of financial resources requires institutional arrangements. What makes integration different from coordination is the extent of institutionalization. Integration, given its level of functionally interdependent relations, pertains to formalized institutions that codify rules and procedures in a convention or treaty. This attests to a dynamic of compatible and shared preferences among cooperating partners. Whereas, coordination is ad-hoc and focused on a single mission. Institutional arrangements realized through coordination are often engendered by epistemic collaboration and only specify general principles or terms of reference that cooperating partners make their best efforts to endorse.

Technological and scientific resources together with authority and decision-making patterns were identified as dynamics of importance to the functional and political arrangements that characterize international space cooperation. The way in which models of strategic interactions relate to outcome-types indicate that functional and symbolic policy preferences and the extent to which they are compatible or shared among political actors plays a fundamental role in differentiating cooperative outcomes.

These dynamics and the four outcome-types are applied to evaluate historical case studies reviewed in Chapter Two. The objective is to specify a framework of analysis for evaluation of the Space Station and International Earth Observing System (IEOS) case studies.

Cooperation Outcomes

The classification of historical cases according to the four cooperation outcome-types is listed in Table 3. Coordination and augmentation are predominant types of outcomes since they allow for the realization of policy preferences as valued by national space agencies. These outcomes are appealing for NASA because distinct political, economic and technical arrangements can be fashioned and technology transfer can be minimized.

Table 3. Classification international space cooperation outcomes.

Case Studies (year of cooperative agreement)	Outcome-Type
International Space Law Regime (1967)	Coordination
International Telecommunications Satellite Consortium (INTELSAT) (1971)	Integration
Apollo-Soyuz-Test Project (ASTP) (1972)	Augmentation
European Spacelab (ESL) (1973)	Augmentation
European Space Agency (ESA) (1975)	Integration
International Solar Polar Mission (ISPM)/Ulysses (1979)	Augmentation
Inter-Agency Consultative Group (IACG) (1981)	Coordination
Committee on Earth Observation Satellites (CEOS) (1984)	Coordination
Space Station Freedom (SSF) (1988)	Augmentation
International Space Station (ISS) (1998)	Interdependence

The historical record indicates that mixed and national responses to cooperation at the coordination and augmentation levels are most common. A mixed response takes place with coordination and indicates institutional arrangements among national entities and epistemic communities; and a bilateral national response, which occurs with augmentation, means the exclusive and direct involvement of state-governments and their national space agencies. Responses vary from agreements on multilateral terms of reference and principles for coordination to bilateral exchanges of letters, memoranda of understanding (MOUs) and intergovernmental agreements (IGAs) for augmentation.

Functional and symbolic policy preferences can engender a departure from coordination or augmentation. Interdependence, which runs counter to preferences that NASA has traditionally held, is a product of symbolic preferences rooted in foreign policy and functional preferences related to managing complex systems. One case of an interdependent outcome, analyzed in Chapter Four, is related to Russian involvement in ISS. Integration outcomes are reflected in both INTELSAT and ESA.[5] For these cases, joint R&D and the aggregation of financial resources are necessary to carry out the proper functioning of missions. A multilateral national response incorporating MOUs and IGAs characterizes interdependence and integration is an institutional response realized through consortia, treaties and conventions.

The range of outcomes demonstrates that responses other than national ones have played roles in the cooperative equation. Institutional responses are evident in the Space Law Regime, INTELSAT, ESA, IACG and CEOS. The United Nations Committee on the Peaceful Uses of Outer Space (UNCOPUOS) served as a forum for codifying the Outer Space Treaty of 1967 which established an International Space Law Regime; INTELSAT exists as an intergovernmental organization (IGO) on the basis of an operating agreement concluded in 1971; ESA was a byproduct of former European space-based IGOs— European Space Research Organization (ESRO) and European Launch and Development Organization (ELDO); IACG was formed on an institutional basis through multilateral agreements among national space agencies and scientists on terms of reference; and CEOS was conceived through agreement on data exchange principles that are supported by a number of IOs.

Institutional responses can involve epistemic collaboration as well. This is relevant for several cases of cooperation concerning human spaceflight, space sciences and Earth sciences. In human spaceflight, epistemic groups realized initial working and technology transfer arrangements that were formalized in a 1972 US-Soviet IGA which led to ASTP. The development of an androgynous docking mechanism for the proper functioning of ASTP involved joint working groups of engineers. Additionally, epistemic communities from national space agencies of the US, Europe, Japan and Canada coordinated plans for Space Station in 1982-1983 even though no respective government had approved the program.

In space sciences, ESA manages its programs through a Science Program Committee (SPC) composed of delegates with competence in scientific matters. The genesis of cooperation in ISPM/Ulysses emanated from transnational scientific collaboration among epistemic groups interested in exploring and investigating the solar environment of the Sun. For IACG, it was transnational epistemic communities of space scientists (e.g., International Halley Watch) that initiated and sustained coordination to study Halley's Comet. In Earth sciences, transnational epistemic collaboration has been indispensable for realizing mission goals. These goals, as CEOS exemplifies, are directed at sharing of data from Earth observations by satellite for global change research use.

Technological and Scientific Resources

Dynamics pertaining to technological resources involve how those resources are distributed among cooperating partners. Distribution patterns are governed through technology transfer and typically follow a "need to know" logic. Incorporating clean technology interfaces with no participation in critical path or infrastructure components minimizes technology transfer. Hardware and systems engineering management are the primary types of technology restricted by national space agencies such as NASA.

Even though a cardinal rule of international space cooperation has been to minimize technology transfer, transfers are allowed if they are within the scope of political actor policy preferences or necessary to technical functions. For example, technology transfer can occur either when symbolic preferences come into play, such as with ISS, or when functional concerns dealing with technical interfacing needs tied to enabling capabilities exist as with INTELSAT, ESA and ISS.

Conversely, scientific resources are generally shared among national space agencies. Science (e.g., space sciences and Earth sciences) is generally thought of and extended as a collective good to maximize research and public use benefit. The sharing of scientific knowledge is most pronounced when science serves as the primary mission goal. This is true for ESA, ISPM/Ulysses, IACG and CEOS. Cooperation within ESA emanates from its mandatory programs in space science which involve transnational collaboration among European scientists and ESA member states; ISPM/Ulysses and IACG put forward mission goals with the intent of maximizing scientific returns; and CEOS advocates principles, such as "maximize use for public benefit," that view the production and dissemination of science (i.e., data about Earth global change processes) as a collective good.

Provisions that assign intellectual property rights to knowledge creation often govern the extent to which science is shared. Rights are put into place to ensure proper licensing of knowledge for application purposes such as patents. This is of concern to national space agencies because knowledge-application involves transforming knowledge-creation into some type of technology with possible commercial or other benefits. Consequently, this may have implications for systems management, engineering know-how and technology transfer. The Space Station, to cite an instance, regulates the distribution of scientific resources through intellectual property right provisions established in the ISS IGA.

Authority and Decision-Making Patterns

Authority patterns depend on whether a case is bilaterally or multilaterally arranged in management and decision-making. Patterns of authority in bilateral arrangements, like MOUs and IGAs between NASA and a foreign partner, suggest that cooperation is a reflection of sovereign (i.e., national) policy preferences and national responses. This is true of US-European, US-Japanese and US-Russian intergovernmental space relations. In contrast, multilateral arrangements— agreements on principles, conventions or treaties— display institutional authority patterns. The Space Law Regime, INTELSAT, ESA, IACG, CEOS exhibit these characteristics. INTELSAT and ESA were formed to develop and manage integrated programs whereupon funds for program implementation are turned over to the respective IO by participating national members; and IACG and CEOS institutionalized principles for sharing science among a number of national and IO members.

One unique case is Space Station. The Station's cooperative framework incorporates both bilateral and multilateral managerial and decision-making arrangements. ISS MOUs specify bilateral arrangements between NASA and the space agencies of Russia, Europe (i.e., ESA), Japan and Canada and a multilateral IGA exists among the governments of these agencies. This IGA, which was last reached in 1998, has established a common institutional legal culture for managing all aspects of the cooperative relationship for ISS.

Functional Policy Preferences

Functional policy preferences are a defining feature of US-European and US-Japanese patterns of bilateral cooperation. Cooperation dynamics in ESL, ISPM/Ulysses and SSF, for example, are characterized by NASA's functional policy preferences. It is the ability that NASA possess to impose these preferences on another party, even if those preferences are not compatible or shared, which gives rise to augmentation.

Functional preferences also played a role in the development of institutional responses for cooperation as typified by Space Law Regime, INTELSAT, ESA, IACG and CEOS. Institutional responses were viable because symbolic preferences were either subordinated or coincided with international or transnational ones rooted in functional issues related to sharing of technological and scientific resources. This implies that coordination and integration, which characterize the aforementioned historical cases, are grounded on compatible functional preferences.

Symbolic Policy Preferences

Symbolic policy preferences matter when national political actors perceive that international space cooperation offers opportunities to realize domestic and foreign policy agendas. The Space Law Regime, especially concerning freedom of passage in space, was supported because it advanced US and Soviet national security interests in spaceborne reconnaissance; INTELSAT was an integral part of US "space" diplomacy during the 1960s and 1970s; ESA promotes, in addition to European foreign policy interests, industrial policies of European states; and Space Station has been and still remains symbolic of US foreign policy interests. As with functional preferences, the extent to which symbolic preferences are compatible play a role in influencing outcomes. In this regard, coordination, interdependence and integration emerge when symbolic policy preferences are compatible or shared between cooperating partners.

FRAMEWORK OF ANALYSIS

The evaluation of international space cooperation undertaken in this chapter has demonstrated the utility of the proposed outcome-types and dynamics of cooperation as a framework of analysis. This proposed framework, which is applied as the process-tracing guideline for case study evaluations of the Space Station and IEOS that follow in Chapters Four and Five respectively, is diagrammed in Figure 1.

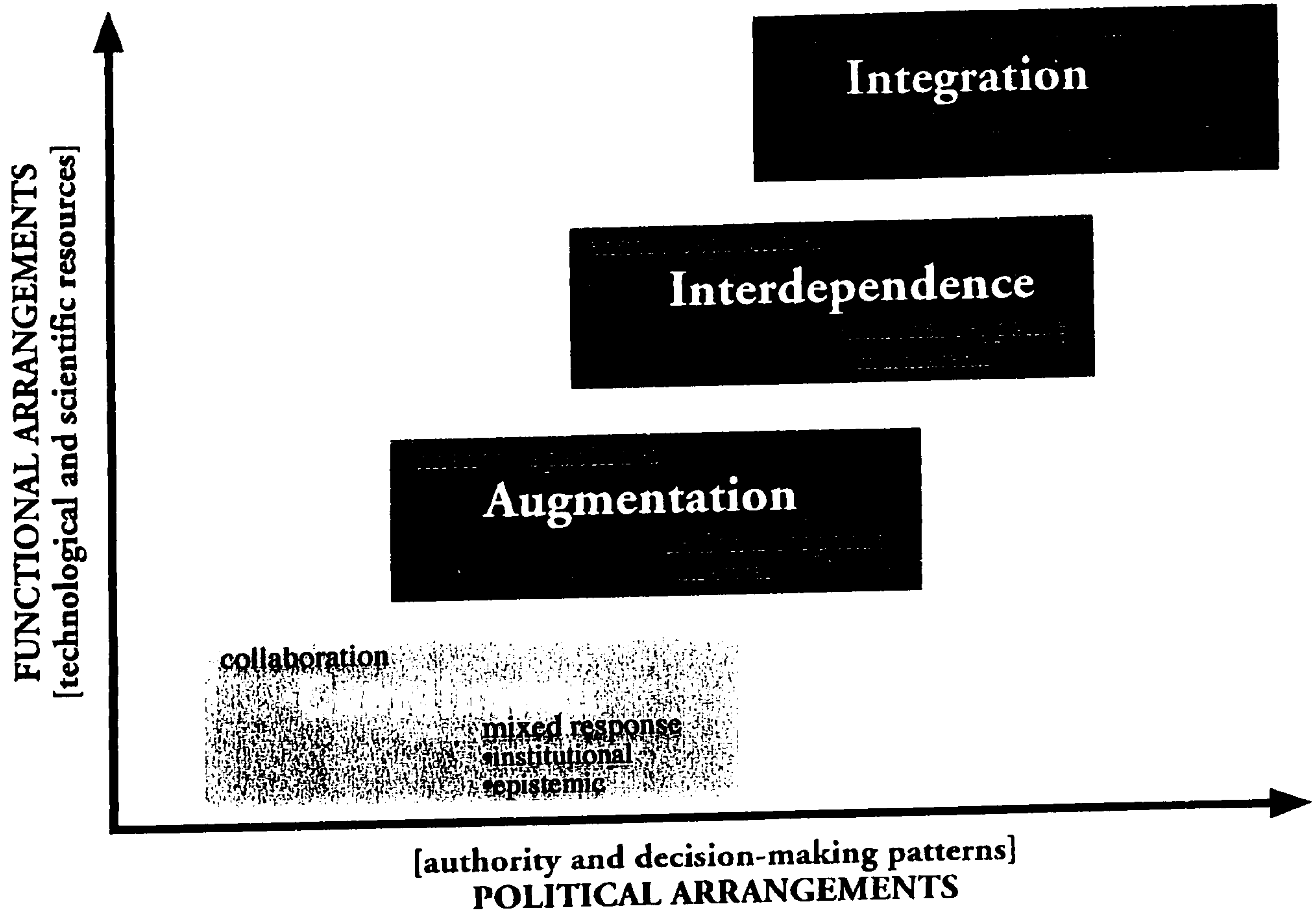

Figure 1. Framework of analysis for international space cooperation.

The four outcome-types— coordination, augmentation, interdependence and integration— are assumed to be differentiated ordinally along a continuum of functional and political arrangements manifested in the dynamics of cooperation. The aim of the case study evaluations to is apply this descriptive framework in order to (a) ascertain functional and political conditions associated with each cooperation outcome-type; and (b) specify variable dimensions that underlie the continuum of functional and political arrangements.

The characteristics of the four outcome-types are spelled out in Figure 1. Coordination concerns scientific collaboration engendered through institutional arrangements and epistemic collaboration. Augmentation equates with technological enhancements of a project that involves bilateral national responses. Interdependence deals with cooperation in enabling technologies that is managed by national responses that are multilateral. Integration denotes shared R&D and the aggregation of funds realized through formal multinational institutions such as IOs.

The dynamics of international space cooperation are summarized in Table 4. Dynamics related to functional arrangements deal with technological and scientific resources, while dynamics linked to political arrangements concern authority and decision-making patterns. Technological resources are governed through mechanisms for control of technology transfer. Scientific resources, while generally shared among cooperating partners, can be regulated through intellectual property right provisions. Authority patterns are characterized by national and institutional responses. Decision-making patterns take on bilateral and multilateral arrangements. Policy preferences structure the dynamics of the functional and political arrangements. The use of cooperation as a means to realize functional and symbolic policy preferences frames the possibilities (i.e., type of outcome) for cooperation.

Table 4. Dynamics of international space cooperation.

Functional Arrangements	Political Arrangements	Policy Preferences
Technological resources: Technology Transfer **Scientific resources:** Intellectual Property Rights	**Authority Patterns:** National, Institutional **Decision-Making Patterns:** Bilateral, Multilateral	**Functional Preferences** **Symbolic Preferences**

NOTES TO CHAPTER THREE

[1]See Stephen M. Shaffer and Lisa R. Shaffer, "The Politics of International Cooperation: A Comparison of United States Experience in Space and in Security," *Monograph Series in World Affairs* 17, 4 (Denver, Colorado: Graduate School of International Studies, University of Denver, 1980).

[2]See Lynn F. H. Cline and Jeffrey D. Rosendahl, "An Assessment of Prospects for International Cooperation on the Space Exploration Initiative," *Acta Astronautica* 28 (1992): 391-399.

[3]See Eligar Sadeh, James P. Lester and Willy Z. Sadeh, "Models of International Cooperation in Human Space Exploration for the Twenty-First Century," *Acta Astronautica* 34, 7-8 (1998): 427-435; and Eligar Sadeh, James P. Lester and Willy Z. Sadeh, "Modeling International Cooperation for Space Exploration," *Space Policy* 12, 3 (1996): 207-224.

[4]For a broader discussion of how an interdependent-sovereign dynamic characterizes collaboration in science and technology, see John. G. Ruggie, "Collective Goods and Future International Collaboration," *American Political Science Review* 66 (1972): 874-893.

[5]To date, NASA has never been directly involved in a cooperative program based on integration. Because of this fact, this particular study does not examine the integration outcome in detail.

CHAPTER FOUR: MISSION FOR EXPLORING SPACE— SPACE STATION FREEDOM AND INTERNATIONAL SPACE STATION

Chapter Four begins with the history of cooperation dealing with NASA's Space Station program. This sets the context for evaluating Space Station according to the framework of analysis developed in Chapter Three. A historical overview of this evaluation, which is analyzed in detail herein, is depicted in Figure 2. The evaluation starts with a look at the efforts of NASA's Space Station Task Force and its associated International Coordinating Working Group (ICWG) from 1982 to 1983. It then proceeds to investigate the period from 1984 to 1988 when the program was designated Space Station Freedom (SSF). This particular historical period is brought to fruition with a 1988 multilateral intergovernmental agreement (IGA)— "Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station."[1]

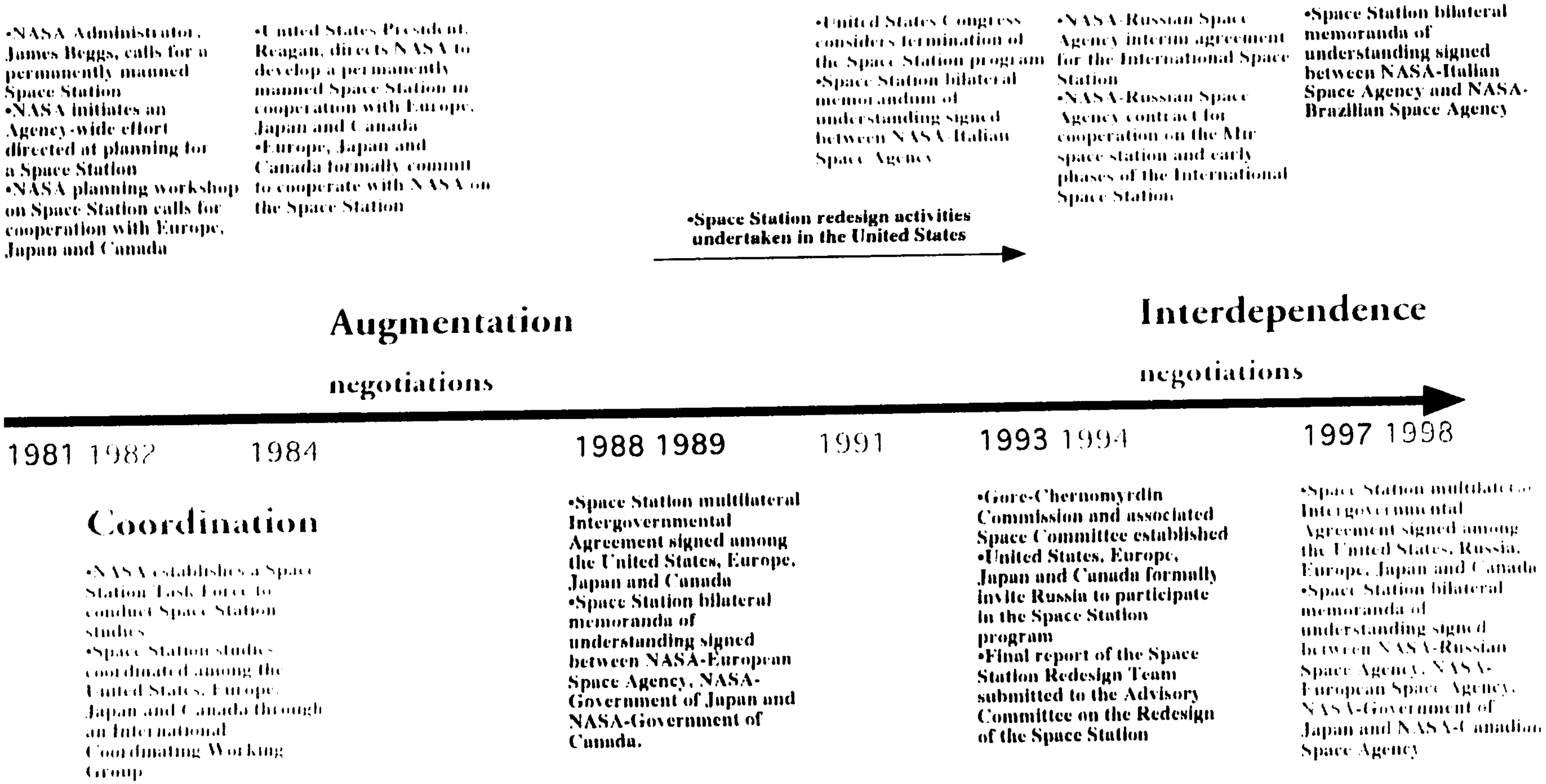

Figure 2. Historical evolution of the Space Station program.

Subsequently, SSF redesign activities from 1988 to 1992 and its effects on cooperation are assessed. Finally, incorporation of the Russian Federation and Russian Space Agency (RSA) into the Space Station program from 1993 to 1998 is probed. This process culminates with a 1998 multilateral IGA— "Agreement among the Government of Canada, Governments of Members States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station."[2]

The coordination, augmentation and interdependence cooperation outcome-types, in that chronological sequence, characterize Space Station. Coordination is evident in the collaboration that transpired within the ICWG from 1982 to 1983. The ICWG fostered collaboration among space science and space engineering epistemic communities in the US, Europe, Japan and Canada aimed at the coordination of Space Station mission design studies. Augmentation is prevalent for the 1984 to 1988 period when cooperation on Space Station was distinguished by political and functional asymmetries in NASA's favor. Interdependence describes the incorporation of Russia and RSA into the program that occurred over a four-year period of negotiations spanning from 1993 to 1997 and resulted in a functionally interdependent Space Station.

HISTORICAL EVOLUTION OF COOPERATION

Space station studies, initiated by NASA scientists and engineers, began in 1959.[3] President Kennedy's declaration in May 1961 that "we should go to the moon" by the end of the decade had significant consequences for the evolution of Space Station concepts at NASA. The Apollo program diverted most of NASA's resources away from Space Station design and planning. At first, NASA assumed that a Space Station in Earth orbit would be a prelude to a manned lunar landing by serving as a staging and servicing base in support of an Earth-orbit rendezvous lunar flight. Once NASA settled on a lunar-orbit rendezvous concept for a lunar landing, however, this more immediate justification for a Space Station was lost.[4] Consequently, design studies that continued throughout the 1960s focused on scientific research aspects of a Station.

These Space Station studies emphasized the concept of a Manned Orbiting Research Laboratory (MORL). MORL became the basis for several attempts during the remainder of the decade of the 1960s to win presidential approval for a NASA Space Station. However, the President's Space Task Group Report of September 1969 on NASA's post-Apollo space program failed to endorse a Space Station.[5] Within a year following this report, prospects for a Station had diminished to the point where NASA believed that its political and technological resources would be better spent on winning approval for a reusable Space Shuttle Space Transportation System (STS). In essence, MORL was a casualty of presidential and congressional efforts to limit government spending in the post-Apollo era.

An experimental version of a Space Station, designated Skylab, became part of NASA's post-Apollo applications program.[6] Skylab, which was in launched in 1973 and had three successive missions where astronaut crews conducted experiments, was conceived as a temporary facility. The success of Skylab reinforced the concept of Space Station as a scientific laboratory and the valuable role that a human crew could play in that effort.

The evolution of Space Station concepts during the 1970s continued to be influenced by a number of conditions in NASA's organizational environment: (a) the view of some in the scientific community, in a time of diminishing federal support for basic research, that human space flight programs were drawing funds away from robotic space exploration; (b) emergence of possible research applications for microgravity; and (c) termination of Apollo and subsequent development of STS. These conditions led to a renewed interest on how a Space Station could benefit humans on Earth. For instance, NASA's 1975 Manned Orbital Systems Concepts study accentuated science and applications research as reasons for a future Station.

By the late 1970s and early 1980s, ideas for a Space Station shifted towards an industrialization base to be developed through a modular design. The key to this change was the success of NASA's STS program, which proved that it was possible to achieve construction of large structures in orbit, and the scientific and technological possibilities of space industrialization. A Space Station of this nature would sustain long-term manned operations and permit staging and servicing in orbit. It would also handle large volumes and masses as well as provide an operational base for space processing and manufacturing. Modularity implied that a Space Station could grow over time from an initial deployment of habitation and support system modules to a structure incorporating technological and scientific mission modules. The Space Station could also evolve into a depot for orbital transfer vehicles in support of missions to the Moon and Mars.

In March of 1977, NASA's Administrator announced that NASA planned to begin development of a Space Station in 1980 to be ready for initial use in 1985. But neither the Ford nor Carter Presidential Administrations supported NASA's repeated funding requests. Additionally, cost overruns in the STS program and a lack of congressional support temporarily halted progress toward a Space Station. In 1979, NASA's Johnson Space Center resumed the Space Station effort with a study of a Space Operations Center. Intended only as an exploration of a concept, the Johnson study proposed a core-facility consisting of a self-contained, continuously manned orbital facility built from several STS launched modules. By April of 1981, the first part of a definition study for NASA's Space Operations Center was completed.

It was at this historical juncture that the idea of developing a Space Station gathered political momentum. Former NASA Administrator, James Beggs, in his 1981 confirmation hearings, called for a permanent manned Space Station as the next major step for this country's venture into space. This was followed by an Agency-wide effort directed at the task of formulating policy, strategy and planning for a Space Station facility. An important aspect of this effort involved international cooperation through foreign participation. To those in charge of planning, it was inconceivable that the US would go forward with a major effort in space and not include some form of international cooperation. This bias towards international space cooperation was an inherent part of NASA's culture since its inception in 1958.[7]

POLICIES OF COOPERATION

Policies surrounding foreign involvement in Space Station date back to NASA guidelines put forward from 1970 to 1982. The thought of foreign involvement in NASA's plans for a Space Station first emerged during post-Apollo planning. In 1970, NASA's Associate Administrator for Manned Space Flight formulated policy guidelines for foreign participation in a Space Station.[8] NASA sought to encourage international participation in the development, operation and uses of a Space Station. These guidelines specified policy preferences related to distribution of technological capabilities, sharing of scientific knowledge and decision-making. Technologically, NASA raised the option of participation as a subcontractor furnishing critical path subsystems. A second option dealt with independently providing an experimental module that would be attached to a NASA core station. This latter option was reinforced by NASA's long-standing functional preferences for discrete technical interfaces and no exchange of funds.

Scientifically, guidelines were established that set no restrictions on the nature of research activities. These activities would be subject to a selection process determined by merit and governed by intellectual property right agreements. Additionally, multilateral decision-making for management of operations and utilization activities was advocated. NASA emphasized equitable distributions of resources based on the formula that technical and scientific enhancements and management participation by any state or group of states would be commensurate with their contributions to the program.

NASA's Assistant Administrator for International Affairs further elaborated upon approaches to an international Space Station in 1974.[9] It was determined that it would be easier to get domestic approval for a Space Station if it was international in scope. Therefore, NASA proposed an approach in which all elements of Space Station—justification, definition, design, assembly, operations and utilization— would be pursued internationally. Procedures for program implementation, technology transfer and program assurances were established in this regard.

NASA identified both Europe and the Soviet Union as potential Partners. Bilateral arrangements for cooperation were ruled out due to the perception that it would not be within the policy preferences of either Partner. Europeans would object because of their fiscally conservation approach and their current level of space commitments in human space flight (e.g., European Space Lab), while the Soviets would object due to political and security considerations. Plus, the Soviet Union should not be advanced as a senior Partner in relation to Europe since the Europeans are allies and they would be better suited as a Partner operationally, technically, financially and politically. For these reasons, NASA advocated a multilateral approach to cooperation involving Europe and the Soviet Union in a tripartite relationship with the US. This partnership was envisioned to proceed with each Partner's independent technical contributions and the integration of functional activities.

A two-track approach, where one dealt with technical matters and a second with policy issues, was recommended for implementation. The first track entailed coordination of conceptual studies among Partners. These studies would be initiated independently and then shared to develop an integrated and joint design. The second track focused on functional policy arrangements. This track worked towards a joint implementation plan that would establish arrangements for financial contributions, procedures for management and decision-making, provisions for systems integration, division of labor, managerial authority, mutual access and operations and utilization of the system.

The Space Station partnership required that each participant have total knowledge about the system. To enable this, NASA would not restrict technology important for building and operating the Station. The program also needed to ensure peaceful purposes, openness and sharing of scientific knowledge gained through experimentation along with exchanges of technical information and intellectual property rights.

NASA's preferences for cooperation evident in post-Apollo planning institutionalized a policy of international involvement for Space Station. This policy is further exemplified by the prominence of international cooperation in an Agency-wide workshop that took place on Space Station planning in November of 1981. The report of the workshop notes:

> There appears to be substantial foreign interest in NASA's future plans for its manned space activities...extending this cooperation by participating in a NASA Space Station seems a logical step to some countries and space agencies.
>
> NASA can derive significant benefits from international participation in its programs if they are properly structured and controlled. These benefits may include economic cost sharing, access to unique or otherwise valuable expertise and improvements in the linking of foreign programs to Space Transpiration System utilization.
>
> The subject of potential international participation in a US Space Station Program must be approached carefully and proceed under clear assumptions and guidelines. A fundamental ground rule should be that planning for a Space Station will be conducted as if the entire project is to be developed as a wholly US effort. Planning should proceed, however, on the basis that it does not foreclose international cooperation. Potential foreign participants should be encouraged to fund and undertake parallel studies of Space Station requirements and concepts which could benefit NASA in its design of the Space Station. Procedures should be developed

> to facilitate controlled exchanges of study results. All potential Partners should be clearly informed that such exchanges...do not represent a commitment on the part of NASA to foreign involvement in the actual development of the station.[10]

The guidelines for international participation on Space Station served as parameters for cooperation that actually took place in the 1980s and 1990s. Guidelines that proved especially pertinent include (a) international participation in the development, operation and uses of a Space Station; (b) foreign contributions through independent experimental modules attached to a core NASA Station; (c) no restrictions on scientific activities; (d) multilateral forums for management and decision-making; (e) contributions and management participation commensurate with investments made to the program; and (f) protection against the unwarranted transfer of technology abroad by calling for development as though it was a "wholly US effort."

The idea of international coordination on conceptual studies, first proposed in 1974 and emphasized by NASA's planning workshop of 1981, took hold as the basis for initiating cooperation. This workshop called for interested foreign participants "to fund and undertake parallel studies of Space Station requirements and concepts that could benefit NASA in its design of the Space Station." Such coordination emerged as the first observable cooperative outcome for NASA's Space Station program.

COORDINATION OUTCOME

In May 1982, without any formal commitment for a Space Station on the part of the President or Congress, NASA established a Space Station Task Force. The Task Force provided focus for NASA's Space Station activities that involved conceptual definition studies and mission utilization plans. Studies and plans were conducted within NASA and coordinated among international Partners under the auspices of the ICWG.[11] The ICWG involved scientists and engineers within NASA that interacted transnationally with their counterparts in Europe, Japan and Canada. For instance, Europe initiated Space Station utilization studies in parallel with the Space Station Task Force in June of 1982 and Japan's National Space Development Agency (NASDA) agreed to commence Space Station studies in July of 1982.

The ICWG demonstrated willingness among Partners to partake in a NASA-led Space Station program and spurred the formulation of a strategy for international cooperation. Four guidelines were established as part of this strategy:

> First, we must determine if each specific proposal is beneficial to the US; i.e., contributes to the overall objectives of the Space Station Program, to NASA's scientific and technological goals, and in a broader sense to overall US foreign policy objectives.
>
> Second, we should be confident that the industrial and technological infrastructure exists within a foreign country in order to handle the tasks proposed.
>
> We should also assure ourselves that the proposal is realistic in terms of projected costs.
>
> Finally, while it might be attractive if the potential Partner proposed hardware that matched its utilization requirements, I believe that we should be satisfied that the Partner has utilization requirements for the

> Space Station System as a whole, and that its specific proposal contributes to that system.[12]

Possible concerns related to technology transfer were also addressed. Since the greatest source of technology transfer is industry-to-industry relations and joint teaming for research and development (R&D), NASA avoided industrial relations and dealt directly with foreign national space agencies. To ensure that technology transfer is avoided or minimized, it was incumbent upon NASA to select proposals for cooperation where the foreign country has indigenous technological capabilities and where the contributions are discrete hardware pieces with minimal interfaces to the Space Station.

Foreign participation in Space Station enhanced prospects for its domestic approval. The coordination efforts of the ICWG bolstered NASA's contention to develop a Space Station. Coordination was valuable to establish an international partnership and to reduce overall mission costs. Moreover, the successful development of a Space Station was judged to be a symbolic policy tool of national prestige and US world leadership. Yet from 1982 to 1984, neither NASA nor its potential foreign Partners formally committed to a Space Station program.

While coordination efforts were ongoing, NASA advocated policy guidelines that determined the type of foreign contributions that were feasible. These guidelines reflected past NASA policy concerns regarding technological and managerial control and no exchange of finds. For example, a February 1982 NASA position paper on international involvement in the US Space Station program put forward guidelines to ensure that future discussions adequately protect US national security and limit the transfer of technology.

> Control of overall station design and development remains with the US; however, other countries' capabilities and end-product utilization requirements should be considered in the early planning stages.
>
> All Partners will accept full financial responsibility for carrying out their portions of the program.
>
> To minimize technology transfer problems, participation in any one element of the program will not entitle a participant to technical information on any other portion of the program.
>
> To minimize managerial and technical interface problems: obligations and responsibilities of each cooperating Partner will be clearly defined on a case-by-case basis; foreign contributions should, insofar as possible, take the from of discrete hardware packages that lend themselves to clean managerial and technical interfaces; and involvement of foreign participants in management decision-making will be restricted to that necessary and proper for the effective fulfillment of their responsibilities.[13]

This position paper spells out what components are eligible for cooperation. Only discrete hardware components, implying no participation in critical path technologies, are permitted. This would allow for clean technical and managerial interfaces. To this end, NASA determined that foreign contributions should be substantial, significant and well-defined.[14] Substantial indicates that contributions should enhance capabilities in a useful, visible and lasting fashion; significant implies that the level of responsibility is consistent with the nature of the contribution; and well-defined denotes that foreign Partners take ownership and responsibility for their specific and discrete contributions to ensure technical, financial and operational simplicity. The foreign Partners must also assume financial responsibility and no exchange of funds.

Due to the initiative of NASA's Space Station Task Force, scientists and engineers within the space communities of the US, Europe, Japan and Canada cooperated although no respective government had approved or formally committed itself to the program. On a de facto basis, studies of Space Station concepts were internationally coordinated among coalitions of epistemic communities. NASA leapfrogged politics and the discussion over political arrangements related to authority and decision-making by convincing foreign allies to conduct parallel studies.

Significantly, cooperation that involved foreign Partners at the conceptual definition level was unprecedented. The impetus for this emanated from NASA's domestic agenda to win political support through an all-encompassing definition of mission objectives for its Space Station concept. The Space Station Task Force identified more than one hundred missions that promised something of value to the constituencies that NASA sought political support from.

The cooperative strategy of coordination was successful due to its focus on mission objectives. Allowing the parties to envision a single technological program serving many scientific purposes obscured policy differences. The intent was to shore up domestic support by building an international scientific and engineering coalition of epistemic communities within the scope of policy preferences ensuring NASA's dominance, especially in controlling critical path components and in minimizing complex technical and managerial interfaces and possibilities for technology transfer.

Dynamics of Cooperation

The dynamics of cooperation related to this coordination outcome are characterized by a number of aspects. First, NASA intended to preclude foreign participation in critical path technologies and joint teaming in R&D to ensure that technology transfer is prevented. Second, the objective of the ICWG was to coordinate and plan for future scientific missions that could be conducted on Space Station. Limits were placed on distribution of technological resources, while scientific resources were openly shared. Third, authority patterns existed at the Agency-level. This is apparent given the role of ICWG and absence of any higher-level governmental commitment on the part of the US or foreign participants. Fourth, the idea that NASA was willing to explore conceptualization and mission definition studies with several foreign Partners reflects a degree of multilateral decision-making unprecedented in the annals of space cooperation.

Last, it is obvious that NASA sought to ensure that its functional preferences would be realized. NASA's wanted to cooperate with its allies, but only on specific functional terms. These terms are exemplified by the fundamental groundrules put forward by NASA which established that a Space Station should proceed as if a wholly US effort. This implied that NASA would develop a functionally independent Space Station that could then be augmented by specific and discrete hardware contributions on the part of foreign participants.

Even though coordination of Space Station studies under the ICWG raised the possibility that NASA was then open to some degree of shared decision-making, it is clear that NASA retained a dominant role in deciding what kind of Station would be built and under what set of functional terms and political conditions. One important part of these political conditions was to symbolically affirm US global leadership. This sense of leadership is reflected in Table 5.

Table 5. Leadership benefits from Space Station cooperation.*

Policy Objective	Leadership Benefit
General political support.	Space achievement symbolizes technological and managerial competence and validates claims to global leadership.
Promote multilateral cooperation with and among other nations to strengthen "Free World" alliances.	Encourages other countries to associate their interests with that of the US.
Enhance prestige and ensure science and technology leadership.	Conditions imposed by NASA from start of planning for cooperation intended to ensure leadership and minimize risks of technology transfer.
Ensure domestic political support and enhance technological development.	Capabilities provided by Partners viewed as important enhancements to a US core (i.e., functionally independent) Station.
Maximize national economic benefits.	Control foreign access to technology involving commercial know-how; divert foreign resources that could otherwise be exploited to economically compete with the US; and enhance cost-effectiveness through increased and more effective use of resources.

*Adapted from John M. Logsdon, *Together in Orbit: The Origins of International Participation in Space Station Freedom* (Washington, DC: Space Policy Institute, George Washington University, December 1991).

The coordination outcome did not seem to substantially alter NASA's policies and functional preferences for cooperation as they have evolved in the post-Apollo era.[15] On the other hand, coordination in the early planning phases indicated a consideration of foreign interests and objectives unprecedented in space cooperation hitherto. Also, de facto cooperation paved the way for the de jure cooperation that followed for the development, operations and utilization of a NASA-led international Space Station program.[16]

AUGMENTATION OUTCOME

Policies regarding foreign participation in NASA's Space Station program are based on a fundamental set of guidelines that have been developed and followed during the Agency's history. These guidelines were restated in a 1983 NASA memorandum concerning "Policy for International Cooperation in the Definition and Development of a Space Station:" [17] The purpose of this memorandum was to ensure that NASA controls and determines any cooperative space project, management is not unduly complicated and the risk of technology transfer is minimized. Memorandum points were:

1. Cooperation must be beneficial to the US.
2. Projects and activities are entered into because they are scientifically and technically valid and of mutual interest.
3. Agreement is reached on specific projects rather than generalized programs.
4. NASA's official Partners are government agencies which negotiate and supervise joint efforts.
5. Each participant will accept full financial and technical responsibility for carrying out its participation in the program.
6. Obligations and responsibilities are clearly defined on a case-by-case basis.
7. Generally speaking, for large development programs, it is desirable for each side to have a requirement for utilization of the end product.
8. In large development projects, there may be certain fundamental capabilities...that will be restricted to US development.
9. Foreign contributions should, insofar as possible, take the form of discrete packages that lend themselves to clean managerial and technical interfaces.
10. In US development projects in which there is international participation...control of overall design and development remains with the US and involvement of foreign participants in management...and decisions will be restricted to that necessary and proper for the effective fulfillment of their responsibilities.
11. Participation in one element of a project does not entitle a participant to technical information on the total project. Only the minimum of technical information is exchanged to ensure effective interface among the various elements of the project.

12. Participants must understand that large development projects evolve and therefore, will probably result in design changes.

For NASA to proceed with international participation on the basis of government-to-government political commitments and within the general parameters listed above, several policy issues had to be addressed. A 1983 assessment of these issues includes:

> **What Space Station components are not eligible for cooperation?**
> NASA still needs to decide whether certain elements, while requiring a clean interface, may still be elements which the US should build.
>
> **Foreign involvement in Phase B** *[development studies, preliminary design phase]*
> Should NASA undertake Phase B's on all Space Station elements, while foreign space agencies fund independent parallel Phase B studies on Space Station elements in which they have a particular interest? Or should NASA entertain joint Phase B studies?
>
> **Quid Pro Quos**
> One major element that must be reviewed...are potential quid-pro-quos that NASA will want to offer in exchange for hardware contributions... examples that would be appropriate to a Space Station: NASA commitment to buy additional hardware; preferred access to the Space Station on a variety of uses; reduced (or no) costs for utilization; and opportunities for flight of foreign personnel. Of course, formulas for these would have to be worked out so that the benefits match the size of the contributions.[18]

At issue, was whether NASA should build a "core" Space Station[19] with augmented capabilities provided by foreign Partners through "clean" technical interfaces, the extent to which foreign Partners would be allowed autonomous and independent development of their contributions[20] and how the distribution resources would be governed through quid-pro-quo formulas[21] pertaining to hardware contributions and utilization rights.

In 1984, President Reagan in his State-of-the-Union Address directed NASA to develop a permanently-manned Space Station. This was to be accomplished by calling on "our friends to help us meet these challenges and share in their benefits" and on NASA to "invite other countries to participate so we can strengthen peace, build prosperity and expand freedom for all that share our goals."[22] "There it was: the chief Executive making a commitment that we [NASA] had been waiting for...we should build a Space Station...and we would do it with the help of our friends and allies aboard."[23]

Following this presidential mandate, NASA's Administrator traveled to Europe, Japan and Canada to extend an invitation for participation. In a March 1984 letter to the Secretary of State and in identical letters to senior government officials in Europe, Japan and Canada. Beggs reported foreign reactions to the invitation by Reagan:

> The reaction so far to the President's call for international cooperation has been both strongly positive and openly appreciative. It has been positive in the sense that our principal Allies are moving quickly, or have already moved, to take political decisions to participate.[24]
>
> Overall, I was extremely pleased by the reactions I received to President Reagan's Space Station initiative. Government and industry leaders at each of my stops exhibited great interest in the possibilities for an international Space Station. I believe this reflects the successful legacy of cooperation already established among us in the space age as well as the groundwork we have laid together over the past two years for embracing this challenge...I am quite optimistic about the prospects for international cooperation on the Space Station project...[25]

Over the course of 1984 and 1985, Europe, Japan and Canada committed to Space Station participation. Cooperation escalated from a possibility discussed and coordinated among space agency experts to a highly visible initiative of the President resulting in political commitments on the part of the US and its allies to participate.[26]

Policies for international involvement were put forward in this invitation to potential Partners in Europe, Japan and Canada.

> ...President believes that international participation in the manned Space Station program can provide a highly positive centerpiece for demonstrating Free World unity, goodwill and technological progress.
>
> Early participation in the planning process...is...essential. I believe that insight into this planning process will allow participants to hone their ideas for participation: it will also allow them to speak directly to their proposals so that the final Space Station design can accommodate them.
>
> As I mentioned, NASA will hold frequent international workshops...to permit this cross-fertilization to occur...President Reagan has committed the US to building a...fully functional Space Station...has also set the stage for working together to develop a more expansive international Space Station with even greater benefits and capabilities for us all to use. Thus, we are inviting your government to take a close look at our plans and concepts and then, based on your long-term interests and goals, share with us your ideas for cooperation that will expand the capabilities of the Space Station.
>
> Because I understand that the relationship between scientific objectives and the Space Station program is important to you, I would be pleased for you to designate an observer to our Space Station Science Advisory Committee...In addition, an Industrial Committee...will be established to ensure that the Space Station maximizes the commercial opportunities of space, another important objective that we all share. We also welcome observers on that Committee...Once we agree more formally on our respective activities during the planning phase, then we look froward to having our Partners as permanent members of both Committees.
>
> Another topic which we discussed is the importance of protecting against the unwarranted transfer of technology. Technology transfer has been an increasing concern...and we will need to work together to make sure we are protecting our respective technology...Major international Partners in the Space Station will receive assured access to the Station. Therefore, protection of intellectual property is a prime requirement if we are to stimulate private sector investment and involvement in this program over the long term.[27]

This statement reveals that NASA intended to continue with foreign participation in planning phases established by patterns of collaboration present during the Space

Station Task Force ICWG. Of significance, is a perceptible shift in NASA's strategy towards space cooperation from "leading through preeminence"— more evident in cooperative patterns during the 1960s and 1970s when NASA dominated and controlled all aspects of cooperation— to "leading through cooperation."

"Leading through cooperation" infers that the US was willing to accommodate foreign preferences and objectives to achieve a cooperative partnership. Accommodation indicated that foreign participants would retain ownership and technical managerial responsibilities for their contributions and share in decision-making for overall operations of Space Station.[28] Cooperation on Space Station signified a "genuine" partnership in which foreign Partners could exercise a certain degree of autonomy. This strategy also implied US political and functional leadership for "demonstrating Free World unity, goodwill and technological progress." To this end, NASA would develop a functionally independent Space Station where foreign Partners augmented capabilities by substantial, significant and well-defined contributions.

As with past NASA practices, there existed a willingness to openly share science, while protect technology. It was anticipated that the science to be conducted on Space Station would be determined through full foreign participation. However, the creation of new scientific knowledge with potential technological applications was to be governed by intellectual property rights. In this vein, it was essential that formulas be put in place that guard directly against the unwanted transfer of technology. Protecting against adverse technology transfer was viewed as supporting vital commercial and national security interests.[29] This was also expressed in a letter written by NASA's Administrator to the Director of NASA's Johnson Space Center.

> One of the most important responsibilities that you will have related to the international aspects of the program is to protect against adverse technology transfer. NASA must support US commercial and national security interests— as we have always done— by ensuring both that the President's technology transfer policies are followed and also that the agency's legal obligations with respect to international technology transfer are thoroughly and carefully discharged.
>
> Space technology is a particular target of the technology penetration efforts of the USSR and its allies. Furthermore, the Administration is also concerned about careless and unnecessary revelation of sensitive technology to our free world competitors— sometimes to the serious detriment of this nation's vital commercial competitive position. Prevention of adverse technology transfer is therefore a charge which I am asking everyone involved in the Space Station program to take very seriously.[30]

This letter went on to specify that NASA will protect against adverse technology transfer by only allowing cooperation on elements that are additive to a NASA core capability. NASA did not, however, preclude transnational industrial relationships where some degree of technology transfer would be facilitated in accordance with export control laws and procedures. NASA drew a clear distinction between technical coordination and technology transfer whereby the former abides by the idea of clean technical interfaces:

> ...technical coordination is impeded by an apparent misunderstanding that technical coordination will lead to premature and uncontrolled technology transfer. The two subjects can and should be separated and we should proceed with technical coordination in parallel with planning for technology transfer. It is also important that the involved principals from the United States...understand how technical coordination and technology transfer can be dealt with as separate issues so that they can monitor coordination with potential foreign Partners and be comfortable that there is no risk of uncontrolled technology transfer.[31]

The guidelines discussed above served as the basis for negotiations on a legal framework of cooperation which followed from 1984 to 1988. NASA put these guidelines into practice through the development of an initial operating capability (IOC)

Space Station with foreign participation to proceed in an "additive" manner. From the onset of negotiations, NASA's position on technological and scientific concerns and authority and decision-making patterns were made clear:

> •Looking for full, meaningful Partners in this project.
> •US intends to spend...on an initial operating Space Station capability.
> •NASA is not interested in teaming... as a form of cooperation.
> •We want our international Partners to fund and manage their own...studies, and exchange information on a government-to-government basis.
> •All of our countries are concerned about unwarranted transfer of technology.
> •A key challenge: protect our industrial competitiveness while exchanging enough information to ensure a successful program.
> •Need to strive for cleanest interfaces possible.
> •Partners will retain ownership of their hardware and assume operational responsibility.
> •Partners will share in the management and operation of...Space Station.
> •Partners will have guaranteed access to the station...
> •Partners will have proprietary rights to their data. Protection of intellectual property is a prime requirement.[32]

The idea of "full" and "meaningful" cooperation implied that NASA was willing to entertain any proposals forthcoming from potential foreign Partners and allow them to share in the benefits of the project on a reciprocal basis, but was not open to joint teaming that would have included shared R&D. NASA favored substantial and significant foreign investments and contributions to Space Station development. This included foreign Partners who were prepared to continue as active participants during operations and utilization phases of the program. Partners were to retain responsibility for sustaining engineering and operational management of the components they provide as well as ownership and access rights.

At the same time, foreign proposals had to be well-defined— that is, limited to augmenting a NASA built and controlled IOC Space Station through discrete hardware elements. An important policy goal was to restrict technology transfer by precluding R&D teaming, preventing foreign contributions in the critical path and striving for clean technical interfaces. The protection of both technology and intellectual property was fundamental to cooperation.

From the standpoint of authority, NASA preferred formal government-to-government relations and agreements covering each phase of the project in addition to sovereign control and operational responsibility of contributed hardware. In relation to decision-making, NASA anticipated participation by its Partners in management. Philosophically, NASA believed that management participation should be commensurate with the degree and type of commitment made to the program. This entailed a quid-pro-quo— in return for funding, developing and assuming responsibility for upkeep and utilization of hardware that is provided, international Partners would play a role in overall management and operations.

As negotiations proceeded, a greater degree of flexibility in what Partners could contribute and in shared management and decision-making became important. A shift in this direction is demonstrated by the adoption of "functional allocations." This meant that foreign Partners could provide hardware that would fill requirements originally conceived as being part of the IOC Station. Of particular concern to congressional leaders, was that in a functional allocation scheme "NASA could be tempted to make compromises with potential foreign participants in order to gain a short-range financial benefit that may have a negative long-range impact on US high technology development."[33] To prevent this possibility, NASA planned to be the dominant and primary developer, outfitter and user of Space Station.[34]

This trend towards functional allocations was reinforced by ESA's insistence on a single multilateral IGA, albeit NASA preferred separate bilateral MOU arrangements by which to ensure its overall technical and managerial control. Such a multilateral IGA implied multilateralization of Space Station in all aspects of jurisdiction, control, management and decision-making. This position was unacceptable to NASA:

> I cannot rule out the possibility that the Space Station program may proceed with Japanese and Canadian cooperation, but without European participation.
>
> It is quite possible that US needs and European desires are incompatible and that we will not suceed in developing a mutually benefical cooperative program with Europe.[35]

The European approach was seen by NASA as inequtable since it was not in line with the quid-pro-quos favored by NASA and it would have fragmented management and decision-making and thus, questioned whether a safe and efficient Station could be operated. At stake, was NASA's overall control and responsibility for the program. Eventually, a compromise was reached where both bilateral and multilateral arrangements for cooperation were agreed upon. This involved three bilateral MOUs between NASA and ESA, Japan and Canada that concerned technical and programmatic aspects of Space Station partnership[36] and a multinational IGA among the governments of the US, ESA member states, Japan and Canada which established policy terms and legal principles of cooperation.[37]

Dynamics of Cooperation

The dynamics of cooperation for this phase of Space Station are framed by a "leadership through cooperation" approach. This implies that the US will produce a core (e.g., IOC) Station with significant contributions from foreign Partners to create an "international Space Station complex with greater capabilities that will enhance the use of space for the benefit of all participating nations and humanity."[38]

Technological and Scientific Resources

NASA established a specific set of guidelines for controlling technology transfer. These guidelines, which reiterated past NASA policy preferences, were based on a clear division of responsibilities. This indicated cooperation would be structured to specifically minimize exchange of information and limit foreign participants to discrete hardware contributions where clean technical and managerial interfaces could be maintained:

> ...MOUs will establish the parameters of the cooperative relationship.
>
> The cooperative programs will be designed and implemented so as to minimize the exchange of information, consistent with the effective and safe conduct of the project.
>
> ...the cooperative arrangements for the Space Station will take place on elements which are additive to the US IOC Space Station...the agency will establish these programs so that it can work across clean technical and managerial interfaces to minimize the amount of information which needs to be exchanged. All exchanges of controlled data will be in accordance with applicable national laws and regulations.
>
> ...information necessary for the purpose of carrying out the objectives and activities of the joint project will be exchanged. Only data necessary for

> the conduct of the joint project...will be provided. Restriction as to the use or disclosure will depend on the nature of the data. In the event it is necessary to exchange controlled technical data, NASA and its foreign Partners will in all cases consult and provide conditions for its exchange and use.[39]

The 1988 Space Station IGA states that Partners are obligated to protect technical data and goods in accordance with their national laws and regulations.[40] In the US, NASA must comply with the Department of State International Traffic in Arms Regulations (ITAR).[41] To ensure the protection of controlled data as well as data exchanges to enable technical coordination, NASA requested and was granted by the Department of State a general approval under ITAR provisions.[42] This approval allowed for the transfer of specific types of technical data crucial to fit (interface), form (integration) and function (safety).

Fit, form and function connotes that participating foreign Partners are provided with minimal essential technical data to permit them to understand the ability of their designs and hardware to meet requirements of the Space Station system. This data includes "design-to" and "operate-to" requirements, design standards, operational planning and training procedures. The ITAR approval did not cover transfer of data related to detailed design, development and production or manufacturing of similar know-how. Transfer of such controlled technologies was to be considered on a case-by-case basis.

The distribution of scientific resources generated through SSF activities was to be governed through the assignment of intellectual property rights.[43] The foundation for intellectual property lies with jurisdiction for activities on-board Station. A territorial approach to jurisdiction based on the extension of national laws to intellectual property is codified in the Space Station IGA:

> ...for purposes of intellectual property law, an activity occurring in or on a Space Station flight element shall be deemed to have occurred only in the territory of the Partner State...[44]

This allows for certainty and predictability as to whose national laws of intellectual property rights are applicable.[45]

There is, however, a specific limit to national jurisdiction over intellectual property rights. This dealt with the concept of "freedom-of-choice" concerning an invention by a person who is not a national of the flight element in which the invention was made. For SSF, a Partner state could not have automatically applied its national laws. As a rule of thumb, the owner of an invention could have filed for a patent and acquisition of ownership in any country irrespective of territorial considerations. The one caveat is that the permission for filing a patent, which must be granted to the inventor, had to be obtained from a designated official responsible for administering export control laws. Moreover, the freedom-of-choice concept did not prejudice the rights of any Partner state where the patent application is first filed to restrict its dissemination.[46]

Authority Patterns

NASA preferred that authority for all decisions related to Space Station be exhausted first at the Agency-level. The foreign Partners found this approach to be problematic opting instead that "there should be a standing government-level mechanism to review and make decisions on matters of a common concern."[47] As a result of compromise, the Space Station IGA exhibits authority patterns at both the agency and higher-governmental levels:

> The Partners, acting through their Cooperating Agencies, may consult with each other on any matter arising out of Space Station cooperation.
>
> Any Partner may request that government-level consultations be held with another Partner on any matter arising out of the Space Station cooperation. The requested Partner shall accede to such request promptly.[48]

Authority patterns break down over three levels: (1) heads of government; (2) heads of agencies; and (3) management bodies. For the heads of government, authority applies to policy issues of concern as it pertains to political commitments and obligations. Authority for heads of agencies concerns functional issues and programmatic aspects. The management bodies are composed of agency-level program directors and managers. These bodies have authority over detailed design, development, assembly, operations and utilization activities.

At issue for the Space Station program, both then and now, is how these authority patterns translate into legal regime matters encompassing jurisdiction, control, liability and customs. Jurisdiction and control of elements are conferred on a sovereign basis (i.e., territorial and national) in accordance with international space law.[49] This exists over elements and nationals that are provided by a state and is also true of intellectual property rights and criminal jurisdiction.

> ...each Partner shall retain jurisdiction and control over the elements it registers...and over personnel in or on the Space Station who are its nationals.[50]

Jurisdiction and control are subject to any relevant provisions of the Space Station Agreements implying limits on sovereignty. In relation to intellectual property rights, the freedom-of-choice concept allowed for nationals to apply for patents in the country of their choosing. An additional limit exists in regard to NASA's IOC Station. The US was granted authority to exercise criminal jurisdiction over any personnel for misconduct that endangers the safety of the IOC Station.[51]

Sovereign limits apply to claims of liability whereby Partners agreed to waive all claims (i.e., a cross-waiver of liability) based on damage to a person, entity or property arising out of "protected space operations" (i.e., space transportation and Space Station activities).[52] Although, there are a number of notable exceptions to this cross-waiver of liability involving the permission to issue claims for one's own chain of related activities, injury or death and damage caused by willful misconduct.

As it applies to customs provisions, sovereign rights are reinforced. It is incumbent upon each Partner to facilitate the movement of persons and goods to implement the Space Station Agreements subject to the particular state's national laws and regulations.[53]

Decision-Making Patterns

Decision-making patterns pertain to management issues and decisions with respect to ownership, utilization activities, consultations and program evolution. The Space Station Agreements incorporate both bilateral and multilateral decision-making patterns and management bodies. This is reflected in both the bilateral MOUs and a multilateral IGA that form the cooperative framework of agreements for Space Station illustrated in Figure 3.

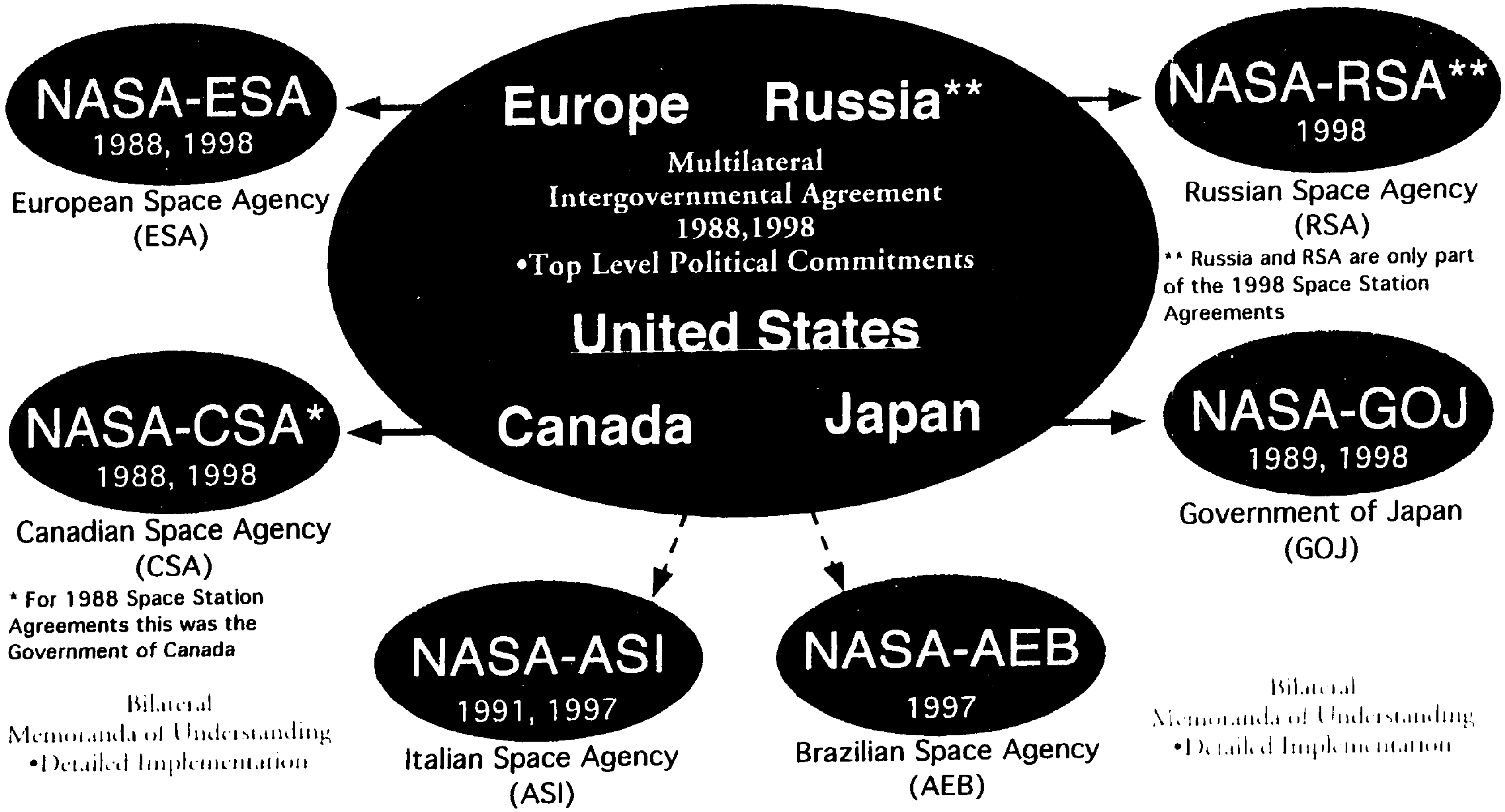

Figure 3. Space Station Agreements.***

*****Note: All the Agreements reached in 1997 and 1998 supplant earlier Agreements.**

A bilateral committee structure serves design, development and assembly phases, while a multilateral committee configuration deals with operations and utilization activities. For design, development and assembly related to program planning and requirements, each MOU— NASA-ESA, NASA-Japan and NASA-Canada— establishes a bilateral Program Coordination Committee (PCC) to coordinate and review these activities.[54]

A Space Station Control Board (SSCB), made-up of NASA, ESA, Japanese and Canadian members, was also instituted to control and document on a bilateral basis the requirements, configuration and housekeeping resource allocations for design purposes and element interfaces unique to NASA and its respective Partners.[55] Concurrently, NASA was required to organize multilateral program reviews at the request of any Partner.[56] This includes, although not specified in the MOUs, multilateral PCC meetings.

A Multilateral Coordination Board (MCB) was established to ensure coordination of Partner activities for operations and utilization plans.[57] The MCB consists of two multilateral panels responsible for the long-range strategic coordination of operations and utilization activities. The objective of these panels, Systems Operations Panel (SOP) and the Utilization Operations Panel (UOP), was to develop a Consolidated Operations and Utilization Plan.[58] The IGA established multilateral program reviews at heads of Agencies and intergovernmental levels to assess progress and deal with substantive political and policy issues:

> ...the Partners shall meet to deal with matters involved in their cooperation and to review and promote Space Station cooperation.[59]

The Space Station management structure is outlined in Figure 4.

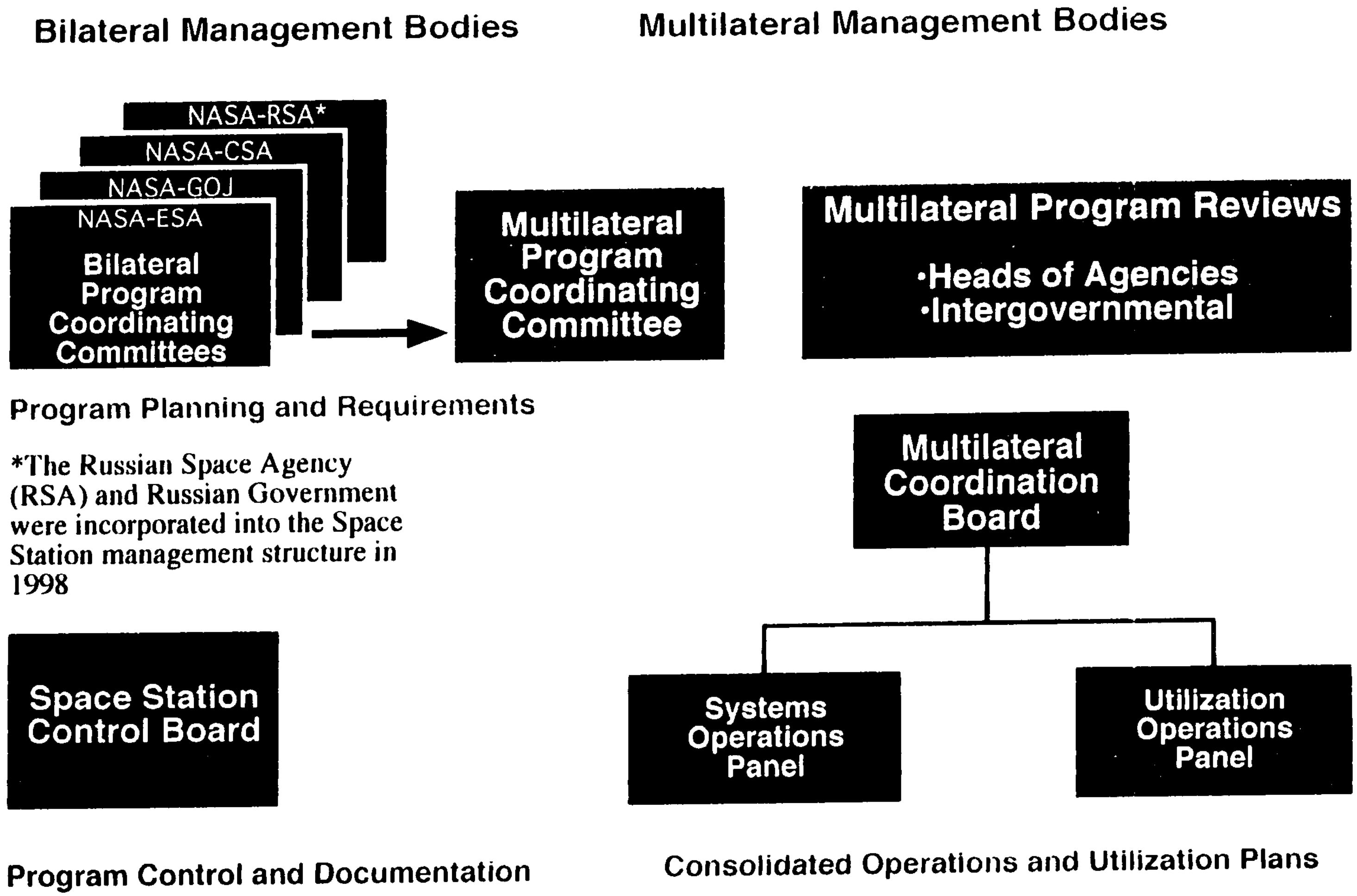

Figure 4. Space Station management structure.

The multilateral nature of management was tempered by recognition of NASA's leadership role in directing, designing, developing, operating and utilizing SSF. The IGA stated that NASA is to provide overall program coordination and direction, system engineering and integration, safety requirements and planning for day-to-day operations.[60] Thus, NASA was to chair the various bilateral and multilateral management and program review bodies. Even though the goal of these bodies is consensus decision-making, the NASA Committee Chairs are empowered to make decisions when consensus cannot be reached.[61]

Initially, NASA's scheme for decision-making regarding both transfers of ownership and utilization activities was unilateral. The US sought veto power over any transfer of ownership by a Partner of its elements or equipment and power to prevent Partners from having a veto over such transfers by the US. A US veto over another Partner's activities was also permitted on foreign policy and national security grounds.[62] For transfer of ownership to nonpartners and their nationals, prior notification was required.[63]

In terms of utilization activities, the Partners favored the ability to make independent decisions and allow for joint concurrence. Each Partner was to independently determine how its element and allocations, including use by a nonpartner, would be utilized. In exchange, a US veto would be allowed on any proposed user element contributed by a nonpartner or other private entity if that element is docked with or is part of the IOC Station:

> Each Partner may use and select users or its allocations for any purpose...except that:
> ...any proposed use of a user element by a non-Partner or private entity under the jurisdiction of a non-Partner shall require prior notification to all

> Partners...and shall also require the concurrence of the Partner...and, if that element is a manned base element or docked with the manned base, that of the United States.[64]

This veto is applicable in cases where a nonpartner is transferred jurisdiction of the user element. If jurisdiction is not transferred, then the US must concur in any nonpartner use of the IOC Station. Likewise, if the US were to propose use of its allocations on Partner elements to a nonpartner, the affected Partner would have to concur.

Pertaining to transportation and communications, independent decision-making was reserved as to how Partners would meet their obligations. The IGA allows for foreign Partner use of their government and private sector transportation and communication systems.[65] Still, NASA's STS is designated as the baseline transportation system and its Tracking and Data Relay Satellite System (TDRSS) as the baseline communication system.

Consultations, which can be called for at the request of any Partner, took on a multilateral dynamic. This was true for all aspects of the cooperative framework including any possible evolution in Space Station capabilities:

> If the requesting Partner notifies the United States that the subject of...consultations is appropriate for consideration by all the Partners, the United States shall convene multilateral consultations at the earliest practicable time, to which it shall invite all the Partners.
>
> Any Partner may request that government-level consultations be held with another Partner on any matter arising out of the Space Station cooperation. The requested Partner shall accede to such request promptly.[66]
>
> Likewise, the evolution of the program is handled in a multilateral fashion.
>
> ...it will be the object of the parties...to cooperate in their respective proposals for additions of evolutionary capability.

> NASA...and the other Partners will participate in an International Evolution Working Group (IEWG) to coordinate their respective evolution studies...
>
> The MCB will review specific evolutionary capabilities proposed by any Partner.[67]

Functional Policy Preferences

For the US, cooperation was linked to technological leadership. This is manifested in the IOC Station and NASA's role in managing development, operations and utilization activities. The foreign Partners— ESA in particular— countered this doctrine of leadership with one of technological autonomy in which authority and independent decision-making is implied. The compromise reached between these positions is that of a "functional allocations" concept.

Functional allocations are based on three important agreements that aim to share both responsibilities and benefits among Partners commensurate with their investment in the project. One, each Partner independently develops, operates, utilizes and owns the elements they contribute; two, each Partner assumes managerial and technical responsibilities for upkeep and utilization of their elements; and three, each Partner plays a role in management and operations of the Space Station. The "United States shall provide to the other Partners resources derived from the Space Station infrastructure it provides to operate and use the manned base"[68] and the respective Partners will each assure access to and use of their Space Station flight elements.[69]

Functional allocation enabled ESA to incorporate into Space Station the Hermes space plane and Man-Tended Free Flyer (MTFF). Hermes was a result of assured access and independent decision-making with regard to transportation to and from the Station.

The MTFF was to be autonomous from the US manned base with independent functional capabilities.[70]

In return for fulfilling responsibilities associated with functional allocations, a specific set of functional quid-pro-quos, in terms of utilization allocations and access rights, was established in the Space Station Agreements:

> In exchange for the United States providing such resources to the European Partner and Japan, the European Partner and Japan shall provide to the United States a fixed percentage of the use of the [European] Attached Pressurized Module...and the Japanese Experimental Module..."[71]

The US was to receive 46% utilization shares in the European and Japanese modules and 97% shares in its own modules. Europe and Japan were to receive a 51% share of their user accommodations. Moreover, each Partner agreed to equitable sharing of common system operations costs.[72]

Canada is unique for a foreign Partner because it provides hardware (i.e., Mobile Servicing Center) in the critical path of Space Station, while not contributing any user accommodations or elements.[73] Even though this does not abide by NASA's functional preference for discrete hardware packages, it is indicative of the functional allocation approach which implies that Partners could provide hardware that would fill requirements originally conceived as being part of the IOC Station. Canada, like the US, must provide its infrastructural resources to the other Partners.[74] In return for its contribution, Canada was to receive a 3% utilization share on all other user accommodations.

The preference to minimize exchange of funds is also reflected in the 1988 Space Station Agreements. First, each Partner is responsible for funding all aspects of its own elements;[75] second, in-kind contributions, such as specific operational activities and barters, in lieu of cash payments can be used to meet common cost obligations;[76] and third, assured access to one another's facilities is to take place on a cost-reimbursable basis.[77]

Symbolic Policy Preferences

The Space Station program was symbolic of US leadership preferences. This was a factor in securing domestic support for the program. Aspects of this leadership were discussed earlier in this chapter and summarized in Table 5. An additional facet of leadership that proved to be problematic to the cooperative relationship involved US national security. In 1987, US policy stated that it might use its elements of Space Station for national security purposes in accordance with US and international law without their consent or necessarily their review.[78]

From the onset of negotiations in 1984, Partners accepted possible US national security uses of SSF if they were peaceful and non-aggressive:

> The US Space Station program is a civil program which will be funded entirely out of NASA's budget...As provided in the Outer Space Treaty...all activity on the Space Station will be limited to peaceful, non-aggressive functions.[79]

> The Space Station that the President directed NASA to build is a civil Space Station. Of course...the Space Station will be available for users. If there are any national security users...all activity on the Space Station will be limited to peaceful, non-aggressive functions.[80]

The 1988 Space Station IGA notes that "the object of this Agreement is to establish...a permanently manned civil Space Station, in accordance with international law."[81] It was commonly accepted by the international community, including the Space

Station Partners, that the principle of "peaceful uses of outer space" as established in the 1967 Outer Space Treaty precludes weapons of mass destruction and militarily aggressive uses of space, but not necessarily the use of space for national security purposes. In this context, "peaceful" and "non-aggressive" means defensive military purposes.

Since both NASA and its Partners believed that the Space Station could be used for "defensive" national security purposes, the concern was how to reflect that fact in the text of the Space Station Agreements:

> NASA believes that the Department of Defense should be able to use the Station and has consistently taken that position in international negotiations. All of our Partners have agreed that the Department of Defense will be able to use the Station. The issue here is how to reflect this in the agreements.[82]

The Partners stated unequivocally that an explicit reference to "national security purposes" is unacceptable.[83] This would have made cooperation difficult to support politically as well as call into question the character of the "civil" Space Station President Reagan invited them to join in 1984. ESA, Japan and Canada made it known to the US in 1987 that they will not be able to sign the IGA and there will be no cooperation if the US insists on retaining an explicit reference to national security uses.[84] NASA concurred with this view and believed that the "peaceful purposes" provision in the IGA fully protects US leadership preferences.

US national security interests also had implications for decision-making dynamics. The Department of Defense (DOD) requested that the IGA provide for an asymmetric US veto over Partner use of their own facilities. NASA viewed this development as an unreasonable request and continued to maintain that Partners should not be denied assurances that they will be able to use their own assets on the Space Station. Moreover, the allowance for governmental consultations were viewed by NASA as providing an adequate means for preventing Partner uses that might offend US foreign policy or national security interests. The Partners also objected to DOD's position on the grounds that they could not contribute billions of dollars worth of hardware and operating costs, while expose themselves to the possibility that the US could unilaterally and repeatedly veto use of their own facilities.

NASA's position prevailed over DOD's because the President and Congress felt that national security interests could be realized and the perceived policy benefits of cooperation outweighed the prospects of failing to reach an agreement:

> NASA believed that DOD's [Department of Defense] concerns about protecting their rights to use the Space Station and guarding against inappropriate uses by our allies can be accommodated without explicit references to national security activities or heavy-handed unilateral veto provisions. Acceptance of the DOD proposals would needlessly risk losing international participation that is the direct result of the President's invitation and would thereby eliminate support in Congress for the civil Space Station itself. On the other hand, language that allows DOD complete access to the Space Station within the bounds of international treaty obligations will be acceptable to the Partners and this will prevent the loss of Congressional support for the program. NASA requests that it be permitted to get on with the program, a Space Station with international Partners as envisioned by the President.[85]

NASA asked the President in an April 1987 letter to make a decision on the national security issue.[86] The President agreed with NASA that US national security interests could be realized within the bounds of international space law thus, salvaging the SSF partnership.

AUGMENTATION TO INTERDEPENDENCE

The multilateral qualities of the 1988 IGA, both in authority and decision-making patterns, tended to legally supercede the bilateral MOUs. An indication of this was that the MOUs served as implementing arrangements subject to and consistent with the provisions established in the IGA.[87] Further, the SSF Agreements established common multilateral relationships exemplified by a number of characteristics: (a) "freedom-of-choice" concept applied to intellectual property rights; (b) common legal regime pertaining to jurisdictional and control issues; (c) multilateral program reviews during design, development and assembly phases; (d) MCB to manage operations and utilization activities; (e) joint concurrence in decision-making for utilization rights and transfer of ownership; and (f) functional allocations for common management and operations, assured access and equitable sharing of technological and scientific resources.

At the same time, there existed some asymmetrical conditions that favored NASA.[88] For Europe and Japan, there was a dependency on the US for a major aspect of their future activities in space since without being attached to the core NASA Station their specific elements could not function. The 1988 Space Station Agreements conformed to NASA's functional preferences for clean technology interfaces, control of critical path items, protection of sensitive technologies and no exchange of funds.

An asymmetry was also present in legal commitments.[89] In Europe, Japan and Canada, the IGA is equivalent to a treaty and is approved by national parliamentary systems. For the US, the IGA is an executive branch agreement that can be superceded by US domestic law. Thus, Congress is not formally committed to any of the provisions set forth in the IGA. Without the legal commitment of Congress, the full faith of the US government is not engaged by the IGA.

The 1988 IGA consisted of clauses for withdrawal, linkage of financial obligations to national funding procedures and availability of funds including Space Station redesigns emanating from these impacts.[90] These clauses provided the means for NASA to reconcile possible domestic constraints with its international obligations to SSF. The Space Station fell prey to domestic policy preferences rooted in the incremental nature of congressional budgetary politics.[91] Without involving its Partners directly in the decision-making process, NASA was compelled by congressional appropriators to redesign the Space Station several times because of rising costs and less than expected funding.

SSF rephrasing activities initiated by NASA in 1989, just one year after the Space Station Agreements were formalized and signed, impacted the international partnership. One contributing factor is that formal agreements were signed before technical requirements were definitively established. This resulted in complex and difficult issues as the Space Station design changed and political expectations were forced to change with them.[92]

Legally, NASA did not violate the SSF Agreements by making changes to the program. The IGA and MOUs state that the ability of each Partner to carry out its obligations is subject to its funding procedures and the availability of appropriated funds.[93] At issue for NASA's Partners, was the credibility and reliability of the US. These concerns were exacerbated since Partners had reformulated their space programs to cooperate with NASA on Space Station based on the expectation that the US would provide a core station with a certain set of capabilities.[94]

By 1991, Space Station redesign activities had reached a critical milestone for international cooperation given that Congress considered termination of the program.[95] The Bush Presidential administration made it known to congressional leaders that continuation of the Space Station program was about American credibility and whether the US would continue its leadership role in space exploration:

> The credibility of the United States as a Partner is based on its ability to make durable commitments. We will increasingly need to cooperate with these allies on common endeavors, whether in security, economic, environment, or science and technology areas. A failure by the United States to keep the Space Station program on track would call into question our reliability. We would have great difficulty seeking the cooperation of key allies on major science and technology programs of mutual interest in the future. I strongly urge that the Senate maintain our leadership role in manned space exploration, and our credibility as a Partner, by supporting Space Station Freedom.[96]

Both congressional proponents and international Partners reinforced this issue of credibility and leadership. In a 1990 letter to the US Senate Committee on Appropriations urging continued funding for the Space Station, sixty-four Senators stated that "Space Station Freedom is a cornerstone of our civil space policy and a symbol of our commitment to leadership and cooperation in the peaceful exploration of space."[97] The Italian ambassador to the US saw Space Station as an opportunity to strengthen transatlantic relations in the face of the Soviet Union and viewed its possible cancellation as a blunder of the highest magnitude. The British, German and French ambassadors to the US felt that termination would have negative long-term consequences, not only for future scientific and technical cooperation, but also for the reputation of the US as a reliable ally and Partner:

> The cooperation concerning the international Space Station is...of a pioneering nature. If it were to fail, the consequences would be disastrous and the international Partners would probably decide not to cooperate with the US in major scientific and technological projects for quite some time.[98]

Without directly being solicited by NASA, Partners lobbied Congress to continue the program. In effect, this established a multilateral coalition among NASA, the presidential administration, congressional proponents and international Partners that directed itself to ensure the viability of Space Station in the face of congressional uncertainty:

> On three different occasions during consideration of the fiscal year 1993 NASA budget this year, the Congress strongly reaffirmed its support of Space Station Freedom with a bipartisan coalition of members...Thanks to your strong support, Space Station Freedom is alive and well and we are closer than ever to turning the dream of this international space-based research facility into a reality.[99]

Space Station redesign activities forced NASA to cut costs by reducing redundant contributions among the Partners. Ironically, this mitigated the extent to which NASA was able to remain independent of its international Partners for the completion of the Space Station thus, enhancing the program's interdependence. In addition to NASA's dependence on the Canadian Mobile Servicing Center for constructing and operating the Space Station, the program became dependent on the Italian Space Agency's (ASI's) mini-pressurized logistics modules (MPLMs) for getting cargo to and from the core station.[100] In the latter instance, an earlier NASA plan to develop larger modules for this purpose was abandoned as part of the redesign that took place in 1993.[101]

The issues surrounding the 1993 Space Station redesign were discussed on a multilateral basis through the Space Station PCCs, Heads of Space Station Agencies and Intergovernmental meetings.[102] A number of guidelines for Station redesign, derived from the existing cooperative framework, were agreed to within these forums. It was agreed that (a) technical and programmatic baseline of any redesign option pursued shall include European, Japanese and Canadian contributions as well as resources to support operations and utilization activities; (b) international Partners will participate in all redesigned transition activities; (c) existing management mechanisms (i.e., PCC, SSCB and MCB) will be used to coordinate redesign activities; and (d) joint consultations on changes in operational costs, including possible cost-ceilings and cost off-sets, and in the possibility of Russian involvement in the program will be held. Essentially, the redesign process initiated by the US due to domestic policy pressures evolved as a multilateral effort among the Station's international Partners.

INTERDEPENDENCE OUTCOME

The evolution of Space Station cooperation from augmentation to interdependence was reinforced by a revision in NASA's guidelines for international cooperation in 1991. This includes the possibility of multilateral cooperative efforts and foreign participation in critical path elements. Albeit, vestiges of NASA's more traditional preferences, such as distinct managerial and technical responsibilities, bilateral decision-making patterns and protection of sensitive technology, are still present.

NASA's management instruction for the initiation and development of space cooperation put forward in December of 1991 reflects a willingness to consider multilateral and functionally interdependent partnerships (i.e., participation through critical path elements), while maintaining traditional policy preferences to the extent possible:

> Programmatic Validity: Cooperation in technical and scientific projects must contribute to NASA program objectives.
>
> The programmatic validity of each cooperative activity must be established since NASA has no budget for international cooperation. Each project must stand on its own merit; NASA does not cooperate solely for political benefit. International cooperation which provides scientific, programmatic (including cost-efficiency), or technical benefits is encouraged. Such cooperation may relate to projects in which NASA has the lead, NASA participation in foreign-led activities, or to **multilateral efforts. Participation by non-US Partners in US missions...may include elements essential for mission success, i.e., critical path elements.**
>
> Mutual Interest and Capability: Cooperation must reflect the mutual programmatic interests of the participants and be within known scientific, technical, and budgetary capabilities of the cooperating parties. Each cooperating Partner is expected to assume full financial responsibility for own commitments.
>
> Managerial and Technical Responsibilities: To minimize the complexity, the division of responsibilities between the cooperating parties should reflect clearly defined and distinct managerial and technical interfaces.
>
> For this reason, NASA has historically preferred bilateral rather than multilateral agreements.
>
> Quid Pro Quo: Each cooperating project must demonstrate a return to NASA. This return should be in the form of data, services, contributions to infrastructure, etc. Science projects must include a commitment to make any scientific results available to the international scientific community within a reasonable period of time.
>
> Protection of Sensitive Technology: Arrangements for cooperative projects must take into consideration the need to protect against any transfer of technology that would violate US export laws and regulations.
>
> The guidelines calling for clear lines of responsibilities, which minimize complexity, as well as each Partner accepting full technical and financial responsibility for its contributions, are mechanisms that help achieve this goal.

US Competitiveness: Arrangements for cooperative projects must take into consideration US industrial competitiveness and the need to maintain technologies critical to NASA.

Exploratory Discussions with Prospective Partners: Exploratory discussions with prospective foreign participants are helpful and encouraged. However, Agency commitments to proceed with implementation of a cooperative effort must not be made or implied prior to full coordination and approval of potential cooperation.

Government Sponsorship: NASA's agreement counterparts will generally be foreign and international government agencies.

Specific Cooperation Agreements: Cooperative endeavors, which commit the Agency, must be embodied in a formal agreement specifically stating the responsibilities of each party. Vague agreements stating intent to cooperate or other generalized terms are to be avoided.[103]

Dynamics of Cooperation

Changes in the external political environment that strongly linked Space Station to foreign policy interests brought forward a new phase of cooperation. The dissolution of the Soviet Union in 1992 led to a convergence-of-norms between the US and Russia that are symbolic of the post-Cold War era. This altered the nature of NASA's cooperative outlook: the political benefits of US-Russian cooperation in space, especially, in the foreign policy realm, outweighed the costs associated with NASA's departure from its traditional cooperative guidelines involving discrete managerial and technical interfaces and no exchange of funds.

A series of interim agreements reached between the US and Russia and a final IGA concluded on January 29, 1998 among the Governments of Canada, Member States of ESA, Japan, Russia and the US functionally integrated Russia into the Space Station partnership. Russia became involved in all aspects of the program. One aspect is Russia's "equal" Partner status in relation to NASA as it concerns authority, management and decision-making rights. A second aspect is that Russia provides critical path infrastructure elements and is an integral part of the core Station on which the partnership is functionally dependent.

A July 1992 contractual study between NASA and NPO-Energia[104] to consider the use of Russian systems in the US human space flight program[105] was the first indication of potential Russian involvement in Space Station. This study examined use of the Russian Mir Space Station to support future SSF operational capabilities and utilization activities, Soyuz spacecraft as an interim assured crew return vehicle (ACRV) for SSF and Russian techniques for automated rendezvous and docking operations. As a first step to support these endeavors, the US and Russia agreed to a joint "Shuttle-Mir" program.[106] This program encompassed the flight of Russian cosmonauts on the Space Shuttle, the flight of US astronauts on the Mir Space Station and joint missions involving rendezvous and docking between the Space Shuttle and Mir. As a result of these studies and agreements, Russian systems— Soyuz ACRV and an androgynous peripheral docking assembly— were baselined in 1993 as part of the Space Station.[107]

In the fall of 1993, a number of multilateral meetings were held among SSF Partners to consider potential Russian involvement in the program.[108] During the course of these meetings, several common ideas were expressed. These ideas are synthesized and summarized below:

•Full, open and joint consultations should occur among NASA and the Space Station Partners prior to any formal decision to include the Russians in the partnership.
•The rights and obligations contained in the Space Station IGA and MOUs must be preserved along with the lower level technical arrangements. This includes, but is not

limited to, assured access to infrastructure elements, availability of user accommodations, and NASA responsibility for overall technical and programmatic integration of the Space Station (i.e., overall system engineering and planning for and direction of day-to-day station operations).

•The Space Station is a single vehicle with an integrated crew where activities are controlled from one integrated plan.

•RSA must operate as a Partner within the framework of the existing IGA and its partnership should be considered part of the existing Space Station program.

•The addition of Russia must not increase the costs to the Partners either in development or operations.

•Russian participation must be beneficial to the program and benefits must be equitably shared among the Partners.

•The management mechanisms— PCC, SSCB and MCB— must be preserved both in development and operations.

On the basis of these ideas, the US and its Partners jointly extended an invitation to Russia to collectively explore its possible partnership in the Space Station program:

> ...the representatives of the Governments participating in the cooperative partnership to build and operate an international Space Station considered a proposal by the United States that Russia be invited to join in this endeavor...The Space Station Partners' Governments therefore wish to extend to the Government of the Russian Federation their invitation to collectively explore possible Russian partnership in the international Space Station program.[109]

This was followed by the first collective meeting of SSF Partners with Russia to discuss and review requirements for Space Station.[110] Requirements that were put forward included:

> •Achievement of a single, integrated international Space Station with permanent human capability.
>
> •Participation of Russia in accordance with principles of the partnership in the IGA/MOUs and consistent with Partner's rights and obligations. Russian rights, obligations and responsibilities as a Partner will be

finalized in the appropriate legal documents at both the IGA and MOU levels.

•Consultation process to define equitable allocation of benefits derived from the inclusion of Russian capabilities as these benefits are identified.

•Minimization of any cost impacts to the Partners for design and development, which result from Russian participation, and optimization of operations costs reductions that result from Russian participation.

•Program implementation, from design and development through operations and utilization, according to IGA/MOU management mechanisms, with any changes to these mechanisms to be mutually agreed upon.

•Fully integrated operation of the international Space Station as a single spacecraft.

•Continued US responsibility for overall program direction and coordination.[111]

Ultimately, in December 1993 a joint invitation was issued to Russia to become a Partner in the detailed design, development, operations and utilization of Space Station:

> Recognizing the Partners' shared objectives of building broad cooperative relationships with Russia...
>
> Hereby invite Russia to become a Partner in the detailed design, development, operations and utilization of the Space Station, within the framework of the Space Station Agreements...
>
> Pursuant to this invitation, the Partners:
>
> 1. Offer Russia to enter expeditiously into negotiations, taking into account the integrated plan developed by the cooperating agencies, with a view to Russia became a Party to the Intergovernmental Agreement governing Space Station cooperation;
> 2. Request that Russia designate an agency of its government to work with the cooperating agencies of the Partners on the Space Station; and
> 3. Charge their cooperating agencies to develop and enter into an understanding to allow participation by Russia's designated agency in the Space Station program until such time as Russia has undertaken to abide by the terms of the Intergovernmental Agreement governing

> Space Station cooperation and...has entered into related arrangements at the Memorandum of Understanding level.[112]

The modalities for Russia's participation were directed to make sure that management, decision-making procedures and rules for exchange of programmatic and technical information were adhered to as stipulated within the framework of SSF Agreements.[113] Initially, NASA and the Partners adopted a minimalist legal approach (i.e., the use of a Protocol) whereby amendments to the existing Space Station Agreements would be made to accommodate Russian participation in the program.

A bilateral process of space cooperation between the US and Russia as symbolic of the post-Cold War era coincided with the multilateral efforts directed at incorporating Russia into the Space Station program. US-Russian summits, held between Presidents' Clinton and Yelstin in April and July of 1993, recognized the great potential for expanded cooperation in space. This potential was realized through the formation of a US-Russian Commission on Economic and Technological Cooperation (also known as the Gore-Chernomyrdin Commission) and an associated Space Committee chaired by NASA's Administrator and RSA's Director General.[114]

In the Commission's first meeting, a three-phase plan to expand cooperation in the area of human spaceflight was formulated.[115] Phase one included Space Shuttle flights to Mir: phase two created a human-tended orbital research facility as a precursor to an international Space Station through NASA upgrades to Mir; and phase three planned to complete construction of the Space Station in which Russian participation is accommodated without significant perturbations to the baseline redesign of 1993.[116] This plan served as the basis for a NASA-RSA Space Station Program Implementation Plan[117] and contract.[118]

From NASA's standpoint, Russian participation could be readily accommodated through the scheme of functional allocations. The US and Russia were convinced that a unified Space Station could offer significant advantages:

> ...the benefits of Russian participation will be incorporated into a design that will evolve in consultations with all the international Partners...
>
> This new approach will make a better Space Station that can provide more robust science and technology and is infinitely more capable and safer to operate.[119]

The efforts of the Gore-Chernomyrdin Commission were brought to fruition with the acceptance by Russia to become a Partner in Space Station:

> The Governments note with great satisfaction Russian acceptance of the invitation from the Governments of the US, Canada, Japan and European Space Agency Member States to join in the international Space Station. The US and Russian Governments direct NASA and the RSA to begin negotiations immediately on the initial Memorandum of Understanding for Russian participation in the Space Station.[120]

The modus operandi to include Russia as a Partner involved establishing parallel tracks of negotiations at both the IGA and MOU levels.[121] The Partners agreed to negotiate a protocol to the 1988 Space Station IGA on the basis of appropriate changes that reflected the expanded partnership and to an interim arrangement between NASA and the RSA for the conduct of activities leading to Russian participation.[122]

NASA and the original Space Station Partners initially preferred an approach whereby changes would be made as though Russia was entering an existing IGA as a related entity on the same legal basis. A draft version of the Protocol to the 1988 IGA, for example, provides for participation by the Russian Federation through the preparation of a NASA-RSA MOU, ownership of elements, right of access and use of space transportation systems and right to exercise criminal jurisdiction.[123] Amendments on these issues incorporated Russia without altering their legal nature as established in the 1988 Space Station IGA.[124]

There were early indications that more substantial changes would need to be made to the Space Station Agreements to accommodate the preferences of the Partners. ESA took the position that they could not concur on bringing Russia into the program without obtaining agreement on a European request for inclusion of a redesigned contribution.[125] This was to include an explicit reference to and use of the European space transportation system (e.g., Ariane) to supply significant on-orbit elements, involvement in operations for the whole Space Station and assurances that ESA's share of common system operations costs will be paid in the form of in-kind goods and services and that those costs will remain within a fixed ceiling.

Europe preferred that NASA conduct its MOU negotiations with the RSA multilaterally or at least include the Partners as observers to those negotiations.[126] This request was to ensure greater political transparency. In both cases— Europe's redesigned contribution and multilateral negotiations for the MOUs— NASA and ESA reached a compromise; NASA would consider Europe's new proposals for contributions and would make use of multilateral consultations to keep Partners informed about the status of NASA-RSA bilateral negotiations on a MOU.

Russia's position, from the onset of its involvement, was to establish itself as an equal Partner with respect to NASA. This implied significant Russian contributions to a joint US-Russian core station and an equal role in overall management and control functions.[127] Although there was sustained opposition from NASA on the latter point, the idea of a US-Russian core gained acceptance:

> ...and the Government of the Russian Federation have space programs to produce significant elements, which together with the core US Space Station, will create an international Space Station...
>
> ...a significant portion of the contribution of the Russian Federation will be essential parts of the infrastructure of the international Space Station complex.[128]

The addition of Russia to the Space Station program was followed by a three-year period, 1994 to 1997, of negotiations. NASA, ESA, Japan and Canada sought to baseline the 1988 Space Station Agreements which implied that Russia would become a Partner with all the rights, obligations and responsibilities enjoyed by NASA's other international Partners and that NASA would maintain its overall authority and decision-making powers. Concomitantly, there were indications that the 1988 cooperative framework was inadequate to deal with the present conditions characterized by a greater degree of multilateralization and interdependence. One sign of this is the multilateral consultation process regarding possible Russian participation. This process took into account the preferences of not only NASA, but also that of Russia and the international Partners. An additional development was the notion that the Space Station will function as an interdependent spacecraft where Russia is a part of the Space Station core.

Technological and Scientific Resources

The analysis of SSF showed that NASA and the US government specifically structured legal arrangements to limit the potential for the transfer of technology. As a matter of practice, NASA does not transfer manufacturing know-how or production technologies or other technologies that affect the economic competitiveness and national security interests of the US. Only technologies important to fit, form and function are transferred.

Russian participation in the Space Station program reopened the issue of how NASA was to protect commercially-sensitive US technology.[129] NASA believed that the incorporation of Russia would allow them to take advantage of the impressive technology demonstrated by Mir and the Russian human spaceflight space program, while adhere to terms and conditions governing technology transfer as agreed in the 1988 Space Station Agreements.[130] Within this purview, NASA provides Russia technical data, software and hardware necessary for NASA and the RSA to meet their obligations for ISS. This is the same type of information provided to Europe, Japan and Canada.

To allay any concerns about technology transfer and cooperation with Russia, NASA put forward a comprehensive set of "Technology Transfer Initiatives" to safeguard against the unauthorized transfer of sensitive technology and to secure that appropriate regulatory export control approvals for transfer of technological items necessary to integrate, test and operate the Space Station as a complete system are in place.[131] NASA's international activities are carried out in accordance with the regulatory export control regime of the US government.[132] In 1993, NASA received Department of State and Department of Commerce approvals to transfer appropriate export controlled technical data. In conjunction with this approval, NASA convened an interagency Space Station Export Control Steering Group to address NASA's needs for appropriate regulatory approvals for the duration of the Space Station program.

In March of 1994, the Export Control Steering Group approved a three-part approach for technology export control on Space Station: (1) request on the part of NASA for a commodity jurisdiction determination to confirm that all Space Station hardware, technical data and software is in compliance with ITAR and Export Administration Regulations (EAR) provisions; (2) submission by NASA of an application to the Department for Commerce for a special comprehensive license to cover the export of all space-related items approved and controlled for export purposes by EAR; and (3) request for a waiver by NASA, as required by ITAR provisions, to permit NASA to affect the export of certain ITAR controlled data to Russia in the same manner as the other Partners. This approach was incorporated into the "NASA Export Control Program."[133]

In the 1998 IGA, the exchange of dat: and goods provision for technology transfer in support of fit, form and function is more explicit than in 1988. The 1998 article stated below calls for a multilateral commitment to technology transfer, while in 1988 this was specified for at the national level (e.g., NASA Export Control Program):

> The transfer of technical data for the purposes of discharging the Partners' responsibilities with regard to interface [fit], integration [from] and safety [function] shall normally be made without...restrictions...[134]

An additional area of flexibility in technology transfer is evident with a NASA-RSA contract for "Supplies and Services Relating to Mir and the International Space Station."[135] To implement this contract, NASA requested and received approval for modifications in control and regulation clauses applicable for federal acquisitions of technology.[136] This stemmed from the realization that the RSA, as a sovereign entity, did not want US export control laws to stipulate conditions of the contract.

Although provisions for intellectual property rights in the 1998 Space Station Agreements concerning extension of national laws to those rights on a jurisdictional basis and "freedom-of-choice" for inventions remained the same as in 1988, procedures to implement these intellectual property rights were specified. In 1992, the roles and responsibilities of the MCB, including procedures to protect intellectual property rights, were established.[137] Intellectual property rights are safeguarded through four basic forms of protection: (1) proprietary data and trade secret protection; (2) patent protection; (3) copyright protection; and (4) trademark protection.[138] The procedures for protecting these forms of intellectual property are set forth in the national laws of the Space Station Partners where the protection is sought. In addition, procedures are developed, as part of the MCB's role, to deal with the protection of proprietary data since a basic form of protection is assurance that the data to be protected remain under controlled conditions to prevent unauthorized access.

Authority Patterns

The basic structure of authority patterns remained unchanged from 1988. These patterns are expressed through heads of governments, heads of space agencies and management bodies as shown earlier in Figure 4. What changed was the nature of decision-making patterns. Decision-making became more multilateral and involved the RSA as a coequal in relation to NASA.

The translation of authority patterns into legal regime provisions underwent a substantial revision in 1998.[139] Though each Partner retained sovereign jurisdiction, in terms of ownership and intellectual property rights, and the responsibility for developing and building the elements that they provide,[140] revisions to the legal regime transpired for criminal jurisdiction, liability provisions and customs. In the matter of criminal jurisdiction, the sovereignty-based regime that was applied in 1988 was modified from one that was rooted in both territorial and national rights to one that places nationality as the primary determinant. The 1988 IGA allowed for criminal jurisdiction over flight elements and personnel (i.e., nationals), whereas the 1998 IGA states that the Partners may exercise criminal jurisdiction only over personnel who are their respective nationals.[141] Further, criminal jurisdiction applies in all cases with no unique rights provided for any Partner or in instances where it concerns the infrastructure of the Space Station.[142]

The 1998 IGA provided a remedy for the problem of concurrent jurisdiction—jurisdiction for affected Partners over their non-nationals— which was not resolved in the 1988 IGA. Partner states agreed that if the criminal activity "affects the life or safety of a national of another Partner State" or "occurs in or on or causes damage to the flight element of another Partner State," then the affected Partner may exercise jurisdiction.[143] This right is granted provided that consultations with the Partner whose nationality is that of the perpetrator takes place and that this Partner concurs or fails to provide assurances that it will pursue the case.

The sovereignty regime for the cross-waiver of liability was extended to include sovereign states that may have relationships (e.g., contractor, subcontractor, user or customer) with a Partner.[144] This extension was primarily inserted to cover the fact that some launches in support of Space Station will take place in Kazakhstan— a state that is not a Space Station Partner but is a related entity of Russia through a treaty governing the use of the Baikonur launch complex.[145] The sovereign right to issue claims was expanded to include, in addition to claims regarding injury, death, damage caused by willful misconduct and intellectual property rights, claims for damage resulting from a failure of a Partner to extend the cross-waiver of liability to its related entities.[146]

Also, the 1998 IGA established a mandatory duty-free customs legal regime:[147]

> Each Partner State shall grant permission for duty-free importation and exportation to and from its territory of goods and software which are necessary for implementation of this Agreement and shall ensure their exemption from any other taxes and duties collected by the customs authorities.[148]

This contrasts the voluntary duty-free regime provision in the 1988 Space Station Agreements.

The limits on the right to exercise sovereign legal authority established in 1998— nationality determinant and elimination of unique rights for the US as it applies to criminal jurisdiction; extension of the cross-waiver of liability to non-Partner sovereign states; and creation of a duty-free customs regime— are indicative of a more common and multilateral based legal regime.

Decision-Making Patterns

Over the course of negotiations, decision-making issues emerged as a problem area.[149] Areas of contention emanated from the preference on the part of the RSA to supplant earlier understandings that were reached in the Partners' joint invitation to Russia to enter the partnership on the basis of the existing Space Station Agreements.[150] The RSA took the position that the SSF IGA and MOUs should not limit, qualify or become a legal precedent for Russia's participation in any way.[151] Specifically, Russia struggled with and resisted the idea of becoming a Partner as a related entity. Russia preferred changes to the decision-making functions of management to facilitate its participation as a coequal with respect to NASA.

The RSA insisted on an idea of "contingent" authority for Space Station ground control and operations,[152] was unwilling to accept NASA's leadership responsibility for safety and mission assurance, opting for a joint responsibility approach instead, and resisted any notion that NASA could play a "directive" role in system engineering and integration activities for Russian elements and contributions. Russia advocated and convinced NASA of the need for joint overall management responsibilities and decision-making authority. This is reflected in the 1994 Interim NASA-RSA agreement:

> RSA will provide overall development, coordination, management, and systems engineering and integration for its Space Station elements.
> RSA will have the responsibility to implement Space Station safety and mission assurance requirements and plans with respect to the elements and payloads it provides throughout the lifetime of the program...
>
> The NASA-RSA Program Coordinating Committee (PCC)...co-chaired by the NASA Space Station Program Director and the RSA Deputy General Director...
>
> ...the Space Station Control Board (SSCB) chaired by NASA and RSA will participate on an equal basis with members of the SSCB...[153]

As negotiations proceeded into 1995, the RSA sought changes to the functions of the existing Space Station management bodies. The RSA aimed to heighten the visibility, self-sufficiency and management autonomy of its Space Station segment and contributions.[154] There was opposition to use of the MCB as it existed at the time to dictate operations and utilization activities of Russian elements.[155] Russia even suggested to incorporate into the management structures its own control boards utilized for Mir. The RSA also expressed concerns about NASA's right to make unilateral decisions during operations and utilization in the event consensus cannot be reached within the MCB. Specifically, the RSA preferred a management decision-making system with mandatory consensus and no appeal, joint decisions at a Heads of Agencies level and a weighted voting scheme based on Partners' contributions to the program.[156] NASA viewed these Russian proposals as a fundamental breach of the respective management bodies as established in the SSF Agreements.[157]

By the summer of 1995, management and decision-making points of contention reached their apex. The issue of RSA's decision-making autonomy versus NASA's prerogative to make unilateral decisions, including its lead role in overall management, affected the entire program and brought negotiations to an impasse. More troubling for NASA were Russian proposals that indicated a move away from the principle of an integrated Space Station to one where the functional autonomy of the Russian segment was stressed.[158] Consequently, management issues persisted until the last stages of the IGA and MOU negotiations in 1996.[159] At the end, a number of compromises were reached as the 1998 ISS Agreements shown earlier in Figure 3 indicate.[160]

First, the ISS Agreements called for NASA to play a lead role in overall management. This lead role was to be "coordinated," rather than "directed," with the Partners on the basis of a genuine partnership and an integrated Space Station.

> The object of this Agreement is to establish a long-term international cooperative framework among the Partners, on the basis of genuine partnership, for the detailed design, development, operation, and utilization of a permanently inhabited civil international Space Station for peaceful purposes, in accordance with international law.
>
> The Partners will join their efforts, under the lead role of the United States for overall management and coordination, to create an integrated international Space Station.[161]

Second, the 1998 IGA explicitly states that management of the Space Station will be established on a multilateral basis:

> Management of the Space Station will be established on a multilateral basis...[162]
>
> ...NASA will:
> ...provide overall program management and coordination for detailed design perform overall system engineering and integration, with participation of RSA and the other Partners...
>
> ...conduct, together with RSA and the other Partners, as necessary: overall Space Station technical reviews, including integrated design, critical design, design certification, safety and mission assurance, operations readiness and flight readiness reviews...[163]

Last, a number of multilateral management forums for development and assembly phases were put in place. Albeit the bilateral PCCs with the addition of a NASA-RSA PCC continued to play a role, there is a specific allowance for multilateral PCC meetings and reviews. Other multilateral management aspects involve: (a) multilateral SSCB to control and mange all assembly and configuration activities; (b) selected multilateral reviews in regard to joint management planning; (c) participation in management mechanisms to achieve commonality and standard interfaces; and (d) the establishment of joint program plans. Essentially, the multilateral management bodies shown earlier in

Figure 4 were reinforced and emphasized over the bilateral ones with the 1998 ISS Agreements.

For operations and utilization, the management scheme remained under the grasp of the MCB. Similar to the arrangements agreed to in 1988, the MCB strives for consensus decision-making and when consensus cannot be achieved the NASA Chair is authorized to make decisions unilaterally. There are a number of caveats, however, to this decision-making authority dealing with consultation and dispute resolution procedures:

> The Multilateral Coordination Board (MCB) meets periodically over the lifetime of the program or promptly at the request of any Partner with the task to ensure coordination of the activities of the Partners related to the operation and utilization of the Space Station...The Parties agree that all MCB decisions should be made by consensus. Where consensus cannot be achieved on any specific issue within the purview of the MCB within the time required, the Chairman is authorized to take decisions. Nothing in this paragraph shall, however, affect the rights of any Partner to use the consultation and settlement of disputes provisions...Pending resolution of the issues through consultations...a Partner has the right not to proceed with implementation of a decision with respect to its elements...The Parties agree that, in order to protect the interests of all Partners in the program, the operation and utilization of the Space Station will be most successful when consensus is reached and when the affected Partners' interests are taken into account. MCB decisions will not modify rights of the Partners specifically provided....[164]

The perceptible shift to a multilateral approach was true in relation to management structures and decision-making as well as negotiations and consultations. NASA, for example, involved the cooperating agencies in NASA-RSA MOU negotiations through consultations. A Multilateral Consultative Working Group, which first met in July 1994, to coordinate and assess impacts on the partnership due to Russian involvement was established.[165] The objective of this group was to ensure a high degree of transparency among NASA, ESA, Japan and Canada during NASA-RSA MOU negotiations:

> NASA and the Russian Space Agency (RSA) will negotiate a Memorandum of Understanding (MOU) detailing the agencies' cooperation in the Space Station Program. Throughout this process, NASA will consult closely with the European Space Agency (ESA), the Canadian Space Agency (CSA), and the Government of Japan (GOJ) so as to ensure a high degree of transparency in the process.
>
> To facilitate these consultations, a multilateral consultative working group composed of CSA, ESA, GOJ and NASA will be established.
>
> The primary goal of this working group will be to support the Space Station Memoranda of Understanding negotiations in areas of multilateral interest...The working group will seek consensus on areas of multilateral interest.[166]

Decision-making with respect to ownership and utilization activities is characterized by a greater degree of symmetry and multilateralism relative to the 1988 Space Station Agreements. Any discussions or reflection of a possible US veto over decisions pertaining to transfer of ownership and utilization activities that had existed in 1988 were absent in 1998. A significant change is the elimination of a possible US veto in cases where utilization activities on the part of a non-Partner or private entity directly affect the core Station. Instead, the 1998 Space Station IGA opted for a multilateral consensus in the event of such a situation:

> Each Partner may use and select users for its allocations for any purpose consistent with the object of this Agreement and provisions set forth in the MOUs and implementing arrangements, except that:
>
> ...any proposed use of a user element by a non-Partner or private entity under the jurisdiction of a non-Partner shall require the prior notification to and timely consensus among all Partners through their Cooperating Agencies...[167]

The 1998 ISS IGA also provides for independent decision-making associated with transportation, communications and multilateral consultations in the case of Space Station evolution or changes in the design that impact other Partners.

> Transportation
>
> Each of the Partners shall have the right of access to the Space Station using its respective government and private sector space transportation systems, if they are compatible with the Space Station.
>
> Communications
>
> Other Partners may provide data relay satellite system space and ground communication networks, if they are compatible with the Space Station and with Space Station use...
>
> Consultations
>
> The Partners, acting through their Cooperating Agencies, may consult with each other on any matter arising out of Space Station cooperation.
>
> Any Partner may request that government-level consultations be held with another Partner on any matter arising out of Space Station cooperation. The requested Partner shall accede to such request promptly. If the requesting Partner notifies the United States that the subject of such consultations is appropriate for consideration by all the Partners, the United States shall convene multilateral consultations at the earliest practicable time, to which it shall invite all the Partners.
>
> Any Partner that intends to proceed with significant flight element design changes, which may have an impact on the other Partners, shall notify the other Partners accordingly at the earliest opportunity. A Partner so notified may request that the matter be submitted to consultations...[168]

In particular, the consultations provision was considered critical by ESA— a reflection of Europe's unhappiness with earlier US redesign efforts on which it felt the Partners had not been adequately consulted:[169]

Functional Policy Preferences

From the onset of negotiations in 1993, NASA and the international Partners made it clear that there would need to be an equitable allocation of potential benefits derived from the inclusion of Russian capabilities.[170] Functionally, cooperation with Russia on the Space Station was determined to possess a number of programmatic and technical benefits. These functional policy benefits are summarized in Table 6.

Table 6. Functional policy benefits from Space Station cooperation with Russia.

Functional Policy Benefits of Cooperation with Russia on Space Station
•Establishes a more robust Station at a lower cost that can be utilized at an earlier date.*
•Provides increased robustness— enhanced technological capabilities and critical redundancy.**
•Provides critical redundancy enhancing program flexibility and safety.
•Establishes a more beneficial distribution of operational roles.
•Allows all the Partners to take advantage of the impressive technology demonstrated by Mir and the Russian human spaceflight program.

*NASA estimated in February of 1997 that cooperation with Russia on the Space Station saves $2 billion dollars and eighteen months of development time.[171]
**Critical systems redundancy provided in launch/space transportation support, communications, life support, attitude control (propellant resupply and reboost) and extra-vehicular activities (EVAs).

After the first year of negotiations, the protocol approach, based on making minimal changes to the SSF Agreements, was dropped because Russia questioned the fundamental premises and ground rules of that partnership. While the original idea had been to limit the changes to those required to reflect the addition of Russia, this was not possible. Given these Russian objections, the realization of important functional benefits, such as those identified in Table 6, could only be realized with a renegotiated framework of cooperation. Once the opportunity to make fundamental changes was opened, there was no stemming the tide, as each Partner sought its particular modifications.[172]

Augmentation to Functional Interdependence. From a functional standpoint, Space Station underwent a transformation from augmentation to interdependence. Initially, the program was based on an "additive" concept— a functionally independent NASA core with augmented capabilities provided by international Partners. The 1988 IGA supplemented the "additive" concept with that of "functional allocations"— shared participation on the basis of functional quid-pro-quos in the development, operations and utilization of NASA's core Space Station. Currently, the incorporation of Russia into the program has led to the formulation of a third concept based on "functional interdependence". The Space Station Partners referred to this functional interdependence as an integrated Space Station.

A functionally interdependent Space Station suggested that all Partners could contribute to critical path and infrastructure elements and play roles in assembly, development, operations and utilization activities through multilateral approaches to management and by providing critical support services such as space transportation and communications. There are several important aspects to this. One, the functional basis for ISS consists of an independent core system operating across international elements with a single command, control and utilization authority; two, the combined configuration of the US, international Partners (Europe, Japan and Canada) and Russian elements function as an integrated vehicle where each element is significantly interdependent; three, the Station is designed and operated as a single platform with a single strategic plan; and four, the crew is managed as a single international one to operate the entire Station. Figure 5 illustrates the technical and functional nature of this interdependence.

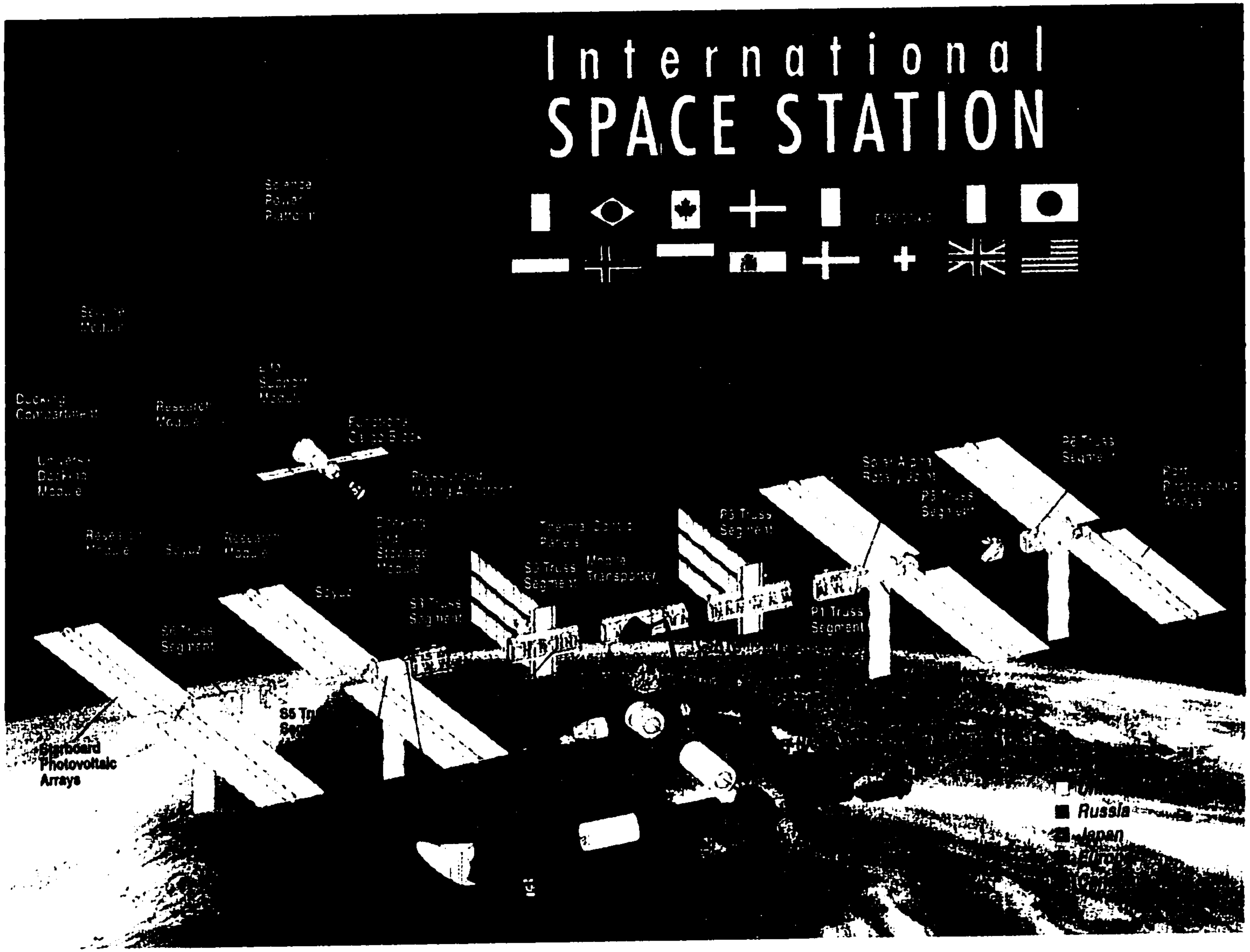

Figure 5. Functional Interdependence of the International Space Station.*

***Source: Boeing**

During negotiations with the RSA held from March 1994 to April 1995, NASA refused to designate Russia's participation as being part of the Space Station's core. NASA maintained its earlier position of an additive Station with functional allocations.[173] This connoted that Russia could contribute critical path components, but could not be co-joined to the NASA core.

Russia preferred their contributions to be self-sufficient.[174] This denoted the existence of two stations with close technical and managerial links between them.[175] The Russian Space Station segment would be fully operational and autonomous and simply be attached to the NASA core Space Station in a one (RSA) plus four (NASA, ESA, Japan, and Canada) arrangement. This was viewed as a political ploy on the part of the Russians, as opposed to one based on any technical reasoning, to realize a technical and managerial status in the program that is on par with its main counterpart in NASA. One indication of this is that the RSA also proposed a joint US-Russian core Station.[176] It seemed that NASA's initial reluctance to accept a joint core approach reinforced the notion that the two stations idea was politically motivated and probably aimed at securing such a joint core approach in the first place.

The two stations proposal raised concerns for NASA since it ran counter to the idea of an integrated Space Station in the areas of operations, utilization, management, crew, transportation and communications. To ensure an integrated Station, NASA accepted the idea that a joint US-Russian core and infrastructure should serve as the foundation for the program.[177] A joint core approach became part of the Space Station IGA:

> **The United States and Russia...will produce elements, which serve as the foundation for the International Space Station.** The European

> Partner and Japan will produce elements that will significantly enhance the Space Stations' capabilities. Canada's contribution will be an essential part of the Space Station.[178]

This development elevated Russia's role to that of "enabling" the Station's robustness.[179] To wit, functional interdependence implied that the Space Station could not be built and operated as designed without Russia.

The idea that the Space Station will become more robust means greater functional interdependence among the Partners. This was true not only with the joint US-Russian core and critical path contributions by Canada and Italy, but also with transportation, communications and operations systems. In the 1988 Space Station Agreements, NASA was to provide baseline space transportation (with assured access by all Partners) and baseline communications systems and assume responsibility for overall operations. With the compromise to develop a joint US-Russian core, this baseline approach fell by the wayside.

A Russian proposal put forward early on in the negotiations recommended to jointly supply, along with NASA, launch and return space transportation services and communications to the other Partners.[180] This idea gained momentum as it became clear that a joint US-Russian core was to serve as the Station's foundation. As a result of this development, NASA dropped both the idea of STS as the baseline transportation system and TDRSS as the baseline communications system.[181]

For transportation, the international Partners agreed to not only have an assured access, but an equal right of access based on the utilization of their own space transportation systems:

> Each of the Partners shall have the right of access to the Space Station using its respective government and private sector space transportation systems, if they are compatible with the Space Station. The United States, Russia, the European Partner, and Japan, through their respective Cooperating Agencies, shall make available launch and return transportation services for the Space Station (using such space transportation systems as the U.S. Space Shuttle, the Russian Proton and Soyuz, the European Ariane-5, and the Japanese H-II). Initially, the U.S. and Russian space transportation systems will be used to provide launch and return transportation services for the Space Station and, in addition, the other space transportation systems will be used as those systems become available.[182]

Regarding communications, a joint US-Russian baseline approach was adopted with the right of the other Partners to use complimentary systems:

> The United States and Russia, through their Cooperating Agencies, shall provide the two primary data relay satellite system space and ground communications networks for command, control, and operations of Space Station elements and payloads, and other Space Station communication purposes. Other Partners may provide data relay satellite system space and ground communication networks, if they are compatible with the Space Station and with Space Station use of the two primary networks.[183]

The US-Russian joint core approach had spillover effects on Space Station operations in propellant resupply, attitude control and reboost for the maintenance of a stable Earth orbit. Russia provides for some of these critical operations and other ones that include:

•Service Module (SM) providing a capability for attitude control and reboost with complete basic functional outfitting to support habitation of three crew members.

•Two life support modules to accommodate additional equipment to support Space Station.

•Two docking compartments to support extra vehicular activity (EVA) for assembly and operations.

•Science Power Platform which includes Autonomous Thrusting Facilities, power distribution and conditioning equipment, accommodation sites for external payloads and a remote manipulator system.

•Soyuz vehicle to provide on-orbit shelter, crew rescue and emergency crew return functions in accordance with technical capabilities of one permanently docked Soyuz vehicle.

•Progress vehicle to provide Space Station reboost capabilities and delivery of infrastructure elements, propellant, water, atmospheric gases and delivery and return of dry cargo including crew supplies, logistics and scientific equipment. [184]

ESA, as part of its redesigned contribution to Space Station, sought the use of its Ariane launch vehicle and an automated transfer vehicle (ATV) which NASA and the other Partners accepted.[185] NASA saw the use of the Ariane/ATV for delivery of infrastructure elements and for reboost and propulsive attitude control as an important redundancy in critical operations.[186]

Transfer of Funds. NASA has historically conducted international cooperation with the intent to minimize the exchange of funds.[187] Since 1992, however, foreign policy preferences led to a significant departure from this precedent in NASA activities with Russia.[188] The first instance of a transfer of funds from NASA to Russia involved the NASA-NPO Energia contract discussed earlier. In October 1992, a NASA-RSA Protocol on Human Space Flight Cooperation stated that NASA would provide compensation to the RSA for services and goods to be provided as part of joint Space Shuttle-Mir missions and hardware support for the Space Station program.[189] At the first Gore-Chernomyrdin Commission meeting held in September of 1993, it was envisioned that the US would provide compensation to Russia for services to be provided during cooperation on Space Station.[190] These agreements resulted in a contract proposal in the amount of $400 million between NASA and the RSA in December of 1993.[191]

In March 1994, the Russian Contractor, Khrunichev, tasked with developing and building the Functional Energy Block (FGB), made it known to NASA that funding for it was not included in the Russian space program budget.[192] This problem was exacerbated by concerns surrounding the funding of activities in support of ISS as stipulated in the NASA-RSA Contract:

> If in the near future the United States and Russian Governments fails to solve this problem, the Center [i.e., Khrunichev] will be forced to stop work on this project [i.e.. FGB], which will put...the success of the whole program [i.e., the International Space Station] in doubt.[193]

These concerns led to an agreement in April 1994 to provide immediate NASA funding for FGB development.[194]

During negotiations on the definitization of the NASA-RSA contract, Russia proposed to expand the Contract to $650 million for the same services that were included for $400 million to accommodate FGB development. Although this was rejected since NASA had no budget flexibility with Congress to pay more for the items,[195] the definitized Contract of June 1994 earmarked a total of $20 million out of the $400 million in initial development funds for the FGB[196] and called for NASA to purchase the FGB for use on ISS.[197] The contract stipulated that Russia was to provide NASA, in exchange for a firm-fixed price of $400 million, supplies and services related to joint Space Shuttle-Mir missions and a FGB Energy Block to support operations on ISS.[198]

Given the need for additional funding, Russia expressed concerns over the "minimize exchange of funds" principle. The intent on the part of NASA, however, was that the NASA-RSA MOU would not preclude transfer of additional funds to the RSA:[199]

> The Parties will seek to minimize the exchange of funds while carrying out their respective responsibilities in this cooperative program...This MOU does not affect existing contractual arrangements and would not preclude further contractual arrangements by either party.[200]

With this one significant exception of the contractual relations between NASA and the RSA, the "minimize exchange of funds" principle continued as an inherent part of the Space Station framework of cooperation.[201] During the rounds of negotiations spanning from 1994 to 1997, Partners sought not only to minimize but to explicitly zero out the exchange of funds especially, as it relates to common system operations costs.

In particular, the US was seeking to avoid transferring funds to Russia for its role in the assembly phases of the Station, crew transfer, crew rescue and logistics resupply.[202] Also, Russia preferred not to transfer funds to NASA. This resulted in agreement on a balance of contributions across the life of the program among the Partners. Under this agreement, Russia's common system obligations are not costed and NASA does not pay for Russian common system operations, while among NASA and ESA, Japan and Canada, functional quid-pro-quos for common system operations costs were established:

> NASA, RSA and the other Partners will equitably share responsibilities for the common system operations costs or activities: that is, costs or activities attributed to the operation of the Space Station as a whole...RSA will be responsible for the share of the common system operations costs or activities corresponding to the support of the operation of the elements it provides. NASA, the GOJ [Government of Japan], ESA and CSA [Canadian Space Agency] collectively will be responsible for the share of the common system operations costs or activities corresponding to the support of the operation of elements they collectively provide...[203]

This "no exchange of funds" arrangement was problematic for the program's functional stability as it relates to self-funded Russian contributions. Funding problems for the RSA caused delays in the development of Russia's self-funded critical path elements. The key political issue for NASA was how to build the best Space Station technically, while meeting the functional and political challenges of having Russia as a Partner and still maintain the prescribed development and assembly schedule.[204]

Since late 1995, Russia's ability to carry out its participation in ISS has been increasingly uncertain due to a lack of Russian government funding to the RSA and its Contractors. In spite of repeated assurances of support at the highest governmental levels, funding has been inadequate, late and often in the form of questionable credits or unsecured bank loans.[205] The specific nature of Russia's critical enabling role in the program and the failure to play that role due to funding issues raised doubts about the viability of the program.[206] Continued funding problems primarily with the Russian Service Module (SM) impacted the Space Station assembly sequence a number of times.[207] This prompted the NASA Advisory Committee on the ISS to recommend that NASA take necessary actions to assure the success of the Space Station program in the event that Russia is unable to provide its critical path hardware; and, if Russia cannot fully meet its commitments to the program, NASA should be in a position to reduce its functional dependency on Russia throughout the lifetime of the program.[208]

As a result of these developments, NASA began, in January of 1997, to develop a contingency plan. One aspect of these plans was the agreement, at the request of the RSA, to use funds from the NASA-RSA Contract of June 1994 to expedite the development of the SM.[209] A second aspect of this plan involved the development of an

Interim Control Module (ICM) to provide for Station reboost and control until the SM could be launched.[210] Both NASA and the RSA agreed that the development of an ICM is an attractive technical solution for the SM delay and has the added benefit of providing early redundancy for attitude control and reboost.[211]

At issue was Russia's political commitment: was Russia willing to spend its scarce resources on Space Station at the expense of other funding priorities?[212] Indicative of this political aspect is Russia's compliance with NASA's request to baseline the Station's assembly sequence with the SM.[213] A decision in favor of SM could only be made if funds as previously promised from the Russian government were transferred to RSA and its Contractors. As of October 1998, Russia had met this condition and the SM is currently undergoing preparations for launch. The current assembly sequence has scheduled SM for a fall 1999 launch.

Functional Quid-Pro-Quos. There are two types of functional quid-pro-quos applied to ISS. The first was directed at achieving no exchange of funds and establishing a not-to-exceed figure for common system operations costs. This is to be implemented through offset arrangements, trades of goods and services in lieu of cash payments for cost reimbursable activities, such as launch services, and bartering deals. The second quid-pro-quo focused on sharing concepts for operations and utilization allocations on the Space Station. The Space Station Agreements base common system operations costs on the percentage of utilization resources allocated to each Partner.[214]

In response to both ESA and Japanese requests for an updated common systems operations cost estimate during negotiations in 1994, NASA developed and proposed a concept of operations sharing that would result in no exchange of funds based on an appropriate sharing of common systems operations functions among the Partners. Also, largely due to budgetary and cost concerns, ESA proposed the establishment of a "not-to-exceed" figure for common costs associated with Space Station operations to which NASA agreed to.[215] A system for the equitable sharing of operations costs and obligations and appropriate offsetting arrangements was established:[216]

> Any Partner may, as agreed with NASA, in consultation with the other Partners, perform common system operations or other activities to offset its responsibility for common system operations costs. NASA will establish with this Partner, and any affected Partners, implementing arrangements on the contents and scope of the common system operations activities and on any other activities to be performed by this Partner to offset its responsibility for common system operations costs.
>
> Full offset of the RSA share of common system operations costs, through performance of common system operations and other activities, are as agreed...[217]

Offsets to common systems operations cost obligations involved commitments to use specific Partner capabilities. ESA and NASA agreed to offset European common systems operations cost obligations by utilizing the Ariane/ATV in propellant and cargo supply and for Station orbital reboost. Japan even sought a role for its H-2 launch vehicle for a similar offset.[218] Canada's operations costs were offset by its Special Purpose Dexterous Manipulator for Space Station assembly and maintenance activities.

Additional facets of functional quid-pro-quos are trades for reimbursable services through the provision of in-kind goods and services and barter deals. Europe and Japan, for example, provide goods and services in lieu of cash payments for Space Shuttle launches to place their elements on-orbit.[219] This led to additional offsets under which Europe and Japan provide hardware to NASA.[220] In the case of ESA, part of the quid-pro-quo for hardware is early access— prior to the on-orbit delivery of ESA's Columbus Orbital Facility— for European astronauts.[221] The agreement on a balance of contributions between RSA and NASA includes bilateral barters.[222] One example is the Space Shuttle launch of the Russian Science Power Platform. All in all, "Partners shall also seek to minimize the exchange of funds in the implementation of Space Station cooperation...through the use of barter."[223]

Functional Allocations. Another contentious issue between NASA and RSA, in addition to the differences on management philosophy, was functional allocations related to sharing concepts for utilization and operations.[224] NASA wished to incorporate Russia into the allocation scheme for common system operations costs established in 1988, while RSA expressed concerns about dealing with such costs monetarily. Rather, Russia preferred to assess these common obligations in terms of activities.[225] Russia argued that since its contributions— infrastructural foundation and accommodation elements— are on par with NASA, it should be exempt for these cost obligations. Further, a comparison of Russia's contributions and determination of their value in relation to other elements was problematic since there was no agreed measuring rod for infrastructure value. The RSA user accommodations are of a different design and capability than those from NASA or other Partners and given the different economies, cost calculations were not considered a meaningful measure.[226] Consequently, RSA proposed an allocations concept, accepted by the other Partners, based on a principle of "you keep what you bring."[227] Space Station allocations are divided into two with one set applied to Russia and another to NASA and ESA, Japan and Canada. This implied that Russia would retain utilization rights for its user accommodation elements and would have full use of resources provided by its infrastructure.

The Space Station Agreements allocate user accommodations— pressurized volume in the modules and external attachment sites— and resources, such as power and crew time, to carry out utilization activities and common system operations responsibilities. These functional allocations are based upon a negotiated settlement on the value of permanent on-orbit elements contributed by the Partners. Three types of allocations are specified: (1) utilization accommodations; (2) utilization resources; and (3) common system operations. For utilization accommodations, "any Partner providing user accommodations will retain the use of those accommodations, except for any allocations to other Partners, in compensation for their provision of resources, based on those Partners' contributions of infrastructural elements:

> NASA will retain the use of 97.7% of the user accommodations on its laboratory modules, 97.7% of the use of its accommodation sites for external payloads and will have the use of 46.7% of the user accommodations on the European pressurized laboratory, and 46.7% of the user accommodations on the JEM [Japanese Experimental Module];
>
> RSA will retain the use of 100% of the user accommodations on its laboratory modules and the use of 100% on its accommodation sites for external payloads;
>
> ESA will retain the use of 51% of the user accommodations on its laboratory module;
>
> The GOJ [Government of Japan] will retain the use of 51% of the user accommodations on its laboratory module; and
>
> CSA [Canadian Space Agency] will have the use of the equivalent of 2.3% of the Space Station user accommodations provided by NASA, ESA and the GOJ.[228]

For utilization resources, the RSA will utilize those resources that it provides and the other Partners have allocations by percentages: 76.6% to NASA, 12.8% to Japan, 8.3% to ESA and 2.3% to the Canada. Common systems operations costs are commensurate with these resource allocations. In the case of the RSA, the balance of contribution agreement covers its common system operations responsibilities.

The Partners have the right under the Space Station Agreements to negotiate arrangements with non-Partners for participation in utilization and provision of hardware.[229] These arrangements must be within the allocated user accommodation resources and crew opportunities, and non-Partners who become participants must accept the legal regime established in the IGA. On this basis, NASA reached MOU agreements with the Italian Space Agency (ASI) and Brazilian Space Agency (AEB) in 1997. These MOUs were depicted earlier in Figure 3.

It was agreed that ASI will develop and provide to NASA, through a transfer of ownership and as part of NASA's contribution to Space Station, three MPLMs.[230] In exchange, ASI will receive rights from NASA to utilize 0.85% of its allocations on the Space Station, NASA will provide STS launch and return transportation services for ASI's utilization allocation, communications in use of the TDRSS and will provide ASI with one crew member every five years from NASA's crew allocations.[231]

A similar arrangement was reached between the US and Brazil concerning the design, development, operations and use of flight equipment and payloads for Space Station. The US-Brazilian MOU established that (a) Brazil will receive 0.45% of NASA's utilization allocations; (b) Brazil will retain ownership of some specified elements (transferring ownership to NASA other specified elements) whereupon NASA will provide STS launch services for those elements; and (c) NASA will provide Brazil with one crew member allocation for one on-orbit increment from NASA's crew allocations.[232]

Symbolic Policy Preferences

As SSF was symbolic of US leadership preferences, ISS is symbolic of US-Russian post-Cold War relations. Table 7 lists the perceived US foreign policy benefits from Space Station cooperation with Russia. These benefits were seen as outweighing the risks associated with Russia's critical path involvement in the program.

Table 7. Foreign policy benefits from Space Station cooperation with Russia.

Foreign Policy Benefits of Cooperation with Russia on the Space Station
•Serves as a symbolic end to the cold war.
•Enhances US efforts to strengthen Russia's commitment to adhere to the guidelines of international nonproliferation standards regarding ballistic missiles and nuclear technology.
•Lends support to US efforts to privatize and demilitarize the high-technology sector in Russia.
•Is a clear symbol of US support of the political and economic reforms within Russia. It provides tangible US support to Russia in its transition to democracy and a market economy and encourages Russian scientists and engineers to work on "peaceful" projects rather than selling their talents to other, possibly hostile, states.
•Cooperation with Russia on the Space Station is an important step in working to integrate Russia into the western community of nations. This includes incentives to adopt Western practices and opportunities for industry-to-industry relations.

The Gore-Chernomyrdin Commission reflects these symbolic policy aspects of the Space Station. US President Clinton used the Commission as means for cooperative space activities and US foreign policy towards Russia. An important political quid-pro-quo for Russian participation in the Space Station program was evident from the first

Gore-Chernomyrdin Commission meeting.[233] This quid-pro-quo was based on Russian acceptance and adherence to the Missile Technology and Control Regime (MTCR). This regime places missile export controls on signatory states to prevent the proliferation of ballistic missile technology. Agreement on MTCR provisions, through a MOU between the US and Russia on Missile-Related Exports, cleared the way for an expanded partnership in space cooperation:

> The agreement illustrates our mutual commitment to promoting nonproliferation and effective export controls. It provides a strong foundation upon which we will continue to build our partnership with Russia in space cooperation...[234]

This expanded partnership involves cooperation in the area of human spaceflight, Space Station, Earth observations from space, space sciences and aeronautical sciences.[235] The Gore-Chernomyrdin Commission facilitated agreements that strengthened economic cooperation through trade and investment, especially in energy-related and space-related projects. For example, a "US-Russian Commercial Space Launch Agreement" opened the international commercial space launch market to Russia and was "a first step toward Russia's entry into other high-technology international markets."[236]

One issue that carried over from 1988 was that of national security. The Russian and the Japanese preferred text in the IGA that banned certain types of weapons and control systems that could be used to support military uses. Of concern were dual-use technologies— civil technologies with potential military applications. Since the US opposed any type of language banning possible national security uses, the issue of national security was handled as in 1988 with the stipulation that ISS would only be used for peaceful purposes in accordance with international law.[237]

SUMMARY

NASA's Space Station program evolved over three distinct phases of cooperation encompassing: (1) coordination; (2) augmentation; and (3) interdependence. This dynamic process of change reflects the adaptation of the program to changing domestic and international political conditions. The first phase, which took place from 1982 to 1983, dealt with the coordination of mission concepts. Due to the initiative of NASA's Space Station Task Force, space agency experts from the US, Europe, Japan and Canada discussed plans for a Station though no respective government had approved the program; studies of Space Station concepts were internationally coordinated among epistemic communities. This strategy was successful due to its focus on the overall scientific objectives of the project to the exclusion of management and costs issues as well as knowledge concerns related to technology transfer and intellectual property rights.

In the second phase, which spanned from 1984 to 1988, cooperation went from a possibility discussed among space agency experts to one that garnered political commitments on the part of US and its allies to participate. These commitments were formalized in 1988 and 1989 with a legal framework of cooperation for the designated SSF. Different legal interpretations regarding this framework became a factor in negotiations. ESA, for example, insisted upon a single multilateral IGA even though NASA preferred separate MOU bilateral arrangements. The compromise reached embraced both a multilateral IGA among the US, ESA, Japan and Canada and a series of

bilateral MOUs between NASA and its foreign Partners. This combined multilateral-bilateral approach characterized the cooperative dynamics of Space Station.

The SSF partnership was characterized by an asymmetry in NASA's favor as the IGA and MOU agreements abided by NASA's traditional policy preferences of cooperation ensuring dominance, especially in controlling critical path components and minimizing technology transfer. Additionally, NASA was to develop a "core" Station to which foreign Partners would functionally augment. This implied that foreign contributions were functionally dependent on NASA's core Station. At the same time, ESA was able to achieve a measure of power symmetry, in relation to authority and decision-making autonomy, by putting forward a doctrine of "eventual autonomy" manifested in the incorporation of the Hermes space plane and the MTFF as part of SSF.

In the interim period of cooperation— the period between the realization of a legal framework of cooperation for SSF and the incorporation of Russia into the program beginning in 1993— the program fell prey to domestic preferences rooted in the incremental nature of US congressional budgetary politics. Without involving its Partners directly in the decision-making process, NASA was forced by congressional appropriators to design and redesign the Station several times. Significantly, domestic budget constraints forced NASA to cut costs by reducing redundant contributions among the Partners. This mitigated the extent to which NASA was able to remain independent of its international Partners for the completion of the Station enhancing the program's functional interdependence.

A third phase of cooperation emerged due to changes that took place in international politics that strongly linked the Station to US foreign policy interests. The dissolution of the Soviet Union in 1992 led to a convergence of norms symbolizing the post-cold war era altering the nature of NASA's cooperative outlook. A final IGA concluded in 1998 "Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation, and the Government of the United States of America Concerning Cooperation on the Civil International Space Station" functionally integrated Russia into the Space Station program. Functional integration signifies that Russia provides critical path infrastructure elements on which the partnership depends on throughout the program.

In 1993, President Clinton linked the now called ISS to US foreign policy interests. These preferences were directed at integrating Russia into a partnership among traditional allies in the US, Europe, Japan and Canada, maintaining Russian technological and industrial capabilities in human space flight, facilitating Russia's economic transition to capitalism, strengthening Russia's emerging democratic political system and providing incentives for Russian scientists and engineers to stay at home through participation in hardware development for the Station.

To realize these preferences, NASA departed from its traditional policy preferences of cooperation. First, NASA funds were contracted out for Russian goods and services in support of Space Station related activities diverging from the "no exchange of funds" preference. Second, Russian contributions to ISS are in the critical path items of a now US-Russian core station. Russia's emergence as a critical path Partner shifted NASA's more traditional functionally dominant role in cooperative space endeavors distinguished by augmentation to one characteristic of interdependence involving symmetrical distribution of resources and multilateral decision-making patterns.

NOTES TO CHAPTER FOUR

[1]"Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988.

[2]"Agreement Among the Government of Canada, Governments of the Member States of the European Space Agency, the Government of Japan, the Government of the Russian Federation and the Government of the United States of America Concerning Cooperation on the Civil International Space Station," January 29, 1998.

[3]The first Space Station study began at NASA's Langley Research Center in 1959 and culminated in a symposium held jointly by NASA, the Institute for the Aeronautical Sciences and the Rand Corporation in 1961. These studies proposed modular designs for living and working areas, microgravity platforms for docking and experiments, power plants and logistical vehicles.

[4]For a detailed historical overview of the debate surrounding the lunar-orbit rendezvous and Earth-orbit rendezvous concepts, see James R. Hansen, "Enchanted Rendezvous: John C. Houbolt and the Genesis of the Lunar-Orbit Rendezvous Concept," *Monographs in Aerospace History Series* 4 (Washington, DC: NASA, December 1995).

[5]See Space Task Group Report, *The Post-Apollo Space Program: Directions for the Future,* September 1969, in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: Government Printing Office, 1995), 522-543.

[6]In 1963, NASA's Office of Manned Space Flight embarked upon post-Apollo planning and by 1965 settled upon a post-Apollo applications program intended to make full use of the technological capabilities developed for the lunar landing missions. It is noteworthy that Skylab was viewed as an experimental facility and not as a permanent space station.

[7]See John M. Logsdon, "Together in Orbit: The Origins of International Participation in the Space Station, *Monographs in Aerospace History Series* 11 (Washington, DC: NASA, November 1998), 3-6.

[8]Dale D. Myers, Associate Administrator for Manned Space Flight, NASA, Memorandum to Associate Administrator. "Policy Guidelines for Foreign Involvement in the Space Station," April 8, 1970.

[9]Arnold W. Frutkin, Assistant Administrator for International Affairs, NASA, Memorandum to Deputy Administrator, "International Space Station Approach," June 7, 1974.

[10]Advanced Programs, Office of Space Transportation Systems, NASA, "Proceedings of Space Station Planning Workshop Held at the Michoud Assembly Facility in New Orleans, Louisiana," November 18, 19 and 20, 1981. Also, see John M. Logsdon, *Together in Orbit*, 7-8.

[11]Mission areas that were included in Space Station studies conducted by NASA and its potential foreign Partners encompassed: material science and space processing; life sciences; space sciences and applications; Earth observations; astronomical observations; and technology and operations. See John D. Hodge, NASA, "Space Station Program Description and Document," undated [1984].

[12]Kenneth S. Pederson, Director of International Affairs, NASA, Memorandum to Director, Space Station Task Force, "Strategy for International Cooperation in Space Station Planning," undated [August 1982].

[13]Kenneth S. Pederson, Director of International Affairs, NASA, Position Paper to Associate Deputy Administrator, "International Involvement in a US Space Station," February 26, 1982.

[14]Robert F. Freitag, Chairman, Space Station Program Review Committee, NASA, Memorandum to Space Station Program Review Committee, "Policy for International Cooperation in the Definition and Development of a Space Station," undated [October 1983].

[15]See John M. Logsdon, *Together in Orbit, The Origins of International Participation in Space Station Freedom* (Washington, DC: Space Policy Institute, George Washington University, December 1991), 119-143.

[16]See Kenneth S. Pederson, "International Cooperation on a Permanently Manned Space Station" (paper presented at International Colloquium on Space Stations: Legal Aspects of Scientific and Commercial Use in a Framework of Transatlantic Cooperation, Hamburg, Germany, January 7, 1985).

[17]Freitag, "Policy for International Cooperation."

[18]Kenneth S. Pederson, Director of International Affairs, NASA, Memorandum to Director, Space Station Task Force, "Policy on International Involvement in a US Space Station," July 20, 1983.

[19]The core Space Station provides for power, heat dissipation, life support, data systems, crew quarters, transportation to-orbit, in-orbit assembly and interfaces with Partner modules and hardware contributions.

[20]For the European space program, the appropriate balance between European autonomy and intimate engagement with the US on Space Station became a major policy issue.

[21]Quid-pro-quos for the Space Station program, in terms of finding an equitable balance between costs, contributions and benefits, represented a fundamental challenge in forging a Space Station partnership. See Kenneth S. Pederson, "Space Station: Opportunity for International Cooperation and Utilization" (paper presented at 35th International Astronautical Federation Congress, Lausanne, Switzerland, October 7-13, 1984).

[22]*Public Papers of the Presidents of the United States: Ronald Reagan, 1984* (Washington, DC: Government Printing Office, 1986), 90.

[23]Hans Mark, *Space Station: A Personal Journey* (Durham, North Carolina: Duke University Press, 1987), 196.

[24]James M. Beggs, Administrator, NASA, Letter to George P. Shultz, Secretary of State, March 16, 1984.

[25]James M. Beggs, Administrator, NASA, Letter to Kenneth Baker, Minister of State for Industry with Special Responsibility for Space and Information Technology, United Kingdom, April 6, 1984.

[26]See Logsdon, *Together in Orbit*, 1991, 54-60.

[27]Beggs, Letter to Kenneth Baker.

[28]Pederson, "Space Station: Opportunity for International Cooperation."

[29]NASA's technology transfer policy put forward in 1984 encouraged domestic dissemination of technology to enhance the competitive posture of US industry and concomitantly, sought to prevent the loss of technology to international adversaries (e.g., Soviet Union and Soviet-Bloc countries) and economic competitors (e.g, Europe and Japan), which could compromise national security and continued US economic growth.

[30]James M. Beggs, Administrator, NASA, Letter to Gerald D. Griffen, Director, NASA Johnson Space Center, April 12, 1984.

[31]Robert F. Freitag, Director, Policy and Plans Office, NASA, Memorandum to Director, International Affairs Division, "Technical Coordination Versus Technology Transfer," December 6, 1984. In this memorandum, Freitag states that "we tend to overreact to the threat of being accused of transferring technology where, in fact, we are several thresholds away from violating the spirit and fact of transfer."

[32]"Suggested Talking Points for Philip Culbertson at the First International Space Station Workshop," NASA, International Space Station Workshop, September 20-21, 1984.

[33]Bill Green and Edward P. Boland, Members of the House of Representatives HUD-Independent Agencies Subcommittee, Letter to William R. Graham, Acting NASA Administrator, January 14, 1986.

[34]Mary D. Kerwin, NASA, Memorandum to John D. Hodge, Associate Administrator for Operations, Space Station, "Space Station International Agreements," January 13, 1986.

[35]James C. Fletcher, NASA Administrator, Letter to Admiral Pondixter, Assistant to the President for National Security Affairs, November 29, 1986.

[36]"Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Government of Japan on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," March 14, 1989; "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988; Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Ministry of State for Science and Technology of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," September 29, 1988.

[37]See "Agreement Among the Government of the United States of America," September 29, 1988.

[38]Article 1.2., Ibid.

[39]"Space Station Technology Transfer Control Plan," NASA, [undated]; and Robert V. Lottman, Chairman, Working Group on International Cooperation, NASA, Memorandum to Members, Working Group on International Cooperation, "NASA's Approach to Controlling International Technology Transfer," April 9, 1985.

[40]Article 19, "Agreement Among the Government of the United States of America."

[41]In relation to space, the International Traffic in Arms Regulations (ITAR) states that "all spacecraft and satellites (both manned and unmanned, active and passive, military and civilian), and their components, as well as, all launching and recovery equipment specifically designed for use with spacecraft, and all space related electronics are governed by the provisions of ITAR."

[42]Pursuant to ITAR, Space Station Contractors, acting on NASA's behalf in fulfillment of contract tasks and acting under specific direction from NASA in fulfilling the obligations of the MOUs between NASA and European Space Agency, Japan and Canada, require no license or other separate approval to transfer such data. See General Counsel, NASA, Memorandum to Associate Administrator for Procurement, "Mechanism for Technology Transfer," November 28, 1988.

[43]Intellectual property is understood to mean those property rights that may exist in or be established and exercised under the national laws of the Partners in relation to inventions, discoveries and creative works, in a manner that affords the inventor or creator or any legal assigns or licensees of the inventor or creator the right of proprietorship. See Associate General Counsel, NASA, Memorandum to Distribution, "Intellectual Property Rights Provision for Legal Annex, Space Station IGA," August 11, 1987.

[44]Article 21.2, "Agreement Among the Government of the United States of America."

[45]Associate General Counsel, NASA, Note to R. Wojtal and M. Finarelli, "Comments Regarding Intellectual Property on the Space Station Circular 175 Package," May 31, 1988.

[46]Article 21.3, "Agreement Among the Government of the United States of America."

[47]Ralph Braibanti, United States Department of State, Memorandum to Participants, Space Station Backstopping Group (Issues Paper Working Group), "Issues Paper for Use in Resolving Remaining Interagency Issues on the Revised IGA Draft," March 31, 1987.

[48]Articles 23.1 and 23.2, "Agreement Among the Government of the United States of America."

[49]Article VIII of the 1967 "Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, Including the Moon and Other Celestial

Bodies" states: "A state party to the Treaty on whose registry an object launched into outer space is carried shall retain jurisdiction and control over such object, and over any personnel thereof, while in outer space or on a celestial body."

[50]Article 5.2, "Agreement Among the Government of the United States of America."

[51]Article 22.2, Ibid. There are also problems of concurrent jurisdiction, such as crime committed by a national of one Partner in the element of another that are not resolved in the 1988 Intergovernmental Agreement.

[52]Article 16, Ibid. It should be noted that there was no agreement in the Intergovernmental Agreement for appropriating joint and several liabilities for shared operations and services.

[53]Articles 18.1, 18.2, Ibid.

[54]Article 7.1.b, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency."

[55]Article 7.1.d, Ibid.

[56]Articles 7.1.c and 7.1.i, Ibid.

[57]Article 8.1.b, Ibid.

[58]Articles 8.1.c, 8.2.a, 8.2.b, 8.3.d, Ibid.

[59]Article 24, "Agreement Among the Government of the United States of America."

[60]Article 7.1, Ibid.

[61]Article 7.5, Ibid.

[62]Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues."

[63]Article 6.4, "Agreement Among the Government of the United States of America."

[64]Article 9.8, Ibid.

[65]Article 12.1 and 13.1, Ibid.

[66]Article 23.2, Ibid.

[67]Articles 14.1, 14.4 and 14.5, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency."

[68]Article 9.1, "Agreement Among the Government of the United States of America."

[69]Articles 4.1 and 12.1, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency."

[70]Annex, Ibid.; and Article 3.3, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency."

[71]Article 9.1, "Agreement Among the Government of the United States of America."

[72]Common system operations are activities that benefit the Space Station as a whole. Costs for common systems operations were agreed in 1988 to be shared according to the following formula: NASA, 71.4%; Europe, 12.8%; Japan, 12.8%; and Canada, 3%.

[73]Since Canada was in the critical path for the Space Station, it had to agree to transfer ownership, including work and technology in-progress, in the event it withdrew from the program. See Article 27.3, "Agreement Among the Government of the United States of America."

[74]Article 9.5, "Agreement Among the Government of the United States of America."

[75]Article 15, Ibid.

[76]Article 9.1, Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency." Also, see Lynn F. H. Cline, "International Negotiations: The International Space Station Agreements" (paper presented 47th International Astronautical Congress, Beijing, China, October 7-11, 1996).

[77]Article 12.2, "Agreement Among the Government of the United States of America."

[78]Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues." This policy position was put forward in the National Security Council, National Security Decision Directive (NSDD) 257.

[79]See Beggs, Letter to Kenneth Baker.

[80]See Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues."

[81]Article 1.1, "Agreement Among the Government of the United States of America."

[82]James C. Fletcher, Administrator, NASA, Letter to Frank C. Cariucci, Assistant to the President for National Security Affairs, April 13, 1987.

[83]Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues."

[84]The US called a three month hiatus in Space Station negotiations in the winter of 1986-87 to accommodate the Department of Defense concerns about keeping open its options to use the Space Station for national security purposes. The result of this review was a new draft Intergovernmental Agreement that imposed more stringent management constraints on the Partners' use of the Station and made explicit reference to US national security use of the Station. The pause in negotiations and the newly hardened approach after nearly three years of negotiations (1984 to 1987) led to extensive press coverage and had serious international and domestic repercussions. The stakes were significant for the President: the international Partners unequivocally stated that they could not accept the provisions in the then current draft Intergovernmental Agreement because these provisions call into question the basic civil nature of the program that they joined and funded out of their civil space budgets. See Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues."

[85]Braibanti, "Issues Paper for Use in Resolving Remaining Interagency Issues."

[86]Fletcher, Letter to Frank C. Cariucci.

[87]Article 4.2, "Agreement Among the Government of the United States of America."

[88]See John M. Logsdon, "International Space Cooperation Lessons from the Space Station Experience" (paper presented at 41st Congress of the International Astronautical Federation, Dresden, Germany, October 6-12, 1992.)

[89]For a characterization of the asymmetry in legal commitments concerning the Space Station partnership, see Michael Bourley, "The Legal Hazards of Transatlantic Cooperation in Space," *Space Policy* 6, 4 (1990): 323-331.

[90]Articles 15, 25 and 27, "Agreement Among the Government of the United States of America."

[91]For aspects of how political incrementalism influenced the Space Station Freedom program, see Howard E. McCurdy, *The Space Station Decision, Incremental Politics and Technological Choice* (Baltimore, Maryland: Johns Hopkins University Press, 1990), 99-107 and 224-235.

[92]See John-David Bartoe, "Future International Cooperation on Space Stations" (paper presented at 41st Congress of the International Astronautical Federation, Dresden, Germany, October 6-12, 1990).

[93]Article 15, "Agreement Among the Government of the United States of America;" and Article 16.2, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency."

[94]"Space Station Rephrasing Activities," NASA, August 28, 1989.

[95]From 1991 to 1997, nineteen attempts were made to terminate the Space Station program (sixteen in NASA funding bills and three in broader measures). In every case, Congress voted in favor of the program with a comfortable majority, although in 1993 a House amendment to terminate Space Station was defeated by 216 to 215. See Marcia S. Smith, "NASA's Space Station Program, Testimony before the Subcommittee on Science, Technology and Space Committee on Commerce, Science, and Transportation United States Senate" (Washington, DC: Congressional Research Service, June 18, 1997).

[96]James A. Baker, Secretary of State, United States, Letter to Claiborne Pell, Chairman, Committee on Foreign Relations, United States Senate, July 1, 1991.

[97]Howell Heflin, Senator, United States, Letter to Barbara A. Mikulski, Chair, Subcommittee on VA-HUD Independent Agencies, Committee on Appropriations, United States Senate, August 14, 1990. Sixty-four Senators also signed the letter on July 30, 1990 before it was submitted to Senator Mikulski.

[98]Heinz Riesenhuber, German Ministry for Science and Technology, Letter to Robert R. Roe, Chairman, House Committee on Science, Space and Technology, United States House of Representatives, November 21, 1989.

[99]Daniel S. Goldin, Administrator, NASA, Letter to Jean-Marie Luton, Director General, European Space Agency, October 13, 1992. The same letter was also sent to

Richard Dore, President of the Canadian Space Agency (CSA); Luciano Guerriero, President of the Italian Space Agency (ASI); Kanzo Tanigawa, Minster of State for Science and Technology, Japan; and Masato Yamano, President of the National Space Development Agency (NASDA) of Japan.

[100]The Italian Space Agency (ASI) agreed to independently develop mini-pressurized logistics modules (MPLMs) as part of NASA's core Space Station. ASI agreed to transfer to NASA the ownership and control of the MPLMs, albeit ASI will play a role in their integration into the core Space Station. See Articles 1, 4 and 6, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Italian Space Agency for the Design, Development, Operation and Utilization of Two Mini Pressurized Logistics Modules and a Mini Laboratory for Space Station Freedom," December 6, 1991.

[101]*Space Station Redesign Team Final Report to the Advisory Committee on the Redesign of the Space Station*, NASA, June 1993.

[102]Multilateral Meeting of the Space Station Program Coordinating Committees, November 17, 1993; Intergovernmental Meeting on Space Station, October 16, 1993; Multilateral Meeting of the Space Station Program Coordinating Committees, August 20, 1993; Space Station Cooperating Agencies Heads of Agencies Meeting, July 27, 1993; Multilateral Meeting of the Space Station Program Coordinating Committees, July 21, 1993; Space Station Cooperating Agencies Heads of Agencies Meeting, June 4, 1993; Intergovernmental Meeting on Space Station Redesign, May 13, 1993; and Multilateral Meeting of the Space Station Program Coordinating Committees, April 2, 1993.

[103]NASA Management Instruction, NMI 1362.1C, "Initiation and Development of International Cooperation in Space and Aeronautical Programs," December 31, 1991 (effective date), December 31, 1995 (expiration date).

[104]NPO is the Russian acronym for the Russian Scientific Production Association.

[105]"Memorandum of Discussion, The Administrator of the National Aeronautics and Space Administration of the United States of America and the General Director of the Russian Space Agency of the Russian Federation on Civil Space Cooperation," Moscow, July 1992.

[106]"Implementing Agreement between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency of the Russian Federation on Human Space Flight Cooperation," Moscow, October 5, 1992; and "Protocol to the Implementing Agreement between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency of the Russian Federation on Human Space Flight Cooperation," October 5, 1992.

[107]See *Space Station Redesign Team*, 175-178.

[108]Multilateral Meeting of the Space Station Program Coordinating Committees, November 17, 1993; Multilateral Meeting of the Space Station Program Coordinating Committees, October 29, 1993; Intergovernmental Meeting on Space Station, October 16, 1993; and Multilateral Meeting of the Space Station Program Coordinating Committees, October 14, 1993.

[109]Intergovernmental Meeting on Space Station, October 16, 1993.

[110]Space Station Heads of Agency Meeting, "Joint Statement," November 7, 1993.

[111]"Integrated Plan for Russian Involvement in the International Space Station," November 19, 1993.

[112]"Joint Invitation at the Occasion of the Intergovernmental Meeting of the Space Station Partners," Washington, DC, December 6, 1993.

[113]Heads of Cooperating Agencies on Space Station, Letter to Yuri N. Koptev, Director General, Russian Space Agency, January 1994. The Russian Space Agency never formally responded to this letter.

[114]The US-Russian Commission on Economic and Technological Cooperation was chaired by United States Vice-President Gore and Russian Prime Minster Chernomyrdin and was more commonly known as the Gore-Chernomyrdin Commission. This Commission established a Space Committee that is headed by NASA's Administrator, Daniel S. Goldin, and Director General of the Russian Space Agency, Yuri Koptev.

[115]During the period of negotiations leading up to the January 29, 1998 Intergovernmental Agreement on the International Space Station, the Gore-Chernomyrdin Commission met for a total of nine times between September 1993 and November 1997.

[116]US-Russian Joint Commission on Energy and Space, Office of the Vice-President, "Joint Statement on Cooperation in Space," September 2, 1993.

[117]"Addendum to Program Implementation Plan, Alpha Station," November 1991. This plan represented a historic opportunity to bring Russia into an existing multilateral partnership under US leadership. Daniel S. Goldin, Administrator, NASA, Letter to John H. Gibbons, Assistant to the President for Science and Technology, November 1, 1993.

[118]"Letter Contract NAS15-10110 between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency of the

Russian Federation for Supplies and Services Relating to Mir-1 and the International Space Station: Phase One and Selected Phase Two Activities," December 15, 1993.

[119]"Statement by Daniel S. Goldin on the Cooperative Agreement between the United States and Russia on Space, Aeronautics and Science," September 2, 1993.

[120]This statement was made at the second Gore-Chernomyrdin Commission held in December of 1993.

[121]"Changes in the Space Station Legal Framework to Include Russia as a Partner," March 18, 1994.

[122]Associate Administrator for Policy Coordination and International Relations, NASA, Memorandum to Associate Deputy Administrator, Technical, "Space Station Agreements," March 23, 1994.

[123]"Protocol Amending the Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," March 23, 1994 [Draft].

[124]At this juncture, no amendments were made to provisions on international rights and obligations, jurisdiction, management, detailed design and development, operations, crew, evolution, funding, cross-waiver of liability, customs and integration, exchange of data and goods, intellectual property and consultations.

[125]Director, Human Space Flight Group, NASA, Memorandum to Associate Administrator for Policy Coordination and International Relations and Deputy Associate Administrator for Space Station, "IGA Preparations," February 14, 1994.

[126]Meeting of the Intergovernmental Agreement Partner States and the Russian Federation, March 17-18, 1994.

[127]Lynn F. H. Cline, Office of External Relations, NASA, Memorandum to Wil Trafton, NASA Space Station Program Director, "Russia Command and Control Proposal," February 8, 1994.

[128]"Protocol Amending the Agreement," March 23, 1994 [Draft].

[129]This concern was raised by Congress during NASA appropriations hearings in 1994.

[130]Jeff Lawrence, Associate Administrator for Legislative Affairs, NASA, Letter to Barbara A. Mikulski, Chair, Subcommittee on VA-HUD and Independent Agencies, Committee on Appropriations, United States Senate, June 3, 1994. This letter addressed questions of concern raised during Senate Appropriations Hearings on NASA's budget held on June 7, 1994.

[131]"NASA Technology Transfer Initiatives," undated [March 10, 1994].

[132]This regime consists of the provisions, for export control jurisdiction over certain types of hardware, software and technical data to be used in the International Space Station program, which are stated in the Department of State's International Traffic in Arms Regulations (ITAR) and the Department of Commerce's Export Administration Regulations (EAR).

[133]"NASA Export Control Program (NASA/ECP)," November 1995.

[134]"Agreement among the Government of Canada," Article 19.3.

[135]"Letter Contract NAS15-10110."

[136]D. Evelyn Lyon, Senior Attorney, NASA, Memorandum to Donna Fortunat, NASA, "Request for Deviations from the Federal Acquisition Regulations (FAR) and the NASA FAR Supplement (NFS) for Contract No. NAS 15-0110 with the Russian Space Agency," June 21, 1994.

There were a total of thirty-one deviations that were requested by NASA. This includes deviations for protecting national interests, rights in data in general, restrictions on certain foreign purchases and technical data issues, stop-work, partial shipments, examination of records, order of precedence, material safety data, frequency authorization, duty-free entry, inconsistency between English version and translation of contract, technical data certification, patent indemnity, cross-waiver of liability, limitation of funds, disputes, changes, government property, inspection of supplies, quality requirements, conformance, supplies, limitation of liability, material inspection, facilities and termination.

[137]Multilateral Meeting of the Space Station Program Coordinating Committees, Multilateral Control Board Executive Secretary, "Roles and Responsibilities," November 24, 1992.

[138]"Space Station Freedom Procedures for the Protection of User Intellectual Property," Attachment to the Utilization Management Plan, July 27, 1992.

[139]Cline, "International Negotiations."

[140]Article 5.2 of the "Agreement among the Government of Canada" states that "Pursuant to...the Outer Space Treaty...each Partner shall retain jurisdiction and control over the elements it registers..." This principle is unchanged from that as stated in the 1988 Space Station Intergovernmental Agreement.

[141]Article 22.1, "Agreement among the Government of Canada."

[142]Initially, a RSA proposal to the text of the Intergovernmental Agreement called for Russia and the US to have unique rights in criminal jurisdiction concerning the Space Station infrastructure that was established exclusively for the US in the 1988 Intergovernmental Agreement. This idea, however, was dropped at the insistence of the other international Partners and in concurrence with Russia to delete the text dealing with these unique rights entirely.

[143]Article 22.2, "Agreement among the Government of Canada," January 29, 1998.

[144]Article 16.2, Ibid.

[145]Lynn F. H. Cline and Graham Gibbs, "Re-Negotiation of the International Space Station Agreements- 1993 to 1997" (paper presented at 48th International Astronautical Congress, Turin, Italy, October 6-10, 1997).

[146]Article 3.d.5, "Agreement among the Government of Canada."

[147]The idea to provide duty-free importation and exportation was a result of a Russian proposal put forward in May of 1996 and accepted as part of the ad referendum Intergovernmental Agreement text of December 1996.

[148]Article 18.3, "Agreement among the Government of Canada."

[149]Steve Shuman and Jay Steptoe, General Counsel, NASA, Memorandum to Distribution, "First Round of the NASA/RSA Negotiations on the Interim Agreement," April 18, 1994.

Negotiations held between NASA and the RSA in 1994 focused on establishing an interim memorandum of understanding (MOU) that provided Russia with a legal standing in the program until Russia became a party to the Intergovernmental Agreement. The principal purpose of this interim MOU was to integrate the RSA into the Space Station management mechanisms. See Article 1.3, "Interim Agreement between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency for the Conduct of Activities Leading to Russian partnership in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," June 23, 1994.

[150]The Russian Ministry of Foreign Affairs officially accepted on December 17, 1993 the December 6, 1993 joint invitation to participate in the Space Station Program. However, the Russian Space Agency did not formally accept the terms of this invitation— acceptance of legal obligations and responsibilities as established in the 1988 Space Station Agreements— as spelled out in a January 1994 letter of understanding from the Heads of the Cooperating Agencies.

[151]The Russian Ministry of Foreign Affairs concurred with this position.

[152]NASA's position was to maintain exclusive command and control providing direction solely from Mission Control Center (MCC) Houston. While, RSA's position, that of "contingent authority," was to establish a MCC Moscow to exclusively control its part of the Station as well as a management council to provide command and control functions on the basis of consensus.

[153]Articles 2.1, 3.5, 3.6 and 4.2, "Interim Agreement."

[154]Deputy Associate Administrator for External Relations, Space Flight, NASA, Memorandum to Distribution, "Space Station Memoranda of Understanding Negotiations," April 18, 1995.

[155]Deputy Associate Administrator for External Relations, Space Flight, NASA, Memorandum to Distribution, "NASA-RSA Space Station Memorandum of Understanding (MOU) Negotiations," June 16, 1995.

[156]Deputy Associate Administrator for External Relations, Space Flight, NASA, Memorandum to Distribution, "NASA-RSA Space Station Memorandum of Understanding (MOU) Negotiations," May 2, 1995.

[157]NASA did explore ways to allow for an appeal to Heads of Agencies in the case of a unilateral MCB related decision by NASA.

[158]Department of State, United States, Outgoing Telegram, "Space Station: Round VII Meetings, Moscow, July 6-11, 1995," August 1995.

[159]Space Station negotiators reached an Ad Referendum Agreement on the text of an Intergovernmental Agreement Concerning Cooperation on the Civil International Space Station on December 14, 1996. Review of the text by the participating governments resulted in only one proposal for modification by the Japanese dealing with subrogated claims.

[160]"Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Government of Japan Concerning Cooperation on the Civil International Space Station," February 24, 1998; "Agreement

among the Government of Canada;" "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Russian Space Agency Concerning Cooperation on the Civil International Space Station," January 29, 1998; "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the European Space Agency Concerning Cooperation on the Civil International Space Station," January 29, 1998; "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and Canadian Space Agency Concerning Cooperation on the Civil International Space Station," January 29, 1998.

[161]Article 1, "Agreement among the Government of Canada."

[162]Article 7.1, Ibid.

[163]Article 6, "Memorandum of Understanding Between the United States National Aeronautics and Space Administration and the Russian Space Agency."

[164]Article 8.1, Ibid.

[165]This approach was not perfect and required the NASA negotiating team to back and forth between the Multilateral Consultative Working Group and the RSA, but it did provide a cooperative method by which all parties could agree to the new MOUs. Cline and Gibbs, "Re-Negotiation of the International Space Station."

[166]"Consultation Process for Memoranda of Understanding With Regard to Inclusion of the Russian Space Agency in Space Station Cooperation," July 11, 1994.

[167]Article 9.3, "Agreement among the Government of Canada."

[168]Articles 12.1, 13.1 and 23, "Agreement among the Government of Canada."

[169]Cline and Gibbs, "Re-Negotiation."

[170]Multilateral Meeting of the Program Coordinating Committees, November 17, 1993.

[171]Committee on Science, House of Representatives, US Congress, "Statement by Daniel S. Goldin," February 12, 1997.

[172]Cline and Gibbs, "Re-Negotiation."

[173]NASA Memorandum, "Space Station IGA Negotiations, April 27-28, 1994," May 11, 1994.

[174]Deputy Associate Administrator for External Relations (Space Flight), NASA, Memorandum to Distribution, "NASA-RSA Space Station Memorandum of Understanding (MOU) Negotiations," June 16, 1995.

[175]This preference for a two station approach was put forward by Russian during the Intergovernmental Agreement and Memorandum of Understanding negotiating rounds held in April and May of 1994.

[176]Russia first proposed this idea of a joint core in "Protocol Amending the Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," July 28, 1994 [Draft].

[177]See "Protocol Amending the Agreement Among the Government of the United States of America, Governments of Member States of the European Space Agency, the Government of Japan, and the Government of Canada on Cooperation in the Detailed Design, Development, Operation and Utilization of the Permanently Manned Civil Space Station," June 29, 1995 [draft].

[178]Article 1.2, "Agreement among the Government of Canada."

[179]Marcia S. Smith, "Russia's Participation in the International Space Station Program, Testimony before the House Science Committee" (Washington, DC: Congressional Research Service, February 12, 1997).

[180]"Protocol Amending the Agreement," July 28, 1994 [draft].

[181]"Protocol Amending the Agreement." June 29, 1995 [draft].

[182]Article 12.1, "Agreement among the Government of Canada."

[183]Article 13.1, Ibid.

[184]Article 3.3, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency." NASA also adapted the orbit of the ISS to an inclination of 51.6° from SSF's 28.8° to permit access by Russian launchers.

[185]European Space Agency embarked on a redefinition of its contribution to the Space Station program in response to NASA's 1993 redesign and to budget constraints affecting European space budgets. This redefinition also deleted the European Man Tethered Free Flyer and the European Polar Platform.

[186]The use of European Space Agency's Ariane/Automated Transfer Vehicle (ATV) propellant/reboost mission was first called for in a document signed by the NASA Administrator and the European Space Agency Director General on March 7, 1995. Also, Articles 6.2.b.13 and 6.2.b.14, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the European Space Agency Concerning Cooperation on the Civil International Space Station," January 29, 1998 specifically call for this use of the Ariane/ATV.

[187]Since the inception of NASA in 1958, the only cases where an actual transfer of funds took place in support of space cooperation was NASA's procurement of the European Space Lab in the early 1980s and the procurement of Space Station goods and services from Russia under "Letter Contract NAS15-10110."

[188]See *US-Russian Cooperation in Space*, Office of Technology Assessment, United States Congress, OTA-ISS-618 (Washington, DC: Government Printing Office, 1995).

[189]Article 1.11, "Protocol to the Implementing Agreement."

[190]Office of the Vice-President, United States, "US-Russian Joint Statement on Cooperation in Space," September 2, 1993.

[191]"Letter Contract NAS15-10110."

[192]Khrunichev State Research and Productive Space Center, Letter to Daniel S. Goldin, Administrator, NASA, March 1, 1994.

[193]Ibid.

[194]Yuri Koptev, Director General, Russian Space Agency, Letter to Daniel S. Goldin, Administrator, NASA, May 23, 1994; and Daniel S. Goldin, Administrator, NASA, Letter to Yuri Koptev, Director General, Russian Space Agency, June 1, 1994.

[195]The cost of NASA acquisitions from the RSA were limited due to a Congressional budget cap on Space Station spending.

[196]The $20 million dollars was disbursed over two years with an $8 million payment in fiscal year 1994 and a $12 million payment in fiscal year 1995.

[197]NASA News Release 94-01, "NASA and Russian Space Agency Sign Space Station Interim Agreement and $400 Million Contract," June 23, 1994.

[198]NASA and the RSA signed a protocol for the US purchase of the FGB on February 8, 1995 at a price of $190 million. The protocol called for the FGB to be

launched as the first element of the International Space Station and guarantees, with no additional cost to NASA, the launch of the FGB on a Russian Proton booster and navigational control in orbit along with related engineering, integration, logistics, maintenance and training support.

[199]Steve Shuman and Jay Steptoe, General Counsel, NASA, Memorandum to Distribution, "First Round of the NASA/RSA Negotiations on the Interim Agreement," April 18, 1994.

[200]Article 16.4, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency."

[201]Article 15.5, "Agreement among the Government of Canada."

[202]Cline and Gibbs, "Re-negotiation."

[203]Article 9.3, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency."

[204]Smith, "Russia's Participation."

[205]This was expressed in a statement by Daniel S. Goldin to the Committee on Science, US House of Representatives, February 12, 1997.

[206]F. James Sensenbrenner, "The International Space Station Partnership, Report on the Official Visit of Representatives F. James Sensenbrenner and Jerry Lewis to Paris and Moscow, January 7-9, 1996," Committee on Science, US House of Representatives.

[207]The Space Station Control Board (SSCB) has put forward six assembly sequence plans from July 1994 to October 1998; Revision A, July 1994; Revision A1, December 1995; Revision B, May 1996; Revision C, May 1997; Revision D, May 1998; and the Planning Reference, October 1998. In Revision C, the Russian Service Module was to launch in December 1998; in Revision D, the launch was to be in April of 1999; and in the October 1998 plan, the launch is scheduled for July 1999.

[208]Thomas Young, Chair, NASA Advisory Committee on the International Space Station, Letter to NASA, March 19, 1997.

[209]$20 million in rephrased funds from the NASA-RSA Contract NAS15-1011 were transferred to fund first priority activities on the Russian Service Module.

[210]The decision to develop a NASA Interim Control Module was taken at a NASA/RSA Joint Program Review, January 24, 1997.

[211]"Protocol between NASA and the RSA on the Provision of an Interim Control Module for the International Space Station," February 6, 1997.

[212]Smith, "Russia's Participation."

[213]This set of criteria was put forward by Daniel S. Goldin during testimony to Congress in April of 1997.

[214]Article 9.3, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency Concerning Cooperation on the Civil International Space Station."

[215]A not-to-exceed figure for common systems operations costs was called for in a document signed by the NASA Administrator and the European Space Agency Director General on March 7, 1995. Article 15.4, "Agreement Among the Government of Canada" states that "The Partners shall seek to minimize operations costs for the Space Station." In particular, the Partners, through their Cooperating Agencies, in accordance with the provisions of the MOUs, shall develop procedures intended to contain the common system operations costs and activities within approved estimated levels.

[216]Article 15.1, "Agreement among the Government of Canada;" and Article 9.5, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency."

[217]Article 9.5, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency."

[218]See "International Space Station Assembly Sequence (5/31/98: Revision D)," NASA Facts, NASA Johnson Space Center, June 1998.

[219]Lynn F. H. Cline, "The International Space Station partnership" (presentation at a seminar on International Space Cooperation: Real World Examples, American Astronautical Society, June 2, 1998).

[220]European Space Agency is to provide NASA docking nodes and freezers in exchange for a Space Shuttle launch of its Columbus Orbital Facility; and Japan is to provide NASA a centrifuge accommodation module, centrifuge rotor, life sciences glove box and other services for a Space Shuttle launch of the Japanese Experimental Module.

[221]On May 6, 1994, NASA and the European Space Agency reached an "Early Utilization Agreement in Principle" on European Space Agency's provision of laboratory support equipment to the Space Station in return for early utilization opportunities and additional Space Shuttle flight opportunities for European astronauts during the period prior to the on-orbit delivery of the European Columbus Orbital Facility. This agreement was formalized in a "Memorandum of Understanding between the European Space Agency and the United States National Aeronautics and Space Administration Enabling Early Utilization Opportunities of the International Space Station," 1997.

[222]See Cline and Gibbs, "Re-Negotiation."

[223]Article 15.5, "Agreement Among the Government of Canada."

[224]Deputy Associate Administrator for External Relations (Space Flight), "Space Station Memoranda of Understanding Negotiations."

[225]Deputy Associate Administrator for External Relations (Space Flight), NASA, Memorandum to Distribution, NASA, "NASA-RSA Space Station Memorandum of Understanding Negotiations," May 2, 1995.

[226]See Cline and Gibbs, "Re-Negotiation."

[227]Deputy Associate Administrator for External Relations (Space Flight), NASA, Memorandum to Distribution, "NASA-RSA Space Station Memorandum of Understanding (MOU) Negotiations," June 16, 1995.

[228]Article 8.3, "Memorandum of Understanding between the National Aeronautics and Space Administration of the United States of America and the Russian Space Agency."

[229]Cline, "The International Space Station Partnership."

[230]The mini-pressurized logistics modules (MPLMs) are in the critical path and are essential for transferring pressurized cargo to/from the Space Station. Articles 1 and 4, "Memorandum of Understanding Between the Italian Space Agency and the United States National Aeronautics and Space Administration for the Design, Development, Operation and Utilization of Three Mini Pressurized Logistics Modules for the International Space Station," September 24, 1997.

[231]Articles 9 and 11, "Memorandum of Understanding Between the Italian Space Agency and the United States National Aeronautics and Space Administration."

[232]Articles 1, 4, 9 and 10, "Implementing Arrangement between the Government of the United States of America and the Government of the Federative Republic of Brazil

for the Design, Development, Operation and Use of Flight Equipment and Payloads for the International Space Station Program," October 14, 1997.

[233]This meeting was held in September of 1993.

[234]Office of the Vice-President, United States, "US-Russian Missile Export Controls Agreement," September 2, 1993.

[235]By the fifth Gore-Chernomyrdin Commission meeting held in June 1995, eight committees directed at enhancing US-Russian cooperation had been established. These committees include Space Energy, Science and Technology, Defense Conversion, Environment, Business Development, Health and Agribusiness. Memorandum of Understanding (MOU) Agreements reached by the Gore-Chernomyrdin Commission, in addition to those regarding space cooperation, include: US-Russian Environment Agreement; Agreement on the Closure of Plutonium Production Reactors and Cessation of Production of Weapons-Grade Plutonium; MOU on Basic Sciences Cooperation; MOU on Transportation; MOU on Cooperation between Mineral Mining and Management Service; MOU on Cooperation in the Field of Geoscience; MOU on Basic Biomedical Research; MOU on the Establishment of the Oil and Gas Technology Center; MOU on Wood, Pulp and Paper Products; and Agreement on Health Care Support.

[236]Office of the Vice-President, United States, "US-Russian Commercial Space Launch Agreement," September 2, 1993.

[237]Article 1.1, "Agreement among the Government of Canada."

CHAPTER FIVE: MISSION FOR PROTECTING THE EARTH— INTERNATIONAL EARTH OBSERVING SYSTEM

Chapter Five begins with a review of international cooperation pertaining to NASA's Mission for Protecting the Earth. Included within this review is the evolution of the International Earth Observing System (IEOS) as it developed under the auspices of the Earth Observation International Coordination Working Group (EO-ICWG). This sets the context for evaluating IEOS according to the framework of analysis outlined in Chapter Three. The historical evolution of this evaluation, which is described in detail herein, is outlined in Figure 6 on the next page.

IEOS is well suited as a second case study in comparison to Space Station in several respects. First, IEOS dealt with the Mission for Protecting the Earth rather than Exploring Space. Second, it involved identical governmental political actors with the exception of Soviet/Russia (i.e., US, Europe, Japan and Canada) and resulted in different cooperation outcomes and dynamics. IEOS is characterized by the coordination of multinational projects as opposed to the coordination-to-augmentation-to-interdependence pattern evident in Space Station. Third, IEOS, in contrast to Space Station, was formulated as a mission concept, but was never implemented.

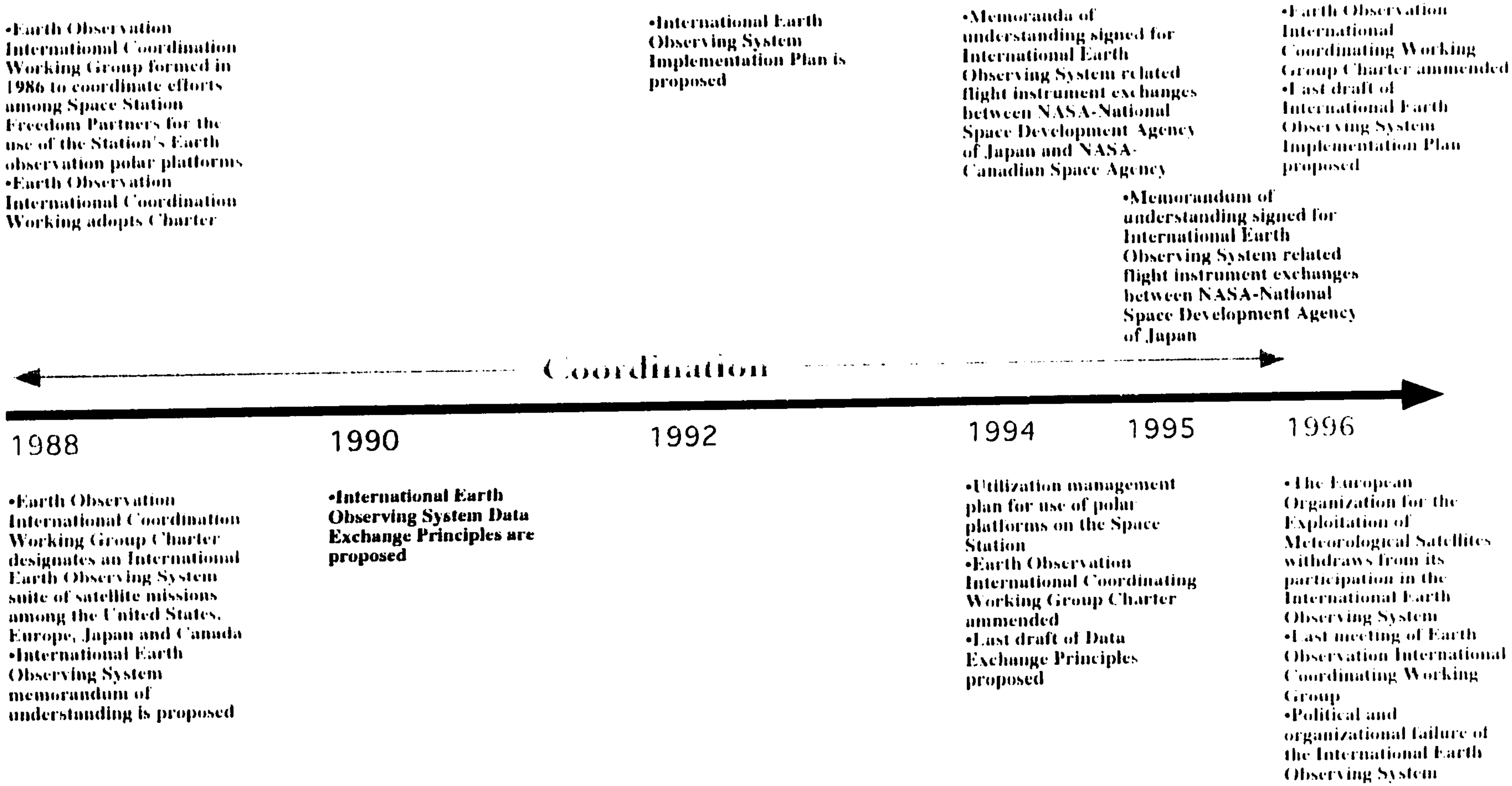

Figure 6. Historical evolution of the International Earth Observing System.

HISTORICAL EVOLUTION OF COOPERATION

In 1965-66 NASA first established a program aimed at studying Earth from space.[1] This program gained political support during post-Apollo planning whereupon the Nixon administration with congressional support approved that NASA develop experimental Earth-observing satellites.[2] NASA deployed the fist in a series of what were initially designated Earth Resources Technology Satellites (ERTS) in 1972. The ERTS name was changed to Landsat by 1975. After deployment of the second and third Landsat satellites in 1975 and 1977 respectively, the system was operationalized and placed under authority of the National Oceanic and Atmospheric Administration (NOAA) in 1979.[3]

Landsat raised a number of foreign policy issues that have influenced how international cooperation has evolved in the area of Earth observations from space. US policy for Landsat was directed to produce Earth remote sensed data for the community of states throughout the world. This commitment was established in 1969 by President Nixon through a pledge before the United Nations (UN) General Assembly.[4] Essentially, it entailed an open and nondiscriminatory access on the part of all countries to data products produced by Landsat.

An open access policy, more commonly known as "open skies," ranged from permitting other countries direct access to Landsat satellites through use of ground stations to providing technical assistance to those wishing to use Landsat data. Beginning in the 1970s, a number of ground station memoranda of understanding (MOUs) were reached between NASA and foreign operators that laid out requirements to make data openly available to any requestor. This policy was codified in US law through the "Land Remote-Sensing Commercialization Act of 1984" and the "Land Remote-Sensing Policy Act of 1992." These acts state that US civil remote sensing data shall be made available to all users on a nondiscriminatory— without preference, bias or any other special arrangement— basis.[5]

Of particular concern to the US was international acceptance of open skies.[6] An open skies policy provides an international legal right for any country to examine Earth from outer space without the prior sovereign consent of states over which observation is taking place. This policy was formulated with the tacit support of Soviet/Russia to ensure the unencumbered right to acquire data from space. It has been a cornerstone of US space policy and diplomacy.[7] Open skies has sustained remote sensing for national security reconnaissance and Landsat-type systems as economic assets.[8]

Notwithstanding the considerable value of Landsat data to other states,[9] the political and legal issues associated with Earth observations from space were controversial. Chiefly, this concerned potential misuse of data gathered without sovereign consent. This challenge to the notion of open skies was debated, beginning in 1970, within the UN Committee on the Peaceful Uses of Outer Space (UNCOPUOS) in its deliberations dealing with the establishment of international principles to govern remote sensing activities from space.[10] From the outset, there was disagreement on fundamental principles pertaining to international law and state sovereignty.[11] Developing states believed they possessed a proprietary right to data collected on their natural resources that were remotely sensed. This was based on the idea that sovereignty exists over the natural resources of a state and thus, prior consent was necessary to acquire and disseminate data on those resources.[12] The US rejected this claim in that it was inconsistent with open skies and the Outer Space Treaty of 1967.

Though Landsat was accepted under the principle of open skies, no international legal commitment exists. At issue was continued access to global data from satellites in space to ensure "freedom of passage" over countries for remote sensing activities and "freedom of data" acquisition and dissemination. "Remote sensing has so great a present and future value that the US would wish to be assured of continuity in the acquisition of global data."[13] It was recognized that open skies required coordination with other states in formulating and implementing an internationally acceptable set of data policy and exchange principles.[14]

Within this purview, NASA began in 1978 to explore several options for international cooperation.[15] One option involved a national system with commitments in international forums for foreign access to data produced by that system. This option is best exemplified by a policy of open skies and the attempts to gain international acceptance for it. A second option dealt with an international system of a similar nature to the World Meteorological Organization (WMO) that would coordinate internationally the available national systems for noncommercial exchanges of data. This option "commends itself...to international situations in which a number of nations operate their own programs but wish to provide for exchanges among them and to establish standards and compatibility for data."[16] There also was some thought given to the possibility of creating an international system based on the International Telecommunications Satellite Consortium (INTELSAT) model where states organize and integrate collectively for commercial operation of a global remote sensing system. To date, there have been no examples where this type of approach to cooperation has been applied to Earth observations from space.

The first option was initially pursued through UNCOPUOS. In 1986, the Committee accepted a set of remote sensing principles which were adopted by the UN General Assembly. These principles advocated that (a) remote sensing activities be carried out for the benefit and in the interests of all countries, taking into particular consideration the needs of developing countries; (b) that remote sensing activities should include international cooperation and technical assistance; (c) that remote sensing should promote the protection of the environment and protection of humankind from natural disasters; and (d) that when one country acquires data over another, the sensed country should have access to data on a nondiscriminatory basis and on reasonable cost terms.[17]

To maximize benefits from remote sensing, these principles encourage cooperation in data collection, storage, processing and interpretation facilities. Significant to open skies, was that developing states jettisoned their demands for prior consent by allowing one country to sense another in exchange for an international regime that emphasized international cooperation and "equitable" and mutually acceptable terms for sharing sensed data. Nevertheless, open skies as a policy is not made explicit within the UN principles.

Given conflicting views within the international community on issues of sovereignty, proprietary rights and freedom of information, UN Remote Sensing Principles represent little more than a reaffirmation of previous ideas that have been incorporated into treaties of international space law.[18] The principles, even from an international legal standpoint, were symbolic and nonbinding to UN member states since they were not made part of the Outer Space Treaty regime or crafted as an international treaty or convention in their own right. Albeit UN member states accepted the idea that their countries could be remotely sensed, issues of sovereignty and proprietary rights in relation to freedom of information and data were not addressed and remained unresolved.

A second option of an international system that coordinates available national remote sensing missions for noncommercial exchanges of data seemed most appealing to NASA.[19] The Committee on Earth Observation Satellites (CEOS), briefly reviewed in Chapter Two, and the EO-ICWG are based on such an approach to international cooperation. The intent of these organizations is to coordinate data management and data policy issues for all spaceborne Earth observation missions worldwide including the development of compatible data products, formats, services and applications.

EARTH OBSERVATION INTERNATIONAL COORDINATION WORKING GROUP

The origins of EO-ICWG date back to 1986 when NASA, NOAA and the European Space Agency (ESA) met in an effort to coordinate research announcements of opportunities, orbital characteristics, requirements for common instrument interfaces and data management and policy issues for the Earth observation polar platforms planned on Space Station Freedom (SSF).[20] At this meeting, a joint NASA/NOAA-ESA coordination group was established.

Because of the need to coordinate with all potential instrument providers for the polar platforms, NASA and ESA incorporated the other SSF Partners— Japan and Canada— into the coordination group at its second meeting in 1986.[21] The impetus for coordination was due to the realization that Earth observations are a global endeavor both in terms of science and applications. International coordination was critical to avoid duplication of effort and waste of resources and to allow for the better promotion of worldwide uses of Earth observation data gathering and dissemination activities.

A number of principles were put forward during the initial 1986 EO-ICWG meetings. These principles were based on "equitable" trade-offs that took into account national preferences related to operational and commercial activities. Equitable trade-offs were to take place in (a) aggregating and allocating resources; (b) sharing plans about instrument development; (c) coordinating ideas through research announcements of opportunities; (d) providing regular exchanges of information and program plans; and (e) minimizing overlap in instrument development. National preferences for operational and commercial activities were met by making sure that the development of instruments and spaceborne means (i.e., spacecraft, launch vehicles and data transmission) do not functionally depend on collaborative efforts.[22] Cooperation was to take place at the level of coordinating as effectively as possible a suite of Earth observation missions.

The EO-ICWG reached a number of understandings related to data rights and data exchange principles (DEPs). It was understood by all participating EO-ICWG agencies that coordination was to focus on free exchanges of data under an open skies policy. The DEPs put forward were based on a free and open flow of data access and information for scientific investigators.[23] Overall, the DEPs were to ensure the continuity and availability of Earth observation data to scientific users worldwide.[24]

Research priorities were to be set by investigator working groups for Earth observations. The EO-ICWG felt that Earth observation scientific communities should be free to recommend acceptance of instruments from any provider assuming that they meet scientific goals as identified in research announcements of opportunities. It was crucial that there would be widespread exchange of data generated by the instruments. NASA proposed an integrated international investigator working group (IIWG) to provide advice on research and utilization of the polar platforms.[25]

The EO-ICWG also discussed allocations, operations and commercial issues. In terms of allocations, the platforms were viewed as one package subject to possible bartering arrangements.[26] This contrasted with the fixed percentage allocations adopted for other Space Station elements. Under the concept of in-kind contributions established for the Space Station, each polar platform participating agency through free data exchanges could be considered to have provided in-kind contributions to compensate other participants for their intellectual property rights.[27] Data rights were to be retained by participating agencies.[28]

Operations had implications for mission control and planned commercial uses. The EO-ICWG proposed a multilateral mission control center whose responsibility would have been to coordinate operations for all platforms.[29] This would have ensured the integration of research activities and that operational user requirements were met. At stake was coordinated use of instruments to support unified objectives in scientific and applied research.[30] ESA, on the other hand, preferred for its polar platform a self-sufficient operations center under its unilateral control.[31] This proved to be problematic as cooperation evolved in the EO-ICWG since it tended to counter the basic multilateral coordinating principles advocated by the other members (i.e., US, Japan and Canada) of the group. For commercial activities, open skies did not imply cost-free access to data.

Commercial users would have to pay marginal access costs and fees to Space Station Partners for putting instruments on the polar platforms.[32] In return, commercial users that provided a specific instrument would be granted exclusive commercial rights to data generated by that instrument.

The scope of coordination within EO-ICWG broadened in 1987 to include mission management principles, data policies and terms of reference. In this regard, a MOU was proposed by NASA that defined terms and conditions for cooperation involving mission planning and development, coordination of research and operations and exchanges of data. This proposed MOU specified responsibilities for operating polar platforms, data rights based on a commitment to nondiscriminatory data distribution and scientific investigator teams in designating and developing instruments.[33]

NASA pursued codification of terms of reference through the proposed MOU. These terms provided a means for free exchange of information, harmonized Earth observation data and coordinated platform instrumentation and payload data handling. The intended role of EO-ICWG was to provide input to the Space Station partnership in its deliberations with regard to utilization of the polar platforms.[34] In 1991, the EO-ICWG was formally delegated responsibility for coordinating use of the polar platforms by the Space Station's Multilateral Coordination Board (MCB).

ESA was structurally impeded in its ability to consider formal terms of reference and an MOU. Organizational and political constraints unique to ESA mitigated against the prospects for multilateral agreement among EO-ICWG members. For ESA, it was paramount that participants retain autonomy and decision-making responsibilities within the framework of their individual political situations and industrial policies. EO-ICWG was envisioned as an ad-hoc body useful for coordinating separate nationally approved missions. At this level of cooperation, ESA suggested a number of areas for coordination including mission objectives, data requirements, instrument groupings, data access policies, instrument provisioning, instrument calibration and data validation and mission operations.

Despite the disagreement on terms of reference and MOU, NASA viewed these areas of coordination as a useful starting point for cooperation. In fact, a number of basic premises were agreed upon. First, NASA, ESA and Japan were to issue separate but coordinated research announcements of opportunity soliciting proposals for provisioning of instruments and exploitation of data coming from the polar platforms. Second, collaboration to harmonize views and objectives of participating agencies was recognized as an important goal. Third, Space Station Partners were to contribute to development, provisioning and operations of the various polar platform elements. In exchange, each Partner could access all elements and data on a nondiscriminatory basis. Lastly, there was agreement on the right to use platforms for other disciplines, such as solar terrestrial physics, and the right for other users— other than the Space Station Partners— to access and utilize Earth observation data generated by the platform's instruments.

At the same time, coordination of this nature fell short of NASA's preference for a formal set of relations within the EO-ICWG. Throughout the lifetime of the group, NASA preferred to achieve multilateral agreement on terms of reference as a set of guiding principles. In addition, NASA felt that the scope of EO-ICWG should be extended beyond Space Station polar platforms to encompass additional Earth observation platforms.

In 1988, an EO-ICWG Charter was adopted through exchanges of letters among heads of the Earth observation offices of SSF Partners (i.e., US, Europe, Japan and Canada). The Charter codified terms of reference discussed in previous meetings and established an enlarged role for the group. This role was to include coordination not only for the planned Space Station polar platforms, but also for additional platforms (i.e., the second NASA polar platform, the second and subsequent ESA polar platforms and the first Japanese polar platform):[35]

> EO-ICWG proposals and recommendations will also address coordination of Polar Platform missions beyond those initially foreseen by the Space

Station Partners, and may also extend to other elements of a global Earth observing system with the agreement of the offices or organizations responsible for such other elements.[36]

NASA insisted that it did not intend to form any other coordinating bodies for Earth observation programs involving polar platforms (i.e., all programs, research and operational, under development in the US, Europe, Japan and Canada) and that it looks to the EO-ICWG for coordinating all relevant issues.[37] This preference was realized through a series of EO-ICWG Charters put forward from 1988 to 1996. These Charters expanded coordination efforts to include a suite of polar-orbiting Earth observation missions among the US, Europe, Japan and Canada designated as IEOS.

INTERNATIONAL EARTH OBSERVING SYSTEM

International cooperation in the IEOS case study is characterized by coordination. IEOS encompassed coordination of unilaterally-approved Earth observation missions within the US, Europe, Japan and Canada. This coordination occurred under EO-ICWG auspices. EO-ICWG member agencies included the Earth observation programs of SSF Partners along with operational organizations closely related to them. Agencies and organizations that intended to provide IEOS elements were comprised of NASA, NOAA, ESA, European Organization for the Exploitation of Meteorological Satellites (EUMETSAT), National Space Development Agency of Japan (NASDA) [38] and Canadian Space Agency (CSA).

The IEOS suite of missions and satellites consisted of (a) NASA's Earth Observing System (EOS) AM, PM and Chemistry (CHEM) platforms; (b) NOAA's Polar-orbiting Operational Environmental Satellites (POES); (c) Europe's (i.e., ESA and EUMETSAT) Polar-orbit Earth Observation Mission (POEM) Environmental Satellite (Envisat) and Meteorological Operational Platform (METOP); (d) Japan's Earth Observing System

(JEOS) Advanced Earth Observing Satellites (ADEOS); and (e) NASA/NASDA's Tropical Rainfall Measuring Mission (TRMM).[39] IEOS missions and satellites are outlined in Table 8.

Table 8. International Earth Observing System.*

Country	Agency	Satellite
United States	NASA NOAA	EOS AM-1; EOS PM-1; and EOS-CHEM POES NOAA-N Series
Europe	ESA *EUMETSAT* *(withdrew, EO-ICWG in 1996)*	POEM Envisat-1 *POEM METOP-1* *(withdrew, IEOS in 1996)*
Japan	NASDA	JEOS ADEOS
Japan and United States	NASDA and NASA	TRMM
Canada	CSA	Contributor to EOS AM-1 Contributor to Envisat-1

*Sources: *Remotely Sensed Data: Technology Management and Markets*, Office of Technology Assessment, United States Congress, OTA-ISS-604 (Washington, DC: US Government Printing Office, 1994), 128; "Charter of the Earth Observation International Coordination Working Group," Adopted on June 8, 1988 and Amended on April 22, 1994 and November 12, 1996.

The technical, scientific, programmatic and policy coordination of IEOS occurred through a number of agreements. These agreements are highlighted in Table 9 on page 208 and Table 10 on page 209. Table 9 shows multilateral agreements that were proposed (draft) or approved by EO-ICWG members and Table 10 lists bilateral IEOS-related agreements on flight instruments involving EO-ICWG member agencies.

Table 9. International Earth Observing System multilateral agreements.

Type and Date	Level	Status
EO-ICWG Charters:		
Adopted-- June 8, 1988	**Multilateral**	**Approved**-- exchange of letters.
Amended-- April 22, 1994; November 12, 1996	**Multilateral**	**Approved**
IEOS Memorandum of Understanding:		
December 2, 1988.	**Multilateral**	**Draft**-- "Cooperation in Earth Observations Using Polar Platforms"
IEOS Intergovernmental Agreement:		
July 26, 1993	**Multilateral**	**Draft**-- Discussion Paper
IEOS Data Exchange Principles:		
June 21, October 22 and December 6 1990	**Multilateral**	**Drafts**-- Data Policy White Paper
February 26, March 7 and December 4, 1991	**Multilateral**	**Drafts**
September 9 and November 20, 1992	**Multilateral**	**Drafts**
[undated] 1994	**Multilateral**	**Draft**
IEOS Implementation Plans:		
August 27, 1992	**Multilateral**	**Draft**
January 14 and November 7, 1994	**Multilateral**	**Drafts**
September 27, 1996	**Multilateral**	**Draft**
Utilization Management Plan for Polar Platforms:		
June 29, 1992	**Multilateral**	**Draft**
June 30, 1994	**Multilateral**	**Approved**-- plan was part of Space Station Freedom Agreements.

At the multilateral level, the dearth of approved agreements is clear. Even though a number of proposed drafts directed at developing an IEOS MOU, IGA, DEPs and Implementation Plan were put forward, the parties failed to reach formal agreements on them. In fact, the EO-ICWG Charter and Utilization Management Plan for "Space Station Polar Platforms and Supporting Ground Elements" are the only instances where multilateral agreement was reached. It was this inability to reach approved multilateral agreements that eventually led to the demise of the EO-ICWG and IEOS mission concept in 1996.

Table 10. International Earth Observing System bilateral agreements.[40]

Type and Date	Level	Status
IEOS Flight Instrument Exchange MOUs and other related agreements:		
•NASA/Ministry of International Trade and Industry of Japan Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) for EOS AM-1, September 16, 1994.	**Bilateral**	**Approved** **References IEOS DEPs**
•NASDA/NASA Advanced Earth Observing Satellite (ADEOS), October 25, 1994.	**Bilateral**	**Approved** **References IEOS DEPs**
•NASA/CSA Measurements of Pollution in the Troposphere (MOPITT) for EOS AM-1, November 15, 1994.	**Bilateral**	**Approved** **References IEOS DEPs**
•NASA/NASDA Tropical Rainfall Measuring Mission (TRMM) October 20, 1995.	**Bilateral**	**Approved** **References IEOS DEPs**
Amendment to NASA/NASDA Tropical Rainfall Measuring Mission (TRMM), June 2, 1997.	**Bilateral**	**Approved** **Removed reference to DEPs**
•NASDA/NASA, Advanced Microwave Scanning Radiometer (AMSR) Interim Letter Agreement for flight on EOS PM-1, June 1996.*	**Bilateral**	**Approved**
•NASDA/NASA/NOAA Advanced Earth Observing Satellite-II (ADEOS-II), March 31, 1997.	**Bilateral**	**Approved**
•NASA/ESA EOS-Envisat Data Exchange, 1998.	**Bilateral**	**Pending (as of 1998)**

*Note: At first, Italy intended to provide a Multifrequency Imaging Microwave Radiometer (MIMR) which became an ESA instrument. When ESA dropped this plan, it was replaced by AMSR from NASDA.

In contrast to the multilateral level, bilateral MOUs on specific flight instrument exchanges in support of IEOS were reached between NASA/Japan, NASA/NASDA and NASA/CSA.[41] A number of these agreements also referenced the IEOS DEPs that were drafted at the multilateral level. With the demise of the IEOS concept in 1996, however, this reference either became obsolete or, as several agreements listed in Table 10 indicate, were not referenced to begin with.

Dynamics of Cooperation

Technological and Scientific Resources

The primary reason for EO-ICWG, one that all member agencies valued, was to inform each other regularly on plans to establish and implement Earth observation missions from space and to that end to share technical and scientific resources. For IEOS, this was premised on shared functionalities to provide for a coherent Earth observing system. Efforts to realize a coherent system focused on "adaptability" and "commonality" of functions.

Adaptability of function related to technical coordination.[42] There are several dimensions to this. One, coordination of plans to provide instrumentation and use of polar and low Earth orbiting systems to maximize scientific, operational and applications benefits to the global user community. Two, optimization of available resources for Earth observation platforms. Three, coordination of research announcements of opportunities and their evaluation. Four, determination of data policy and technical issues regarding orbital parameters, instrument exchanges and data calibration and validation. The emphasis was to bring about open and affordable access to data that was going to result from IEOS.

EO-ICWG established a number of working modules through which technical and scientific coordination for IEOS was to take place. These modules covered instrument exchanges, mission operations and planning, data management, data policy and calibration of instruments and data validation. The instrument exchange module defined mutual responsibilities, obligations, roles, principles and overall agreements for provisioning of sensor instruments between platform and instrument providers; the mission operations and planning module established management priorities for coordination including system integrity and emergencies, calibration and validation, critical support for global change research and routine priority data acquisitions; both the data management and data policy modules were closely related and dealt with issues such as data standards, data archiving, algorithms for data processing, calibration and validation, documentation to permit creation of data products and DEPs; and the calibration and validation module ensured that both platform and instrument providers harmonized such efforts with each other and the global change research community to meet user needs. It was understood that work on these modules allowed for cooperation to mature to the point where an integrated plan to coordinate IEOS could be developed.[43]

Such an integrated plan entailed commonality of function.[44] The focus was on payload planning and sharing of technology and getting the best possible set of sensors optimally manifested on whatever platforms were collectively available. This involved commonality of instrument interfaces and design. An integrated system implied sharing of opportunities to fly Earth science research payloads (i.e., sensor flight instruments) and interoperability of systems to support operations.

Flight instrument exchanges between platform and instrument providers were an anticipated feature of IEOS. This required close technical coordination for standardizing instrument interfaces, data transmissions, data products and software algorithms used to process data. The missions that were coordinated under the IEOS label were multinational from this standpoint. Multinational implied augmentation of capabilities on specific IEOS satellites. The NASA platforms had non-NASA payload elements as did NASDA's ADEOS and TRMM. As was documented in Table 10 earlier, this set of relations was formalized through a series of bilateral MOUs between NASA and Japan and Canada.

Interoperability was evident with the concept of an IEOS Data and Information System (IEOSDIS). IEOSDIS intended to develop a set of interoperable systems supported through an integrating infrastructure such as CEOS. This system would have networked links between IEOS data nodes to support data exchange and satisfy operating requirements and user needs.[45]

Technology Transfer. Technology transfer issues were of concern to IEOS. NASA was worried that controls on the export of space-based remote sensing imagery systems and data products could undermine open skies. In reply to a policy proposal put forward in 1993 by the US National Security Council (NSC) for such controls, NASA stated that:

> Our long-standing practices in this regard contributed directly to the development of...United States...as the leader in civil remote sensing technology and to the establishment of open data regimes as the standard for countries carrying out their own...programs. The wide spread acceptance and support for this...policy have led to the development, together with our cooperating partners, of a shared data policy for the International Earth Observing System...This shared data policy is key to the willingness of our international partners to contribute to the advanced and costly space-based systems necessary for extended study to enhanced understanding of global change.
>
> With this in mind, we believe the current policy options review should carefully avoid creating any ambiguities as the continuity of current...open data policy in support of research activities.[46]

To maintain a data policy of open skies, NASA called for an exemption from licenses that are normally regulated through Department of State and Department of Commerce export control regimes. The US government concurred with this position and restated its commitment to an open skies data regime as it applies to civil remote sensing systems conducted on a government-to-government basis for global change research use.

NASA also recognized that some controls would be necessary for technical data and goods that needed to be exchanged in support of adaptability and commonality of functions as well as interoperability. Export controls were put in place to govern functional interfaces among IEOS elements (i.e., platforms, spacecraft and instruments). The "exchange of technical data and goods" principles set forth in Space Station agreements were involved because IEOS incorporated the Station's planned polar platforms. Consequently, form (interface), fit (integration) and function (safety) data and goods— excluding detailed design, manufacturing and processing data and associated software— were to be exchanged without restrictions as to use or disclosure— except as otherwise restricted by national laws or regulations relating to export controls or control of classified data.[47] These rights to technical data and goods were incorporated into the bilateral MOUs reached between NASA and Japan and Canada regarding IEOS-related instrument flight exchanges.[48]

Furthermore, NASA established a technology transfer control program for IEOS agreements at both the multilateral and bilateral levels. This program included (a) blanket authorization to transfer public domain information (i.e., program status, platform accommodations data related to foreign instrument interfaces, mission operations data and related software) to IEOS member agencies; (b) transfer of technical data or software beyond that in the public domain (i.e., technical data in sufficient enough detail to enable the production or manufacture of data products), if necessary to fulfill IEOS obligations,[49] was to be granted only after NASA obtained the requisite governmental approvals; (c) transfer of technical interface, safety, operations and flight certification data was to be specifically identified to make certain that no technical data was transferred to which NASA was not obligated to provide (i.e., NASA was only obligated to provide data related to from, fit and function); (d) foreign access to NASA and contractor facilities was to be limited to those project personnel that NASA determined as essential for IEOS; and (e) hardware that NASA was obligated to provide under the various IEOS agreements was to be furnished on a temporary basis— i.e., NASA's technical equipment was to remain the property of NASA.[50]

Data Distribution and Intellectual Property Rights. In spite of open skies, the distribution of data and intellectual property rights to that data were pertinent issues. Since IEOS DEPs allowed for data to be provided for research and application purposes to any users selected by EO-ICWG agencies, controls over data requested by third parties (i.e., non-EO-ICWG agencies) and when data collection and distribution comprises foreign policies of the participating states were issues of concern. The US took the position that any foreign entity wanting data would have to get permission of the relevant platform and instrument providers. As the primary platform and instrument provider for the US, NASA intended to grant approval to all data requests for all types of data use under its open skies policy unless there existed a specific foreign policy or national security reason to deny such access.[51] Such a denial of access involved "shutter control" over Earth observation systems. The policy, then (1994) and now, is to limit data collection and distribution by remote sensing systems to the extent necessitated by situations where foreign policies, national security and international obligations may be compromised.[52]

Intellectual property rights applied to technical data dealing with instrument specifications and scientific data coming from sensors onboard an IEOS satellite. NASA sought to retain data rights for instrument providers and to define them through a legal framework such as an IEOS MOU, while ESA and Japan preferred a joint arrangement between instrument and platform providers and questioned the need to legally define rights.[53] These different positions were reconciled when EO-ICWG members agreed that intellectual property rights should be determined by each agency without requiring consistency in how rights are asserted.[54] This position failed to resolve differences regarding data property rights. For example, differences over intellectual property rights posited such a major problem in the NASDA/NASA ADEOS MOU that in the end it was agreed to avoid statements on ownership of data and to note who owns the particular instrument and spacecraft that enables data to be gathered.[55]

An exception to these patterns of establishing data rights involved the intellectual property rights regime advanced as part of the utilization management plan submitted to the MCB for use of the Space Station polar platforms.[56] User intellectual property rights were to be safeguarded through proprietary protection. A basic attribute of this protection was the assurance that data remain under controlled conditions to prevent unauthorized disclosure or use. These conditions stipulated that the agency furnishing data shall ensure that a notice is affixed to data identifying it as proprietary and indicating any specific restrictions that may apply for use by the receiving agency. This regime allowed for the availability and distribution of data gathered by polar platform sensors.[57] Sensor derived data was excluded from proprietary protection. This exclusion was critical to IEOS DEPs which stipulated that data was to be readily accessible and distributed for research, operations and application public benefit uses. It implied that the notion of open skies supercedes any specific proprietary right.

Authority Patterns

Authority patterns revolved around the extent to which coordination efforts should remain informal and ad-hoc or be formalized in some legally binding fashion. This debate took place over the nature of IEOS multilateral agreements— terms of reference (i.e., Charter, MOU and IGA), DEPs, Implementation Plan— highlighted in Table 9. The outcome of this debate on the side of informality and failure to reach any binding multilateral agreement led to the vegetative state of EO-ICWG and the IEOS mission concept in 1996.

Terms of Reference. A series of EO-ICWG Charters were approved by EO-ICWG member agencies through an exchange of letters of understanding between 1988 and 1996. The Charters vested the group with little authority beyond that of planning, coordinating and making recommendations to Earth observation offices of EO-ICWG member agencies. For instance, the objectives of EO-ICWG, as stipulated in the Charter, were to promote (a) an integrated observing system which will advance scientific understanding of the entire Earth system on a global scale; (b) development of future operational services and the continuity of operational services being provided by NOAA's polar-orbiting satellites; and (c) an effective use of polar and low Earth orbiting platforms.[58] The Charter addressed (a) plans to provide instrumentation and use of polar and low Earth orbiting systems with the aim to maximize scientific, operational and applications benefits to the global user community; (b) plans to optimize use of available resources for planned Earth observation platforms; and (c) coordination of data issues involving policy, management, validation and instrument calibration, orbital parameters, payload operations and research announcements of opportunities and their evaluation.[59]

From the onset of discussions regarding terms of references for EO-ICWG, NASA took the position that coordination efforts required a greater degree of formalization than was originally thought of when the group was formed in 1986 and the first Charter was adopted in 1988. Albeit EO-ICWG agencies saw intrinsic value in technical and scientific coordination in-and-of-itself, NASA believed that for such coordination to be effectively implemented political commitments to terms of reference were necessary. In 1988, NASA proposed that a multilateral IEOS MOU be drafted and signed by EO-ICWG member agencies.[60]

The draft IEOS MOU addressed terms of reference as it applies to (a) specific and firm commitments to technical and scientific cooperation; (b) long-term operational activities; (c) provisions for other bilateral Earth observation mission platforms outside Space Station; and (d) data policy, mission management and decision-making procedures.[61] From NASA's standpoint, the realization of an integrated IEOS system required a legally binding MOU to guarantee consistency and coherence in policy, functions and operations.

Conversely, ESA sought to preserve its autonomy and decision-making authority.[62] The fear was that a multilateral IEOS MOU would not allow for policy and programmatic flexibility. ESA proposed that the Space Station MOUs be applied to the polar platforms and that other bilateral MOUs could be reached on additional Earth observation platforms outside the scope of Space Station.[63] This implied that the Space Station MOUs would be the basis for coordination activities and that the drafting of an IEOS MOU would have impeded such short-term efforts.[64] NASA retorted that Space Station MOUs do not possess the same legal weight as an independent IEOS MOU would have and therefore, would not be a sufficient basis for proceeding with implementation of IEOS. Verily, ESA's position was unacceptable to NASA since it undermined the entire basis for proceeding with an IEOS.[65]

Related to the MOU idea was NASA's proposal in 1993 for an IEOS IGA. The IGA was to express high-level governmental commitments for international cooperation in Earth observation satellites as well as provide a clear legal status for IEOS that included binding commitments to DEPs.[66] As a whole, the proposed IGA was intended as an umbrella agreement that would integrate all aspects of IEOS cooperation in much the same way that the Space Station IGAs of 1988 and 1998 accomplished.

The justification for an IGA was supported by realization that the legal framework for IEOS was insufficient. NASA thought that the EO-ICWG Charter was an inadequate document to guide cooperative efforts that member agencies wished to pursue. There existed concerns that the Charter did not possess the requisite legal stature to enable commitments necessary for implementing IEOS. Because coordination of IEOS activities was an informal endeavor conducted on the basis of promises made by agencies, NASA presumed that it would be easier to protect and sustain international cooperative efforts if commitments were legally binding at the governmental level.[67]

A fundamental problem for NASA was that the coordination within EO-ICWG was not at the governmental decision-making level. The group was vested with little, if any, authority beyond that of planning and making recommendations. NASA saw the existence of EO-ICWG as protecting participants from a potentially chaotic environment that could result in separately and unilaterally trying to develop and implement Earth observation missions. To prevent this scenario from occurring, NASA made the effort to legally obligate member agencies and thus, bestow authority and decision-making prowess to EO-ICWG. Both the proposed MOU and IGA illustrate this point. Further, it is important to recall that ESA, even if it contested the IEOS MOU and IGA, placed value in the EO-ICWG as a technical and scientific collaborative forum for IEOS and as an influential advisory group whose recommendations should be submitted for formal approval within each participating national agency.[68] The point of contention was that NASA wanted formal approval multilaterally under the auspices of EO-ICWG, while ESA strove to preserve unilateral authority and decision-making.

Data Exchange Principles. Another matter of importance to IEOS dealt with DEPs. This was true of the principles themselves, which are discussed later in the section examining cooperative dynamics related to policy preferences, and to the extent to which principles would be binding on EO-ICWG member agencies.

NASA attempted to forge a consensus data policy. Given that the DEPs were incorporated into a series of bilateral MOUs covering specific instrument exchanges for IEOS, a separate multilateral agreement on data principles would have to be reached to make sure data principles were binding on members that are not a party to the MOUs.[69] Data policy mandated a separate identity to make possible reciprocal binding commitments among EO-ICWG partners.[70] To realize such commitments, NASA proposed that a multilateral data policy agreement, known as IEOS DEPs, be approved through an exchange of letters among agencies in the same manner as the EO-ICWG Charter.

An IEOS Implementation Plan was proposed as a means to bring about data policy agreements. The primary purpose of this Plan was to functionally tie together all aspects of IEOS implementation to "provide the international user community with a coherent and consistent set of data and information services governed by an agreed set of principles."[71] This included those aspects carried out by EO-ICWG agencies acting either multilaterally, bilaterally or unilaterally and by the CEOS Working Group on Data (WGD) covering areas (e.g., common data approaches and standards) delegated by the EO-ICWG to CEOS.[72] The Plan was cognizant of both the need to realize a core set of multilateral commitments on data policy, mission management, functionality and interoperability and the preference for autonomy and independent decision-making for each relevant IEOS agency with regard to funding, developing, managing and standardizing its contributions.[73]

In 1994 the EO-ICWG declared that it accepted a set of IEOS DEPs and affirmed that these principles were to be included in appropriate IEOS-related bilateral MOUs on flight instrument exchanges.[74] Though, approval of IEOS DEPs was contingent on an acceptable IEOS Implementation Plan. One idea put forward by NASA to achieve this end was to transfer authority from the EO-ICWG to some independent group— IEOS Coordination Committee— that would specifically guide multilateral implementation activities.[75] This Committee would have served as a focal point for interagency coordination with respect to data management, format, standards, exchanges, acquisition, distribution and archiving as all as operational issues related to platforms, instruments, data handling and ground segments.[76]

ESA opposed these efforts due to several differences it had with NASA. One difference was that ESA wished to place conditions on the use of data. This was expressed in its commitment to DEPs included within the Implementation Plan only for Envisat as opposed to other satellites that ESA may have contributed to IEOS in the future.[77] ESA also objected to the level of detail present in drafts of the Plan. Specifically, ESA preferred to deal with detailed issues related to functionality and interoperability of IEOS at the bilateral MOU level. Lastly, ESA was fearful that any authority bestowed upon an IEOS Coordination Committee would undermine its autonomy and ability for independent decision-making.

These differences festered through 1995 and 1996. NASA pushed for a detailed Implementation Plan as a basic framework for IEOS. ESA was reluctant to complete the Plan before political and funding commitments to IEOS among its member states were made. It was premature to commit to any agreement with EO-ICWG agencies when ESA had not fully worked out and coordinated data access policies for Envisat.[78] At issue for

NASA was the viability of IEOS. For ESA, the dispute had more to do with its autonomy and own internal politics of cooperation then the substantive details of the Plan. Finally, a compromise was reached whereby the Implementation Plan would commit ESA to the agreed DEPs, but would be less specific about technical details of its application to Envisat and other potential contributions.[79]

This compromise resulted in the formulation of an Implementation Plan draft by ESA for consideration by the EO-ICWG.[80] This plan outlined a high-level versus detailed approach to the implementation process. The draft deals exclusively with standard terms, conditions and DEPs. Absent from the Plan were functionality and interoperability guidelines. NASA viewed ESA's draft proposal as wholly inadequate as it no longer characterized a "real" implementation plan due to its lack of detail and any agreement over common functionalities. As a result, neither NASA nor ESA pursued implementation of this Plan.

Memoranda of Understanding. An important aspect of IEOS are the bilateral MOUs on specific flight instrument exchanges listed in Table 10. Significant to authority was that a number of MOUs legally obligated the parties to IEOS DEPs.[81] Outside of these specific bilateral commitments, there existed no multilateral legal obligation to DEPs or IEOS.

By 1994, there was a sense of urgency on the part of NASA, Japan and Canada to approve the IEOS Implementation Plan since several of the bilateral MOUs came into force and satellite systems were being designed and implemented. This plan failed to materialize because of the irreconcilable differences between NASA and ESA discussed earlier. In addition, ESA was the only EO-ICWG member agency that did not enter into bilateral MOU agreements with NASA or other agencies.[82]

Failure to agree to an Implementation Plan left the MOUs without any reciprocal binding commitments to the DEPs. Admittedly, "relying solely on the bilateral MOUs will not work because we have the risk of different interpretations in different agreements thereby, losing all the benefits of having standard DEPs."[83] In 1996, with the demise of EO-ICWG, references to IEOS DEPs either became obsolete or were officially removed from the bilateral MOUs. For example, the TRMM MOU was amended in 1997 to remove reference to the IEOS DEPs[84] and the ADEOS-II MOU contained no direct reference to IEOS DEPs. Nevertheless, the data policies advocated in these MOUs were influenced by IEOS ones.

Similar to the Space Station MOUs discussed in Chapter Four, IEOS-related MOUs dealt with authority dynamics regarding jurisdiction, control, financial arrangements, customs and liability. Jurisdiction and control remained at the national sovereign level, whereupon instruments and equipment furnished under the MOU remained the property of the providing government or national space agency; financial arrangements follow the "no exchange of funds principle;" each MOU established a free customs regime; and liability was dealt with through a cross-waiver agreement.

Failed Cooperation. The first thought about ending EO-ICWG and thus, the IEOS mission concept emerged within NASA in 1995 due to the repeated failures in convincing ESA about the need for formal and binding commitments to an IEOS Implementation Plan. NASA, during internal discussions on EO-ICWG follow-on, emphatically stated that "nobody in NASA supports continuation of EO-ICWG as is" and "everyone is disappointed with ESA..."[85] NASA wished to explore the option of ending EO-ICWG after preparing a formal resolution noting the successful completion of IEOS DEPs, fulfillment of EO-ICWG's role pertaining to Space Station polar platforms and coordination of Earth observation plans and activities in the US, Europe, Japan and Canada.[86] Embedded throughout this discussion was the realization that although coordination efforts had been a success, the group's historic basis was no longer valid.

IEOS had matured as a mission concept to the extent that EO-ICWG as it existed was inadequate to provide coordination that was needed for implementation.

Several reasons were given for NASA's position to end EO-ICWG. First, ESA proposed revising EO-ICWG to focus primarily on one class of missions for global change research use. This would have limited the scope of IEOS to just science. The separation of scientific missions from operational and application ones did not fit IEOS program concepts. Second, there was a failure to develop an overarching framework on data system interoperability and data exchange policy. This led NASA to move data coordination activities to CEOS and its WGD.

The quandary for ESA has always been that it is severely constrained in its ability to meaningfully negotiate and make binding commitments with foreign partners sans membership consent. As Chapter Two discussed, ESA is a complicated case of cooperation that must balance its interests with those of its member states. ESA itself has no real political power or overall authority to make things happen.[87] This makes consensus difficult to reach within ESA and impedes the agency from committing to a consensus direction internationally.

To exacerbate matters, ESA's Charter places Earth observations within the category of optional programs. With such programs, ESA's Council lacks authority to take action on behalf of its members. Also, optional programs can only be sustained if national members who opt for the program remain committed to it. This drove ESA to be excessively responsive to its participating states who possessed divisions on the relative importance of scientific versus operational and commercial objectives for Earth observation programs. Consequently, agreement on a data policy for Envisat became entrapped in ESA's own politics of cooperation. This prevented ESA from entering into any external agreements with NASA or EO-ICWG agencies.

The beginning of the end for the EO-ICWG was reflected in a letter sent by ESA to NASA in 1995 that proposed incorporating aspects of the IEOS Implementation Plan into the bilateral MOU agreements rather than continue with the Plan as a collective multilateral document.[88] In response, NASA submitted a letter to ESA indicating its preference to end EO-ICWG.[89] NASA reasoned that "our experience is pretty clear that ESA is not willing or able to participate as we would like."[90]

EO-ICWG meetings commencing in the Fall of 1995 focused on future strategies. Consensus emerged that the group as it existed at the time was no longer the right forum for coordinating IEOS:

> The fundamental open issue is what the EO-ICWG agencies want to accomplish through this organization...If the "grand vision" of IEOS is not acceptable to all EO-ICWG members, an alternate vision must be articulated and agreed upon...NASA...is no longer convinced that the EO-ICWG is the right forum for this.[91]

NASA preferred to disband EO-ICWG and replace it with coordination through CEOS, ad-hoc meetings and bilateral consultations, while ESA was more interested in reforming EO-ICWG to focus exclusively on scientific research missions. Given its uncertain future, the group had difficulty in achieving full policy, programmatic and technical representation in its meetings. In 1996, EUMETSAT withdrew from EO-ICWG and from its planned satellite (METOP-1) contribution to IEOS.

In the final analysis, differences between NASA and ESA proved to be irreconcilable. Although never officially disbanded, EO-ICWG held its last meeting in November of 1996.[92] Since that time, IEOS as a specific concept involving missions, data principles and implementation plans is in a vegetative state if not completely dead.[93] Nevertheless, the concepts generated by IEOS have evolved into a set of NASA Earth Science and complimentary international missions.[94] This is evident with missions that are underway as agreed to in the bilateral MOUs listed in Table 10. Of note as well, is NASA's effort to reach a bilateral agreement with ESA on EOS-Envisat data exchange.

Decision-Making Patterns

The debate over authority extended to decision-making. NASA preferred multilateral mechanisms for decision-making, while ESA, which guarded its autonomy, preferred independent means for decision-making. Multilateral decision-making is an inherent part of the EO-ICWG Charter which explicitly stated that "it is the aim of the EO-ICWG members to reach conclusions on joint actions and recommendations by consensus."[95] The group recommended that a common command, communications and data handling system (i.e., IEOSDIS) be established. NASA suggested that decisions about Earth observation science be coordinated and decided upon within a multilateral scientific forum designated as IIWG.[96]

Multilateral decision-making also applied to unilateral withdrawal on the part of EO-ICWG member agencies of a platform or an instrument as a contribution to IEOS. It was agreed that the particular agency undertaking such a unilateral decision would be required to completely withdraw all its contributions and in addition, would not be entitled to access IEOS data without paying for it. This was necessary because EO-ICWG member agencies coordinated mission and program planning for IEOS well in advance and a decision to withdraw on a unilateral basis would cause hardship for other agencies.[97]

Alternatively, mission management retained a strong national focus because each party possessed autonomy over its particular polar platform.[98] This autonomy dealt with development, integration and launch operations as well as mission operations such as command, communications, control and data acquisition, processing and distribution. The intent was to coordinate these decisions multilaterally, while concurrently retaining the right for unilateral decision-making. NASA saw multilateral aspects of coordination as essential for realizing and implementing a unified set of EO-ICWG and IEOS functional objectives and policies, whereas ESA sought to retain as much decision-making autonomy and independence as was feasible.

There also existed a set of decision-making procedures related to the role of the EO-ICWG in relation to the Space Station polar platforms. According to the Charter of 1994, the EO-ICWG was formally "delegated the role of planning and coordinating the full international utilization of the Space Station polar platform by the Charter of the Space Station Systems Operations Panel (SOP) and User Operations Panel (UOP)...approved by the Multilateral Coordination Board (MCB) as provided in the Space Station MOUs and IGA."[99] Decision-making procedures were largely guided by the Station's management structure as it pertains to the MCB. The role of the EO-ICWG, as delegated by the MCB Charter, was to achieve coordination and concurrence for utilization plans on the polar platforms. This was to be accomplished on a consensual basis. The utilization plan was to be submitted to the MCB's UOP for approval as part of the Station's Consolidated Operations and Utilization Plan. When the EO-ICWG cannot reach consensus, NASA and ESA reserved the right to submit their plans for the polar platforms independently. Additionally, if the MCB/UOP failed to reach consensus, then NASA and ESA would have the right to take unilateral decisions with regard to the implementation of utilization plans. The EO-ICWG met its obligation to the MCB in 1994 whereupon the EO-ICWG reached consensus on NASA's and ESA's utilization plans and formally submitted those plans to the UOP for approval.[100]

Policy Preferences

The basis of cooperation for IEOS revolved around creating a data policy compatible with mission objectives.[101] This was recognized in 1990 as the "the cornerstone for the entire IEOS activity, and that the cornerstone needed to be laid soon in order to reach agreements (MOUs)."[102] Coordination efforts focused on establishing a set of IEOS DEPs that defined data access and data use rights.

There existed fundamental philosophical divisions between NASA and ESA for data utilization. NASA views data as a collective good for the benefit of research and science. ESA sees data as a private good with the intent of asserting control over it through copyright for operational and commercial development. The extent to which IEOS could be developed as a shared and coordinated system was inherently linked to data policy coordination.[103] In the end, the goals of users are met when data is easily and affordably available. Coherence and consistency between data access and data use policies of the various Earth observation satellites were considered critical for IEOS. Differences between scientific users, who are not expected to pay for data, and operational and commercial users, who are expected to off-set some system costs, had to be identified and reconciled.

NASA sought to apply its policy of open skies that was initially established for Landsat to IEOS:

> The...purpose...is to facilitate full and open access to quality data for global change research.
>
> ...requires an early and continuing commitment to the establishment, maintenance, validation, description, accessibility and distribution of high-quality, long-term data sets.
>
> Full and open sharing of the full suite of global data sets for all global change researchers is a fundamental objective.
>
> Preservation of all data needed for long-term global change research is required.
>
> Data archives must include easily accessible information about the data...
>
> ... international standards should be used to the greatest extent possible for media and for processing and communication of global data sets.
>
> Data should be provided at the lowest possible cost to global change researchers in the interest of full and open access to data.
>
> ...data should be made openly available as soon as they become widely useful.[104]

NASA subscribed to an open, nondiscriminatory data policy where all data would be available to any user on an equitable basis through a multitiered pricing policy. Multitiered implied differences in data access rights between scientific and operational and commercial users. Any user who met the definition of research use would have access to data on research price terms which would be lower than that offered for operational or commercial users. The justification for lower prices was based on the fact that researchers are contributing in-kind through publication of their data analyses and by returning to the data system detailed results of their work.[105] For nonresearch use, NASA proposed one price for any given data set. This price would be determined by the instrument provider and need not be higher than the cost of reproducing data. The bottom line was to avoid the possibility of preferential treatment by ensuring equity and open accessibility to data.

This is best exemplified by policies that called for data access by any requestor, whether for research, operational or commercial use or for use by states that are not party to IEOS, with no period of exclusivity and at the cost of reproducing data for a specific user. The emerging set of data policies for IEOS obligated researchers to make their data available for operational use. It was proposed that all data from Earth observation instruments designated as operational be made available to any user for any use and that operational agencies would have access to all data from all research designated instruments.[106] This position reconciled NASA's focus on research with ESA's greater emphasis on operational and commercial applications.

ESA was particularly bothered about free and open exchange of data that could have operational and commercial benefits such as meteorological data. While an open skies approach was agreeable to ESA as an overall scheme for global change science, ESA sought to protect investments made by member states to IEOS.[107] The effort was to provide operational and commercial services to justify the large investments in Earth observation polar platform programs.[108] This implied that there might be a need to consider differences in treatment of users from countries that contributed to the program in some way and those that did not. Such matters were compounded by the fact that demand for data, especially if provided at a marginal cost of reproduction across-the-board, could exceed the available resources to provide such services.[109] Accordingly, the EO-ICWG acknowledged that instrument providers must have some control over price terms to permit cost recovery and control over volume of demand.

These concerns were manifested in a suggestion by ESA that pricing policies for data be based on preferential rates rather than the cost of reproduction. This was to recognize that those who contribute should have some benefits and that each participating agency's funding and cost recovery policies for investments made to the system are taken into consideration.[110] Even NASA acknowledged a need for some preferential system in pointing out that researchers from noncontributing countries should not have access to Earth observation data on research terms since they did not contribute to the system; access for them would be granted on a commercial versus scientific basis— at reasonable cost terms as opposed to the cost of reproduction.[111] Cost schemes for commercial and scientific users were reconciled by allowing all users to have access to data at the lowest possible cost (i.e., nominal cost of disseminating the data).[112]

Additionally, IEOS DEPs defined categories of users and their specific rights and access terms. Three categories of users were put forward based on use affiliation with the IEOS system: (1) research involving science and applications; (2) environmental monitoring for operational users; and (3) worldwide users which includes all others such as commercial users and nonaffiliated research and environmental monitoring.[113] In this vein, any affiliated party could designate another organization as affiliated with them based on the understanding that each party is responsible for ensuring that the users it affiliates follow the data policy guidelines for their particular category of data use.[114]

In 1990, the EO-ICWG established an international coordination working group for data policy coordination. This group focused on drafting a data policy white paper. The goal of this policy paper was to develop a set of DEPs for IEOS that could be formally agreed to by relevant member states and to develop an IEOS Implementation Plan to maintain coordination in data exchange among the participants.[115] The latest draft of the IEOS DEPs put forward in 1994 states that:

> All IEOS data will be available for peaceful purposes to all users on a nondiscriminatory basis...
>
> There will be no period of exclusive data use.
>
> All IEOS data will be available for the use by each of the agencies and its designated users at the lowest possible cost for noncommercial use in the following categories: research, applications and operational use for the public benefit.
>
> Any of the agencies may designate national users of the respective countries or member states of the agencies as it deems appropriate to be given access to all IEOS data at the lowest possible cost for noncommercial use for the public benefit...
>
> Each data providing agency will fulfill the data requests of the other agencies and their designated users to the maximum extent possible.[116]

IEOS DEPs are based on two fundamental principles that underlie the concept of open skies: (1) nondiscrimination; and (2) nonexclusivity. Nondiscrimination is based on the idea of an equitable treatment for all potential users in terms of data access and use. This denotes that (a) data will be available for the use of each of the agencies and its designated users at the lowest possible cost for noncommercial research, applications and operational use for the public benefit; (b) agencies may designate users as appropriate to access IEOS data at the lowest possible cost for noncommercial operational use for the public benefit provided the designating agency assumes responsibility for ensuring that all the terms and conditions for data use are met; and (c) data providing agencies will fulfill data requests of other agencies and their designated users to the extent possible.[117]

Nonexclusivity connotes a quid-pro-quo for access to data— i.e., the payback to the public sector that funded the missions and subsidized their data access. Related to this is the designation of no period of exclusive data use. Research users shall be required to submit their results for publication in the scientific literature; application users shall be required to publish their results in a technical report; and both researcher and nonresearcher users shall be required to share their results with the particular agency that provided them with the data.[118] Only in cases where there is a need to provide validated data is there an initial period of exclusive data use. However, the DEPs made it clear that exclusive data use should be limited and explicitly defined. The overall goal should be to release data in some preliminary form within three months after the start of routine reception of instrument data.[119]

One of the main purposes of the IEOS Implementation Plan included the coordination of IEOS DEPs involving functionality of data information and distribution systems, data acquisition, generation of data products, archiving and retrieval of data sets and products, handling of data user requirements and provisioning of data user services and agreements on common approaches, standards and sharing of data exchange formats.[120] The goal of the Implementation Plan was to collect and provide a comprehensive global data set to maximize data use and to allow for long-term access to and utilization of data from IEOS elements.[121]

Despite formulation of IEOS DEPs, philosophical differences between NASA and ESA as well as ESA's structural dysfunction prevented any agreement on DEPs that incorporated ESA within the IEOS scheme. Though DEPs were valid as a concept, means of implementation were problematic.[122] Data policy coordination became an unworkable issue.[123] This contributed to the "vegetative state" of the EO-ICWG and IEOS by November of 1996.

Nonetheless, IEOS DEPs directly influenced data policies for what were previous IEOS missions. This indicates a modicum of policy success for coordination efforts that took place between 1988 and 1996. As Table 11 documents, an "open skies" data policy approach is in place for EOS, TRMM and ADEOS. Albeit data policies have yet to be finalized for Envisat and METOP, ESA has acknowledged a need to openly share data among scientific communities.[124]

Table 11. Summary of selected current data policies.*

Program/Agency	Pricing Policy	Restrictions on Data
NASA EOS	Cost of dissemination	None
ESA Envisat	To be determined; intent is to have a nominal cost for scientific research and development of data applications where all other users would be subject to a pricing policy for data	To be determined; goal is to maximize use for scientific research and to create a market for data
EUMETSAT METOP	To be determined	To be determined
NASDA ADEOS	Cost of dissemination for selected users Cost of reproduction for selected users Free to selected science team	Possibly
NASDA/NASA TRMM	Lowest possible cost	None

*Source: *Toward an Integrated International Data Policy Framework for Earth Observations: A Workshop Report* (Strasbourg, France: International Space University, January 1997).

SUMMARY

The EO-ICWG was formed in 1986 to coordinate plans among the US, Europe, Japan and Canada for Earth observations using the planned polar platforms on SSF. Beginning in 1988 with the drafting and approval of the first EO-ICWG Charter, the working group was able to extend cooperative activities to include a coordinated set of missions named IEOS. Coordination of IEOS, which included the Station's polar platforms as well as other polar-orbiting satellites, focused on adaptability and commonality of functions for operating and utilizing the system.

The major accomplishment of these efforts was the development of IEOS DEPs that were incorporated into bilateral MOUs for IEOS missions involving NASA and Japan and Canada. These principles subscribed to open skies and defined four categories of data use: (1) research; (2) applications demonstration; (3) noncommercial operational public benefit; and (4) other. The IEOS parties agreed to make their data available to each other in the first three categories with no period of exclusive use, at the lowest possible cost and on a nondiscriminatory basis given that the recipient of the data agrees to applicable property right terms and conditions and ensures that the data are used as intended by the designated parties.

Notwithstanding these accomplishments, IEOS as a mission concept was never implemented and only existed from 1988 to 1996. There are a number of reasons for this. First, the EO-ICWG failed to reach multilateral consensus on how to coordinate IEOS. NASA preferred development of an MOU and Implementation Plan, whereas ESA resisted these efforts, proffering that the EO-ICWG at best remain an influential advisory group. These differences were linked to the debate, primarily between NASA and ESA, on the authority and decision-making that should have been bestowed upon EO-ICWG versus the autonomy that would remain with the respective member space agencies.

Second, coordination efforts failed to develop a legal framework for functional interoperability and data exchange policy. This failure is inherently linked to the first one in that interoperability issues and DEPs were to be incorporated into an MOU and Implementation Plan. Despite technical collaboration and drafting of DEPs, which were referred to in a number of bilateral MOUs in support of IEOS, the lack of an overarching framework undermined the ability of member agencies to make any binding commitments for implementing IEOS. Third, the inability to implement IEOS was linked to the unworkability of data policy coordination due to differces with regard to uses of data for scientific and commercial purposes and ESA's overall lack of political support from its national members.[125]

This failure in cooperation, however, was more structural— political and organizational— related to the demise of the EO-ICWG. The primary goal of IEOS to internationally coordinate a program to obtain the needed measurements of geophysical parameters important to the study of global change and other environmental issues is largely being met by other means. The international networking and strategic framework realized through the efforts of EO-ICWG were helpful in each member country for getting approval and sustaining its programs. Coordination of these programs is made possible through bilateral agreements on what were former IEOS missions and CEOS.

NOTES TO CHAPTER FIVE

[1]See Jacob E. Smart, Assistant Administrator for Policy, NASA, Memorandum to Dr. Mueller, et. al., "Earth Resources Survey Program," October 3, 1967; Irwin P. Halpern, Policy Staff, NASA, Memorandum to General Smart, "Earth Resources Survey Program," September 5, 1967; Office of the Secretary, United States Department of the Interior, "Earth's Resources to be Studied from Space," News Release, September 21, 1966; and "Prepared by Jaffe and Badgley at Seamans' Request: NASA Natural Resources Program," May 13, 1966. Also, see Pamela E. Mack and Ray A. Williamson, "Observing the Earth from Space," in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume III: Using Space* (Washington, DC: Government Printing Office, 1998), 167-170; and Pamela E. Mack, *Viewing the Earth, The Social Construction of the Landsat Satellite System* (Cambridge, Massachusetts: The MIT Press, 1990), 45-93.

[2]See Robert P. Mayo, Director, Bureau of the Budget, Memorandum to Honorable Walter J. Hickel, Secretary of the Interior, April 14, 1970. Also, see Mack and Williamson, "Observing the Earth from Space," 168-173; and Mack, *Viewing the Earth*, 45-93.

[3]See David S. Johnson, Chairman, Satellite Task Force, *Planning for a Civil Operational Land Remote Sensing Satellite System: A Discussion of Issues and Options* (Rockville, Maryland: Department of Commerce, United States, National Oceanic and Atmospheric Administration, June 20, 1980), 1-16; and Zbigniew Brzezinski, The White House, Presidential Directive NSC-54, "Civil Operational Remote Sensing," November 16, 1979. Also, see Mack and Williamson, "Observing the Earth from Space," 168-173.

[4]See Mack and Williamson, "Observing the Earth from Space," 185-188; and Glenn H. Reynolds, and Robert P. Merges, *Outer Space: Problems of Law and Policy* (Boulder, Colorado: Westview Press, second edition, 1997), 190-197.

[5]See Section 103, "Land Remote-Sensing Commercialization Act of 1984," United States Public Law 98-365, July 17, 1985; and Sections 103, 105 and 501, "Land Remote-Sensing Policy Act of 1992," United States Public Law 102-555, October 28, 1992.

[6]See "Foreign Policy Issues Regarding Earth Resource Surveying by Satellite, A Report of the Secretary's Advisory Committee on Science and Foreign Affairs," Department of State, United States, July 24, 1974.

[7]See R. Cargill Hill, "Origins of US Space Policy: Eisenhower, Open Skies and Freedom of Space," in John M. Logsdon, ed., *Exploring the Unknown, Selected Documents in the History of the US Civil Space Program, Volume I: Organizing for Exploration* (Washington, DC: US Government Printing Office, 1995), 213-229.

[8]"Foreign Policy Issues Regarding Earth Resource Surveying by Satellite."

[9]One persuasive argument for Earth observations from space was the significant benefits to third world states in areas such as mapping and natural resource location. On this basis, the international response to the deployment of Landsat (i.e., ERTS-1) in 1972 was favorable. See Arnold W. Frutkin, Assistant Administrator for International Affairs,

NASA, Memorandum to Dr. Fletcher, Administrator, "Some Recent International Reactions to ERTS-1," December 22, 1972.

[10]See Reynolds and Merges, *Outer Space*, 197-200; and Hamilton DeSaussure, "Remote Sensing: The Interaction of Domestic and International Law" (paper presented at 38th Congress of the International Astronautical Federation, Brighton, United Kingdom, October 10-17, 1987).

[11]See DeSaussure, "Remote Sensing."

[12]See Ibid.

[13]Arnold Frutkin, Director, Office of International Affairs, NASA, Note to Harrison H. Schmitt, United States Senate, "Future International Organization of Landsat-type Systems," March 29, 1978.

[14]"Foreign Policy Issues Regarding Earth Resource Surveying by Satellite."

[15]"Future International Organization of Landsat-type Systems."

[16]Ibid.

[17]See "Principles Relating to Remote Sensing of the Earth from Outer Space," United Nations Document A/AC. 105/370, 1986.

[18]See DeSaussure, "Remote Sensing."

[19]"Future International Organization of Landsat-type Systems."

[20]"Conclusions of ESA-NASA/NOAA Earth Science/Observation Meeting to Discuss the use of the Polar Platform Element of the Space Station," February 13-14, 1986. Also, see Lisa R Shaffer, "International Cooperation in Earth Observations from Space," *Acta Astronautica* 22 (1990): 350-351.

[21]"Minutes of the Second Meeting to Coordinate the Use of the Polar Platform by Earth Observation of any Space Station Partners," July 8-10, 1986.

[22]"Conclusions of ESA-NASA/NOAA Earth Science/Observation Meeting."

[23]Minutes of the First ESA/NASA/NOAA Earth Observation Coordination Meeting Meeting."

[24]"Minutes of the Second Meeting."

[25]"Minutes of the Fourth Meeting of the International Coordination Working Group of Space Station Partners on the use of Polar Platforms for Earth Observations," February 17-19, 1987.

[26]Ibid.

[27]Ibid.

[28]"Minutes of the Second Meeting."

[29]Minutes of the Third Meeting of the International Coordination Working Group of Space Station Partners on the Use of Polar Platforms for Earth Observations," November 17-18, 1986.

[30]"Minutes of the Fourth Meeting."

[31]Ibid.

[32]"Minutes of the Second Meeting."

[33]"Draft Outline for a Memorandum of Understanding Covering Cooperation in Earth Observations using Polar Platforms" attached to "Minutes of the 7th Meeting."

[34]"Minutes of the 7th Meeting of the International Coordination Working Group (ICWG) of Space Station Partners on the Use of Polar Platforms for Earth Observations," November 16-20, 1987.

[35]Paragraph 2, "Charter of the Earth Observation International Coordination Working Group (EO-ICWG) on the Use of Polar Platforms and Space Station Elements," Adopted: June 8, 1988.

[36]Paragraph 7, "Charter of the Earth Observation International Coordination Working Group (EO-ICWG)."

[37]"Minutes International Coordination Working Group Ninth Meeting," June 6-8, 1988.

[38]The Earth Observation International Coordination Working Group included additional Japanese agencies which did not provide IEOS elements. These agencies included Japanese Science and Technology Agency, Ministry of International Trade and Industry of Japan, Japan Environment Agency and Japan Meteorological Agency.

[39]"IEOS Implementation Plan," [Draft] November 7, 1994.

[40]There were additional IEOS-related flight instrument exchange agreements that existed between NASA and non-members of the Earth Observation International Coordination Working Group. This includes NASA-United Kingdom Letter Agreement for Provision of the High Resolution Dynamics Limb Sounder (HIRDLS) for EOS-Chem, January 1997; and "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Brazilian Space Agency for the Flight of the Humidity Sounder for Brazil (HSB) Instrument on the National Aeronautics and Space Administration's Earth Observation System PM-1 Spacecraft," December 5, 1996. The HSB instrument was initially EUMETSAT's Advanced Microwave Sounding Unit (AMSU) instrument for EOS PM-1. When EUMETSAT dropped this plan, it became HSB from Brazil.

[41]"Memorandum of Understanding Between the National Space Agency of Japan, the National Aeronautics and Space Administration of the United States of America and the National Oceanic and Atmospheric Administration of the United States of America for Cooperation in the Advanced Earth Observing Satellite-II Program," March 31, 1997;

"Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the National Space Agency of Japan for Joint Development of the Tropical Rainfall Measuring Mission," October 20, 1995; "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency Concerning Cooperation in the Flight of the Measurements of Pollution in the Troposphere (MOPITT) Instrument on the NASA Polar Orbiting Platform and Related Support for an International Earth Observing System," November 15, 1994; "Memorandum of Understanding Between the National Space Agency of Japan and the National Aeronautics and Space Administration of the United States of America and for Cooperation in the Advanced Earth Observing Satellite Program," October 25, 1994; and "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Ministry of International Trade and industry of Japan Concerning Cooperation of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the NASA Polar Orbiting Platform and Related Support for an International Earth Observing System," September 16, 1994.

[42]See Paragraph 4, "Charter of the Earth Observation International Coordination Working Group," November 12, 1996.

[43]"Minutes Earth Observation International Coordination Working Group Fourteenth Meeting," December 5-7, 1990.

[44]An additional aspect of early IEOS activities reinforced a commonality of function approach. Such patterns existed between NOAA and EUMETSAT in relation to an Integrated Polar Observing Mission (IPOMS). Although IPOMS was disbanded when EUMETSAT withdrew from the EO-ICWG and IEOS in 1996, it did establish that NOAA was to become dependent on EUMETSAT for continuation of its morning operational observations as no NOAA polar orbiting observation platforms were planned for morning orbit after the year 2000. See "Final Minutes 16th Meeting of the Earth Observation International Coordination Working Group," December 4-5, 1991; and "Minutes Earth Observation International Coordination Working Group Tenth Meeting," December 7-9, 1988.

[45]See "IEOS Implementation Plan," [Draft] August 27, 1992. IEOSDIS, although never realized as intended, has evolved into a series of interoperability agreements between NASA's EOS program and foreign Earth observation programs. Such agreements have been reached or are pending between NASA and Australia, Germany, Netherlands and Russia.

[46]Robert W. Clarke, Associate Administrator for Policy Coordination and International Relations, NASA. Letter to George Tenet, Assistant to the President, National Security Council, December 7, 1993.

[47]Lisa R. Shaffer, Acting Director, Mission to Planet Earth Division, NASA, Memorandum to Department of State, "Clarification of IEOS MOU Provisions for Exchange of Technical Data and Goods," June 15, 1994.

[48]See Paragraph 10, "Memorandum of Understanding Between the National Space Agency of Japan, the National Aeronautics and Space Administration of the United States of America and the National Oceanic and Atmospheric Administration of the United States of America for Cooperation in the Advanced Earth Observing Satellite-II Program," March

31, 1997; Paragraph 13, "Memorandum of Understanding Between the National Aeronautics Space Administration of the United States of America and the National Space Agency of Japan for Joint Development of the Tropical Rainfall Measuring Mission," October 20, 1995; Paragraph 7, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Canadian Space Agency Concerning Cooperation in the Flight of the Measurements of Pollution in the Troposphere (MOPITT) Instrument on the NASA Polar Orbiting Platform and Related Support for an International Earth Observing System," November 15, 1994; Paragraph 6, "Memorandum of Understanding Between the National Space Agency of Japan and the National Aeronautics and Space Administration of the United States of America and for Cooperation in the Advanced Earth Observing Satellite Program," October 25, 1994; and Paragraph 7, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Ministry of International Trade and industry of Japan Concerning Cooperation of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the NASA Polar Orbiting Platform and Related Support for an International Earth Observing System," September 16, 1994.

[49]It was anticipated under proposed IEOS multilateral agreements that transfer of technical data or software beyond that in the public domain would not be needed.

[50]Peter G. Smith, Director of International Relations, NASA, Memorandum to Department of Sate, "NASA Control of Technology Transfer in the IEOS Program," [undated] April 1992; and Shaffer, "Clarification of IEOS MOU Provisions."

[51]This was NASA's position that was put forward in response to the Department of State's Intelligence Community Staff during the Circular-175 process of approval for the proposed International Earth Observing System Memorandum of Understanding.

[52]Robert W. Clarke, Associate Administrator for Policy Coordination and International Relations, NASA, Memorandum to Deputy Administrator, NASA, "NSC Deputies Committee on US Remote Sensing Policy," February 28, 1994. This memorandum discussed the National Security Council's policy paper on remote sensing that called for among other things "shutter control." NASA's recommendation was to concur with this policy paper.

[53]"Minutes Earth Observation International Coordination Working Group Thirteenth Meeting (EO-ICWG-13)," June 19-21, 1990.

[54]"Minutes Earth Observation International Coordination Working Group (EO-ICWG) 17th Meeting," August 27-28, 1992.

[55]Ibid.

[56]In 1991, the EO-ICWG was formally delegated the role of planning and coordinating the full international utilization of the Space Station polar platforms by the Charter of the Space Station Multilateral Coordination Board. The utilization management plan approved by the EO-ICWG in 1994 for this purpose was only applicable to the Space Station polar platforms and not other elements of IEOS.

[57]"Utilization Management Plan for the Space Station Polar Platforms and Supporting Ground Elements," April 1994. This plan was approved at the twenty-first

meeting of the EO-ICWG. See "Meeting Summary Earth Observation International Coordination Working Group Twenty-First Meeting," April 20-22, 1994.

[58]Paragraph 3, "Charter of the Earth Observation International Coordination Working Group," November 12, 1996.

[59]Paragraph 4, "Charter of the Earth Observation International Coordination Working Group," November 12, 1996.

[60]The idea of an IEOS MOU harks back to NASA's traditional approach to international cooperation. Yet, the notion that this MOU be multilateral as opposed to a series of bilateral arrangements was unique and without precedent and indicative of the multilateralism that was and still is pervasive with NASA's Mission for Protecting the Earth (i.e., NASA's Earth Science enterprise).

[61]Article 1, "Memorandum of Understanding Among the United States National Aeronautics and Space Administration, the European Space Agency, the Science and Technology Agency of Japan and the Canadian Space Agency on Cooperation in Earth Observations Using Polar Platforms," [Discussion Draft] December 2, 1988.

[62]"Minutes International Coordination Working Group Ninth Meeting."

[63]Ibid.

[64]"Minutes Earth Observation International Coordination Working Group Tenth Meeting."

[65]"Minutes International Coordination Working Group Ninth Meeting."

[66]S. G. Tilford, Associate Administrator for Mission to Planet Earth, Memorandum to Associate Administrator for Policy Coordination and International Relations, "IEOS IGA," July 28, 1993.

[67]Ibid.

[68]"Minutes Earth Observation International Coordination Working Group Thirteenth Meeting."

[69]"Minutes Earth Observation International Coordination Working Group 17th Meeting."

[70]"Minutes Earth Observation International Coordination Working Group Fourteenth Meeting."

[71]"IEOS Implementation Plan," August 27, 1992 [draft].

[72]Ibid.

[73]"IEOS Implementation Plan," November 7, 1994 [draft]; and "IEOS Implementation Plan, Draft Version 0.2," January 14, 1994.

[74]"Meeting Summary Earth Observation International Coordination Working Group Twenty-First Meeting."

[75]Ibid.

[76]"IEOS Implementation Plan," [Draft] November 7, 1994. Further, NASA believed that the IEOS Coordination Committee would have effectively relieved EO-ICWG from its responsibility to coordinate IEOS and as a result, would have removed the organizational and political impediments to a multilateral agreement on IEOS.

[77]"Minutes of the Twentieth Meeting of Earth Observation International Coordination Working Group," November 3-4, 1993.

[78]"Report on the ICWG Meeting, Paris, 12/13 September 1995," October 13, 1995. This report covered the Twenty-Third Meeting of the Earth Observation International Coordination Working Group held on September 12-13, 1995.

[79]Ibid.

[80]"IEOS Implementation Plan," [Draft] September 27, 1996.

[81]Paragraph 8, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the National Space Agency of Japan for Joint Development of the Tropical Rainfall Measuring Mission," October 20, 1995; Paragraph 5, "Memorandum of Understanding Between the National Space Agency of Japan and the National Aeronautics and Space Administration of the United States of America and for Cooperation in the Advanced Earth Observing Satellite Program," October 25, 1994; and Paragraph 6.2.a, "Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the Ministry of International Trade and industry of Japan Concerning Cooperation of the Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) on the NASA Polar Orbiting Platform and Related Support for IEOS," September 16, 1994.

[82]An agreement between ESA and NASA regarding EOS-Envisat data exchange is still pending as of 1998. Document #42479, Mission to Planet Earth Activities, Office of External Relations, NASA, [undated] 1998.

[83]"Minutes of EO-International Coordination Working Group-24." March 26, 1996.

[84]"Amendment to the Memorandum of Understanding Between the National Aeronautics and Space Administration of the United States of America and the National Space Agency of Japan for Joint Development of the Tropical Rainfall Measuring Mission," June 2, 1997.

[85]Lisa R. Shaffer, Mission to Planet Earth Division, Director, NASA, Memorandum to Associate Administrator, Mission to Planet Earth, "EO-ICWG Follow-On," August 21, 1995.

[86]Ibid.

[87]Jean-Jaques Dordain, Associate Director for Strategy, Planning and International Policy, European Space Agency Headquarters, interview by author, Paris, France, October 17, 1997.

[88]This European preference regarding the IEOS Implementation Plan was spelled out in a 1995 letter from Lanfranco Emiliani of the European Space Agency to Lisa R. Shaffer of NASA as referred to in Lisa R. Shaffer, Director, Mission to Planet Earth Division, NASA, Letter to Lanfranco Emiliani, European Space Agency, September 5, 1995.

[89]Shaffer, Letter to Emiliani

[90]Lisa R. Shaffer, Director, Mission to Planet Earth Division, NASA, Memorandum to Chu Ishida, NASDA, "EO-ICWG," September 8, 1995.

[91]Lisa R. Shaffer, Director, Mission to Planet Earth Division, NASA, Memorandum to Earth Observation International Coordination Working Group Members, "Future Strategy for EO-ICWG," November 5, 1995.

[92]See "Minutes Earth Observation International Coordination Working Group 25th Meeting," November 12, 1996.

[93]Correspondence with Kelly Herberger, Earth Sciences Division, Office of External Relations, NASA Headquarters, Washington, DC, April 9, 1999.

[94]Correspondence with Lisa R. Shaffer, former Director, Earth Sciences Division, Office of External Relations, NASA Headquarters, Washington, DC, March 19, 1999.

[95]Paragraph 7, "Charter of the Earth Observation International Coordination Working Group," November 12, 1996.

[96]The IIWG was to address all scientific user issues within EO-ICWG framework and to coordinate science planning across the entire IEOS system. Concomitantly, the proposed IIWG was not to possess decision-making authority. See "Minutes Earth Observation International Coordination Working Group Tenth Meeting."

[97]"Meeting Summary Earth Observation International Coordination Working Group Twenty-First Meeting."

[98]See, for example, Article 4,"Memorandum of Understanding Among the United States National Aeronautics and Space Administration, the European Space Agency, the Science and Technology Agency of Japan and the Canadian Space Agency on Cooperation in Earth Observations Using Polar Platforms," [Discussion Draft], December 2, 1988.

[99]Paragraph 7, "Charter of the Earth Observation International Coordination Working Group," April 22, 1994.

[100]From 1993 to 1995, EO-ICWG agencies favored a divorce from Space Station acknowledging its inadequacies for realizing IEOS remote sensing purposes. By 1997, the polar platforms were formally dropped from Space Station.

[101]Dixon Butler, Former Senior Scientist, Earth Observing System, NASA, interview by author, Washington, DC, January 8, 1998; and Lisa Shaffer, Former Director, Mission to Planet Earth Division, Office of External Relations, NASA, interview by author, Washington, DC, January 9, 1998.

[102]"Minutes Earth Observation International Coordination Working Group Fourteenth Meeting."

[103]"Minutes of the 8th Meeting of the International Coordination Working Group of Space Station Partners on the use of Polar Platforms for Earth Observations," March 9-11, 1988.

[104]"Data Policy Management for Global Change Research Policy Statements," July 1991. This policy statement became know as the Bromley data principles in that the efforts to reach this policy within among Federal Agencies were coordinated by D. Allan Bromley, Director, Office of Science and Technology Policy, Executive Office of the President.

[105]"Minutes Earth Observation International Coordination Working Group Tenth Meeting."

[106]Article 5, "Memorandum of Understanding Among the United States National Aeronautics and Space Administration, the European Space Agency, the Science and Technology Agency of Japan and the Canadian Space Agency on Cooperation in Earth Observations Using Polar Platforms," [Discussion Draft], December 2, 1988.

[107]Guy Duchossois, Head, Earth Observation Mission Management, European Space Agency, interview by author, Paris, France, October 16, 1997.

[108]"Minutes Earth Observation International Coordination Working Group Tenth Meeting."

[109]"Minutes Earth Observation International Coordination Working Group 17th Meeting."

[110]Ibid.

[111]"Minutes Earth Observation International Coordination Working Group Tenth Meeting.

[112]Minutes Earth Observation International Coordination Working Group 17th Meeting."

[113]"Minutes Earth Observation International Coordination Working Group Thirteenth Meeting."

[114]"Minutes Earth Observation International Coordination Working Group Fourteenth Meeting."

[115]"Final Minutes of the ICWG Data Policy Working Group," December 3, 1991.

[116]"IEOS Data Exchange Principles," [undated] 1994.

[117]Ibid.

[118]Ibid.

[119]Ibid.

[120]"IEOS Implementation Plan," [Draft] November 7, 1994; and "IEOS Implementation Plan," [Draft] August 27, 1992.

[121]"IEOS Implementation Plan," [Draft] January 14, 1994.

[122]Jason Steptoe, General Counsel, NASA Headquarters, interview by author, Washington, DC, January 12, 1998.

[123]Dixon Butler, interview by author, January 8, 1998.

[124]Guy Duchossois, interview by author, October 16, 1997.

[125]Lisa Shaffer, interview by author, January 9, 1998.

CHAPTER SIX: CONCLUSIONS

This study investigated the phenomenon of international space cooperation related to historical case studies associated with Missions for Exploring Space and Protecting the Earth. Cases evaluated were the Space Station and International Earth Observing System (IEOS). Evaluation was conducted according to a framework of analysis that incorporates space cooperation outcome-types and dynamics of cooperation. The four outcome-types include (1) coordination; (2) augmentation; (3) interdependence; and (4) integration; and the dynamics of cooperation encompass (a) technological and scientific resource; (b) authority and decision-making patterns; and (c) policy preferences over outcomes.

This concluding chapter interprets and assesses results of the case study evaluations to make substantive and theoretical contributions towards understanding international space cooperation and contributing to extant theories of international cooperation. To these ends, several questions are addressed. First, what is substantively learned from past and present cooperative experiences? This question is considered by inferring policy results and findings from the Space Station and IEOS case studies. Second, what can the proposed framework of analysis add to the study of international space cooperation? This question is explored by identifying how dynamics of cooperation are valued and associated with space cooperation outcome-types. The framework of analysis is specified and validated to help describe international space cooperation. Third, what are theoretical implications of international space cooperation? This question is probed by assessing how policy results and findings contribute to theories of international cooperation.

EVALUATION OF INTERNATIONAL SPACE COOPERATION

Results

Both the Space Station and IEOS case studies evaluated herein illustrate most directly dynamics of cooperation related to coordination, augmentation and interdependence and do so in ways next described.

Coordination

The coordination outcome is applicable to the early phases of Space Station and to IEOS. Coordination depicted the Space Station Task Force and its efforts from 1982 to 1984 to coordinate conceptual designs for a Space Station among potential partners in the US, Europe and Canada and the collaboration that occurred within the Earth Observation International Coordinating Working Group (EO-ICWG) with respect to IEOS from 1988 to 1996. Space Station coordination focused on programmatic aspects related to mission plans, while IEOS coordination revolved around mission designs and data policy principles to ensure accessibility, availability and use of Earth observation data for global change research.

Space Station Task Force. The Space Station Task Force emphasized planning for scientific missions to the exclusion of larger political and economic concerns regarding technology transfer, costs and management. Coordination of these missions transpired among epistemic communities in the US, Europe, Japan and Canada. An International Coordinating Working Group (ICWG) was established to consolidate mission scenarios that were proposed. A de facto level of international cooperation for Space Station— that which leapfrogged political arrangements— was realized. Coordination worked since no political commitment on the part of the US or its partners was present at that time. Moreover, this made future de jure cooperation on Space Station possible.

Coordination of this nature was historically unprecedented since it took place at the conceptual level as opposed to on an already designed and approved project. Notwithstanding, coordination did not alter NASA's policies for cooperation related to projecting US leadership abroad and precluding foreign participation in critical path technologies. Mission ideas were coordinated multilaterally within certain policy guidelines that followed NASA's traditional preferences for cooperation.

International Earth Observing System. The coordination of technical design plans and scientific data for IEOS was effective and viewed as worthwhile by the Earth science observation offices of the respective national space agency participants. Parallel to this, NASA sought to extend cooperation to functional and managerial issues related to IEOS interoperability. Attempts to forge both bilateral and multilateral agreements for implementation of the system were made. Even though NASA achieved a modicum of success in these efforts by virtue of the agreements on bilateral IEOS flight instrument exchanges with Japan and Canada, failure to reach any multilateral agreement ultimately convinced NASA to walk away from the cooperative undertaking. Essentially, NASA withdrew from the political and organizational structure of IEOS and not, per say, from the fundamental objective of an international system for Earth observations related to open and full acquisition and exchange of data.

Political and organizational failure occurred by reason of a mismatch between coordination and what NASA preferred as an outcome. As the idea for IEOS matured in the early 1990s and bilateral memoranda of understanding (MOUs) that were part of IEOS came into force, NASA believed that coordination was inadequate to achieve its desired outcome. The outcome preferred was one that would realize a multilateral consensus for implementation through agreement on an IEOS MOU, Implementation Plan and Data Exchange Principles. This approach was debated among IEOS participants, particularly between NASA and the European Space Agency (ESA), and these debates were concerned with whether or not cooperative relations should be formalized for the implementation of IEOS.

NASA's intent was to develop a functionally coherent IEOS that addressed adaptability and commonality of function. This implied that participants would rely upon each other for operating the system and for gathering and disseminating Earth observation data. The notion of functional interdependence manifested by interoperability was incompatible with the coordination approach adopted for IEOS. NASA was pushing for an outcome more characteristic of functional interdependence, while ESA sought to retain coordination to maintain their autonomy and independence for decision-making. In the end, incompatible preferences over outcomes spawned an unsuccessful political result for IEOS.

Augmentation

The augmentation outcome is applicable to Space Station Freedom (SSF). A "leading through cooperation" approach was adopted by NASA for SSF. This was manifested in asymmetries to NASA's advantage regarding the distributions of technological resources, managerial authority and decision-making control. NASA put forward a "core" design that stressed the functional independence and operational autonomy of Space Station to which foreign partners could add discrete hardware enhancements. Namely, foreign participation in critical path and infrastructure technologies and systems was explicitly ruled out. This core design entailed strict controls of technology transfer and a leadership role in authority and decision-making. NASA was able achieve these objectives through a series of bilateral MOUs with ESA, Japan and Canada.

The preferred augmentation outcome for NASA was weakened by the multilateral forums for management and decision-making and by authority patterns that engendered autonomy and independence for foreign partners. This is exemplified by functional allocations and the bilateral-multilateral management schemes employed in the Space

Station Agreements. Functional allocations signified shared responsibility for management and operations. Shared responsibilities are managed by a Multilateral Control Board and executed through a system of functional quid-pro-quos. Ironically, these arrangements had unintended spillover effects that diminished NASA's lead role on the project.

While NASA favored an augmentation outcome and hence, bilateral MOUs to control technical and managerial interfaces, the foreign partners, ESA in particular, were more inclined towards multilateral approaches. ESA achieved a measure of cooperation that established a genuine partnership with NASA where all partners possessed technological, authority and decision-making autonomy. Though a compromise was struck where both a multilateral intergovernmental agreement (IGA) and bilateral MOUs were concluded, functional allocations and multilateral approaches were factors in the interdependence outcome that followed with the International Space Station (ISS).

Interdependence

Cooperation on ISS was earmarked by functional interdependence. The development of a joint "core" approach involving NASA and Russia brought this about. In fact, the Russian Space Agency emerged as NASA's coequal relative to critical path systems, the chairing of management bodies and command and control of operations. Interdependence made it possible for any partner to make contributions to critical path and infrastructure elements (e.g., critical support services for operations and utilization activities such as space transportation, communications, propellant resupply and orbital reboost capabilities). Technical interfaces in support of functional interdependence were facilitated by flexibility in technology transfer for fit, form and functional purposes. This also gave rise to a common multilateral legal regime in matters of authority and decision-making (i.e., management, jurisdiction, control, liability and customs) that was codified in a multilateral IGA on Space Station reached in 1998.

Post-Cold War era symbolism and foreign policy benefits that could be derived from partnering with Russia were justifications for NASA to depart from its traditional preferences. NASA even transferred funds to Russia, forgoing its long-standing practice of "no exchange of funds" between cooperating partners. The formulation of an equal partnership based on parity in the distribution of technological resources and multilateral authority and decision-making arrangements was and continues to be fraught with functional and political risks.

Functionally, delays in assembly and concerns about the viability of ISS due to Russia's political and economic crises and the consequences that these internal conditions have had on their self-funded critical path systems has taken place. Politically, the US linked its strategic foreign policy preferences and relations with Russia to a successful outcome for ISS. These political links compelled NASA to accommodate the functional risks of technological interdependence. Today, ISS is under assembly and a critical Russian component (i.e., Service Module) is currently planned for launch sometime later in 1999 more than two years behind schedule. As a whole, symbolic policy reasons justified functional risks inherent in interdependent cooperative relations.

Findings

Coordination

Results of the case study evaluations connote that coordination is a broader concept than just the collaboration of separate national projects with independent capabilities. The Space Station Task Force showed that coordination is applicable to cooperative endeavors not yet designed and politically approved. IEOS demonstrated that coordination could also take place for multinational projects. The coordination outcome was instrumental in laying the groundwork for future cooperation on Space Station and in initiating and sustaining international agreement on data exchange principles necessary for spaceborne global change research.

Collaborative relationships focused on exchanges of information related to mission design plans and science characterize the dynamics of coordination. This entails multilateral patterns of participation through transnational epistemic coalitions and institutional responses to enhance the technical and scientific gains of a particular mission. The Space Station Task Force involved collaboration in conceptualizing missions among epistemic communities in the US, Europe, Japan and Canada; and IEOS was set-up under the institutional arrangement of the EO-ICWG.

Evaluations undertaken in this study reveal that coordination works as a cooperative outcome to the extent that it can focus on mission design plans and science, while avoid authority and decision-making issues related to management and operations. IEOS failed politically by reason of the attempts to coordinate these latter issues. This failure indicates that in comparison to the other outcome-types the exchanges of knowledge (e.g., mission design) and scientific resources that can take place with coordination are considered of lower value to national space agencies. This means that walk-away costs are comparatively low enhancing the probability that a partner will withdraw from a cooperative enterprise when it encounters policy differences with others. Moreover, items normally considered of higher value to national space agencies, such as technological resources and hardware, are not part of the coordination equation.

Augmentation

Augmentation is reflective of NASA's traditional approach to cooperation rooted in "leading through cooperation." Leadership means that cooperation is arranged according to NASA's traditional policy preferences dealing with (a) no exchange of funds; (b) clearly defined and distinct managerial interfaces and technical responsibilities; and (c) protection of sensitive technologies. Dynamics of augmentation are based on relationships whereby national responses, bilateral patterns of authority and decision-making and controls on technology transfer are predominant features. The SSF case shows that these features are structured through the use of bilateral MOUs to control and limit the roles of its cooperating partners. Cooperation is distinguished by the contribution of discrete hardware packages that are limited to enhancing capabilities on a particular project. SSF, on account of its core design, was essentially a NASA project enhanced by foreign participation.

Because augmentation involves technological enhancements of nationally approved missions, cooperative exchanges that take place in hardware, with respect to functions and operations, are of a low value.[1] NASA intended to build and operate a "core" Space Station whether or not foreign partners contributed to the project. On the other hand, the values placed on political exchanges are comparatively greater than with coordination. In light of the political commitments that are made through MOUs and IGAs, cooperating partners are obligated by law to follow through on their commitments. For example, in the International Solar Polar Mission/Ulysses case reviewed and assessed in Chapters Two and Three, NASA withdrew the planed spacecraft it had agreed to contribute in an earlier MOU with Europe. This decision constituted a higher walk-away cost than with the IEOS case as observed in NASA's damaged credibility as a reliable partner for ESA.

Also, a greater degree of political value can mitigate against the likelihood of political failure. The SSF Agreements played a role in sustaining cooperation in the face of the discussions that took place concerning the possible withdrawal of foreign partners and termination of the program in the US. Costs associated with walking-away form the cooperative endeavor were perceived to be greater than that with coordination since items of higher value, such as technology and hardware, are exchanged and cooperating partners legally obligate themselves through formal agreements.

For augmentation, specific exchanges in technological resources occur through functional quid-pro-quos. Inherent in augmentation is that the partner initiating cooperation plays a leadership role and controls all authority (i.e., management) and decision-making interfaces. It is in this realm that augmentation can erode over time. The Space Station case study indicates that the greater the degree of complexity and functional qui-pro-quos the less that a lead role can be played and the more that shared and equitable participation is a result. This is exemplified by the multilateral IGAs reached for SSF in 1988 and ISS in 1998.

Interdependence

The interdependence outcome-type as observed with ISS is characterized by shared and equitable patterns of participation among cooperating partners. Interdependence exists when foreign partners are an inherent part of the cooperative endeavor including contributions to critical path and infrastructure technologies and systems. Cooperation is enabling (i.e., essential and necessary) to the particular project or mission indicating a high degree of functional interdependence among partners for development, operations and utilization activities. The dynamics of interdependence include (a) equitable distributions of technological capabilities and resources; (b) mechanisms for technology transfer; and (c) shared and multilateral authority and decision-making patterns for management and operational control.

Functional interdependence indicates that a greater functional and political value is placed on the cooperative exchanges than with coordination and augmentation. Functionally, cooperative exchanges take place in critical technologies necessary to the project or mission. Politically, multilateral commitments are made at the highest government level. As the ISS case demonstrated, an IGA between governments tends to legally supercede the MOUs between national space agencies.

Interdependence is a more highly evolved form of cooperation in the scope of functional and political partnering that takes place as compared to coordination or augmentation. This implies higher walk-away costs that probably makes defection and political failure less likely. Also, interdependence reflects the current balance of power (i.e., capabilities) among states in space. It should be noted, however, that interdependence has no historical precedence in space cooperation involving NASA and thus, the current ISS program is serving as a functional and political litmus test for this type of outcome.

The issue of risk has emerged as a concern with interdependence. This is attributable to several reasons. First, high levels of complex functional and managerial arrangements and technological exchanges are needed to interface critical path systems. This makes the prospects of a successful outcome more functionally challenging as weighed against coordination or augmentation. Second, the complex nature of functional and political arrangements, which is manifested through functional interdependence, signifies reliance upon others for the performance of specific tasks. The withdrawal or failure on the part of one partner leaves others vulnerable to the extent that the project as designed could not function. This is the type of outcome that NASA has historically tried to avoid or minimize. Third, state-governments undertake considerable political risk by exposing themselves to strategic vulnerabilities that can link the realization of symbolic policy preferences to a successful outcome. ISS is symbolic of post-Cold War relations between the US and Russia. Interdependence seems to be driven and justified through functional and symbolic policy preferences that compel political actors to depart from their more traditional approaches rooted in coordination for cooperation dealing with science and augmentation for cooperation involving technology.

Integration

Integration involves the institutionalization of interdependent relations whereby joint teaming for research and development (R&D) and the aggregation of financial resources exist. Integration represents an institutional response where national political actors form an international organization (IO) as the principal arrangement for cooperation. Features of integration, though not applicable to Space Station or IEOS, can be postulated based on historical cases assessed in Chapters Two and Three pertaining to the International Telecommunications Satellite Consortium (INTELSAT), ESA and the European Organization for the Exploitation of Meteorological Satellites (EUMETSAT).

In comparison to the other three outcome-types, integration embraces exchanges not only in science and technology but also R&D and funds. Integration creates a common political and organizational environment by virtue of the authority and decision-making powers bestowed by the state to an IO that enables cooperating partners to meet their functional and political obligations. Examples include INTELSAT's Operating Agreement based on investment shares and utilization rights, ESA's Convention that allows for mandatory and optional programs and an industrial policy of "just return" and EUMETSAT's international treaty for operating and sharing meteorological satellite systems and data. These examples imply that the formal institutionalization of cooperative relationships serves as a way in which to mitigate against the risks inherent in functional and political interdependent relations that can emerge within cooperative relationships (e.g., ISS).

FRAMEWORK OF ANALYSIS

The basic premise, advanced by the framework of analysis developed in Chapter Three, that international space cooperation outcomes are differentiated by qualitative differences pertaining to functional and political arrangements is validated by the findings. Functional arrangements concern exchanges that take place in technology and science and political arrangements relate to exchanges that transpire in authority and decision-making.

The findings indicate how functional and political dynamics of cooperation are valued and associated with space cooperation outcome-types. In other words, what are the variable dimensions that specify the functional and political arrangements. Variable dimensions are determined by looking at the range of cooperative dynamics and the ways in which particular conjunctions of those dynamics come together to characterize a specific outcome-type. These dimensions relate to (a) terms of exchange concerning technology, science, authority and decision-making; and (b) functional and political values that partners place on the cooperative endeavor.

Terms of exchange take on values that are either symmetrical or asymmetrical based on the relationships that are formed between cooperating partners. Coordination, interdependence and integration are characterized by symmetrical relationships and augmentation by an asymmetrical one. A symmetrical relationship encompasses equitable distributions of technological capabilities and resources, open exchanges of information, with respect to mission design plans and science, and multilateral patterns of authority and decision-making. These attributes are manifested in mixed responses to cooperation incorporating national entities, institutional arrangements and epistemic collaboration. The symmetrical valued dynamic indicates a degree of technological parity and interdependence where the gains for each partner are absolute.

An asymmetrical relationship consists of controls and limits on the distributions of technological capabilities and resources as well as bilateral patterns of authority and decision-making. These attributes are manifested in a predominantly national response to cooperation characterized by one partner's dominance and "leadership" over other partners. This implies that one cooperating party (e.g., NASA) has a relative advantage over another in technology, science, authority and decision-making.

The functional and political values that partners place on a cooperative endeavor are a function of risk-taking. Simply put, risk-taking is the propensity of cooperating partners to assume functional and political risks. Coordination entails the least risk followed by augmentation, interdependence and integration. With coordination the perceived value of exchanges regarding mission concepts and science is comparatively low as manifested in low walk-away costs and the absence of any binding political commitments. Augmentation involves a greater level of risk in that items of higher value (e.g., hardware) to national space agencies are exchanged and binding political commitments at the national space agency-level are reached (e.g., MOU). Interdependence is earmarked by a high-level of risk where critical path technologies are exchanged and multilateral governmental obligations are formalized (e.g., IGA). Integration is the riskiest proposition for national space agencies because all authority and decision-making are turned over to an IO.

The propensity for risk-taking validates the research assumption that the dynamics of cooperation are structured by the interplay between interdependence— reliance upon others for the performance of specific tasks— and independence— the desire to keep interdependent relations to a minimum. NASA has been willing to assume the low levels of risk inherent in coordination and augmentation because its traditional policy preferences for cooperation that emphasize "independence" can be realized. The more that NASA departs from these policy preferences the greater the degree of "interdependence" and thus, risk that it assumes. This interplay between interdependence and independence describes why NASA resisted efforts that eventually led to a functional interdependent Space Station and why ESA opposed NASA's attempts to more functionally integrate IEOS.

Possible threshold effects that bring about a transition from one type of outcome to another can also be ascertained. These effects have to do with the functional and political initial conditions manifested in terms of exchange and risk-taking. Coordination works to the extent that terms of exchange are symmetrical and focused on issues of science and when risk is perceived to be low. IEOS failed because of an incongruent situation between initial conditions and the coordination outcome-type due to the attempt to cooperate on operational and technological issues that created higher risk. Augmentation is applicable when terms of exchange are asymmetrical and deal with technology, and when functional and operational risks are comparatively low. The transition from augmentation to interdependence, which took place with Space Station, showed that complexification processes and changes in symbolic policy preferences altered terms of exchange making functional interdependence feasible. In a fundamental way, functional and political conditions compel national political actors, such as NASA, to assume a higher degree of risk than would normally be the case if left to their own designs.

The principal policy-relevant implication is that international space cooperation is dependent upon the extent to which functional and political conditions of a particular endeavor are congruent with the outcome-type that is preferred. Incongruent circumstances can lead to points of contention as witnessed between the US and Russia with respect to authority and decision-making on Space Station as well as the dissolution of cooperation as observed with IEOS.

Figure 7, which depicts variable dimensions and threshold effects and their relationships to the outcome-types, portrays a more specified roadmap for understanding international space cooperation. The values related to terms of exchange and risks represent variable dimensions of international space cooperation. These dimensions encompass both functional and political arrangements and frame the conditions underlying the type of cooperation outcomes that are observed. Technology, the degree of complexification in a project and symbolic policy preferences are the threshold effects that engender outcomes different than that from coordination and augmentation.

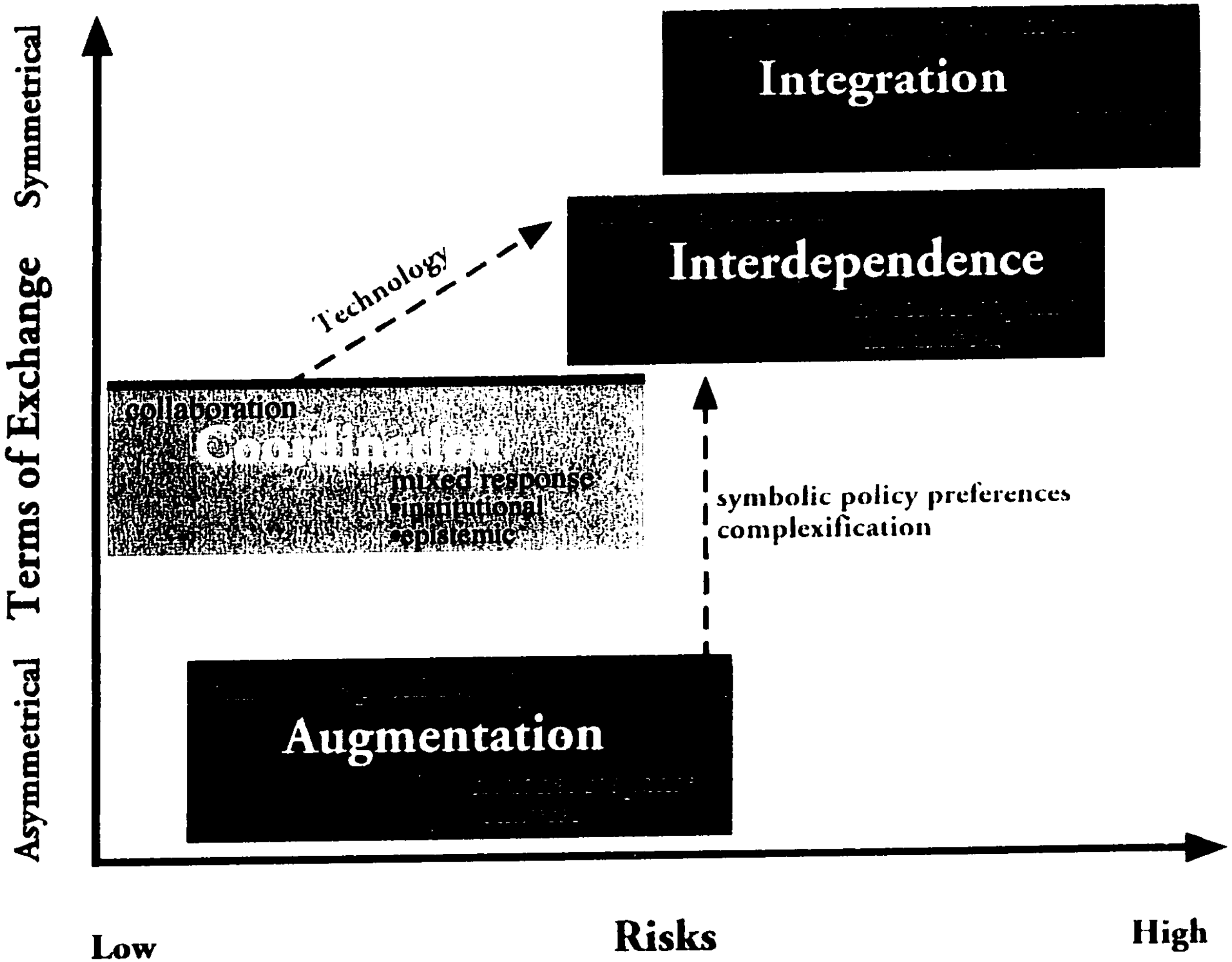

Figure 7. Specified framework of international space cooperation.

Terms of exchange and risks are underlying ordinal variables for coordination, interdependence and integration. These outcome-types are arranged ordinally along a continuum of values regarding terms of exchange and risks. This validates to an extent the ordinal arrangement of outcome-types that was assumed to exist. The one exception to this arrangement is augmentation. This finding may be attributable to the fact that since capabilities in space are distributed more equitably the ability for NASA to dominate a cooperative relationship is diminished. It also may indicate that augmentation may be an outlier form a historical standpoint. When functional and political conditions were favorable, augmentation was the preferred mode of cooperation for NASA, however, as conditions have changed this type of outcome has become less applicable. Clearly, changing conditions played a role in the multilateral and interdependent outcomes realized for Space Station and sought after by NASA for IEOS.

THEORETICAL IMPLICATIONS

The task of this section is to explore how the results and findings contribute to extant theories of international cooperation. Contributions are assessed by identifying a set of "crucial" variables that influence cooperative outcomes in international relations. There are a number of theories that are pertinent for this discussion, including realism, complex interdependence, institutionalism, functionalism and epistemic community theory.

Realism

Realism is concerned that cooperation produces an achievement of gains that reflects the distribution of power in international politics.[2] The link between cooperation and gains emanates from a realist focus on the state's power position and preoccupation with survival in an anarchic, self-help international system. This promotes the state to act in ways that prevent others from achieving advances in their relative power capabilities. Realists argue that since the state is concerned with the distribution of power resources, the willingness to cooperate, even when compatible preferences exist, is inhibited.

International space cooperation takes odds with this realist thesis. Augmentation, which is a direct result of power resources— technological capabilities, political power and institutional assets— distributed in NASA's favor, suggests that this factor promotes, rather than inhibits, cooperation. This is so because both NASA and its cooperating partners can realize important functional preferences. NASA, for example, has been able to structure cooperation by its functional policy preferences in a number of historical cases including SSF. These preferences ensure that NASA has a relative gain advantage over its partners by forbidding technology transfer, controlling critical path systems and preventing transfer of funds. As power resources in space capabilities become more dispersed internationally, which has been the trend, the ability for NASA to impose an augmentation outcome is reduced accordingly. The interdependent outcome that emerged for ISS is reflective of a shift in power that is characterized by a more equitable distribution of space capabilities and resources worldwide.

In addition to this shortcoming regarding the possibility that resource distribution patterns promote cooperation, realism ignores propensities for risk-taking. Augmentation is favorable because it is associated with low functional and operational risks. International space cooperation suggests that power (i.e., an asymmetric resource distribution pattern) becomes a means to a cooperative end— and not an end in-and-of-itself as realism asserts— that is made possible when initial conditions for cooperation are conducive to low risks. The more that these conditions favor functional preferences over politics (i.e., symbolic preferences) the greater the likelihood that risk is perceived to be low.

Complex Interdependence

Complex interdependence theory debunks the realist idea that states seek to maximize their relative power positions. Instead, power politics is replaced by issue politics. In issues demarcated by interdependencies, the state's concern about the distribution of power is unable to prevent cooperation from emerging. Interdependence involves linkages among states that engender cooperation resulting in state sensitivities and vulnerabilities.[3] Sensitivity interdependence is the price that one state pays for the actions of another. Vulnerability interdependence rests on the ability of one state to effectively deal with the actions undertaken by another.

These patterns are reflected in the functional and political interdependence that exists between the US and Russia with respect to ISS. NASA is sensitive to Russia's limited ability to fund and develop its critical infrastructural components for the Space

Station's core causing a price for cooperation paid in the form of delays. Since NASA is vulnerable to Russia's actions and ability to follow through on its obligations, it has had to deal with the problem by developing contingency plans (e.g., interim control module). This functional dimension of interdependence is exacerbated by a political one. In this sense, cooperative intergovernmental relations with Russia and US foreign policy in the post-Cold War era are sensitive to Russia's reliability as partner in space cooperation and vulnerable to the successful implementation of ISS.

Complex interdependence, however, fails to account for reasons as to why a state cooperates when high risk characterized by sensitivity and vulnerability is an inevitable byproduct. One reason is the complex nature of functional relations between states on certain issues such as the functional and operational interdependence that evolved over time for ISS. This implies that the greater the degree of complexification in cooperative relationships, the more that states are willing to assume the risks associated with interdependence.

A second reason is attributable to the roles that interdependent relations and risks play in bringing about a political outcome. Interdependence theory assumes that cooperation is inevitable and risk is a byproduct that states must cope with and adapt to. The experience of international space cooperation indicates that cooperative outcomes are not a direct consequence of interdependent relationships, but rather the distribution of power resources as expressed in terms of exchange and the propensity for risk-taking. ISS, for example, is characterized by the symmetrical terms of exchange and the use of risk as political quid-pro-quos to realize geopolitical preferences.

Institutionalism

Institutionalism is based on the premise that international institutions promote cooperation.[4] Institutions are a result of the formalization of social practices consisting of recognized functional roles coupled with clusters of rules or conventions governing relations among the occupants of those roles.[5] The distinctive political and organizational features of institutions enhance the ability to realize international agreements.[6] This includes promoting state concerns on a particular issue area, enhancing national policy and administrative state capacities and framing a common political and legal environment. In effect, international institutions foster multilateral relationships that provide the incentive structure for cooperative politics.[7]

The phenomenon of international space cooperation demonstrates that multilateral cooperation can take place in the absence of institutions. This implies that institutions may not be a "crucial" variable for multilateral cooperation as institutionalism predicts. A critical dimension is the degree to which compatible preferences can foster a common political and legal environment. The IGAs reached for Space Station in 1988 and 1998 are indicative of this. Further, IEOS failed as an institutional forum precisely because multilateral agreements entailing a common approach to issues were not realized.

Space cooperation denotes that states in multilateral relationships enter in contractual arrangements based on policy preferences that engender common understandings, rules and practices among each other. An important question that is pertinent and left unanswered by institutionalism, is why would states want to enter into multilateral relationships to begin with. One answer has to do with policy preferences that promote the achievement of absolute gains such as facilitating public goods and collective goals. This engenders a collective action norm into international decision-making processes enabling cooperation.[8] IEOS and the cooperation that has ensued in Earth observations from space are a result of science (i.e., Earth remote sensed data) being extended as a public and collective good.

A second answer may have to do with the preference to sustain the continuity of a particular normative framework rooted in a shared community of purpose.[9] Since the end World War II, the US has promoted a "multilateral preference" for arranging international relations.[10] This has been manifested in support of the United Nations, and multilateral trade and defense pacts. It is this "multilateral preference" as part and parcel of American strategic foreign policy interests that may explain why the US cooperated on the Space Station multilaterally.

Functionalism

Functionalism postulates that the state acting on its own is increasingly dysfunctional in a modern world of technology and complexity.[11] To remedy this dysfunctionality, functionalism prescribes the formation of functional institutions. This will take place, even if states do not deliberately intend to create institutions, because of problems arising from the impacts of technology, science and interdependencies that functional relations address in the first place. Functionalism embeds political divisions between states within a complex set of functional relations creating incentives for cooperation. The end objective is a subordination of national loyalties based on relative gains and power to transnational interests grounded in absolute gains and cooperative policies.

Such functionalist tendencies were present in IEOS. The problem of global change necessitated the formation of multilateral functional arrangements to ensure that scientific data to assess the problem would be readily accessible and available. Followed to its logical conclusion, functionalism would foresee the formation of an institution. The explanation as to why IEOS failed as an institution sheds some light on several shortcomings that may exist within the functionalist school-of-thought.

IEOS, despite its concern with functional matters, failed as an organizational framework because of political divisions. The implication is that functional problems on their own are not a sufficient basis for cooperation. Incentives for cooperation are a factor of both functional and political conditions. Neofunctionalists address this concern by claiming that politics creates incentives for the formation and proliferation of functional institutions.[12] Functional problems can still cause cooperation, but only if there are compatible political preferences.

An additional explanation relates to the issue of risk. The willingness to engage in functional relations is rooted in the perception of low risk. Coordination, as an outcome that promotes functional collaboration— but not institution building (i.e., integration)— is characterized by low functional and political risks. IEOS worked to the extent that risk remained low. Once the stakes were raised to a higher risk situation involving attempts to forge a multilateral institutional framework cooperation failed. The notion that risk affects the propensity for cooperative functional relationships is reinforced by the dearth of interdependent outcomes and functional institutions in international space cooperation.

Epistemic Community Theory

Epistemic communities are defined as knowledge-based groups that share common beliefs in the scientific method, cause-effect relations and political worldviews.[13] These communities are consensual and believe in transnational patterns of collaboration for sharing scientific and technical information. This process of cooperation involves epistemic communities as agents of sociopolitical learning on account of the knowledge they possess and apply. Since these communities often possess a cognitive monopoly on a certain range of complex scientific and technical issues, they can bring about policy learning on specific issue areas. This can catalyze international cooperation by persuading state-governments to adopt policy preferences that are congruent with an epistemic community's cause-effect claims and political worldviews.

Aspects of epistemic community theory are reflected in Space Station and IEOS. The ICWG of the Space Station Task Force and IEOS involved collaboration among epistemic groups of scientists and engineers in formulating mission designs. In both instances, coordination worked since it corresponded with multilateral and transnational forums for sharing information that are congruent with the political worldviews that epistemic communities hold. These communities were able to play a role in space cooperation because the monopoly on knowledge that they possessed engendered policy learning. The attempts to establish a coherent data exchange policy to facilitate global change research on the basis of "open skies" in the IEOS case, for example, influenced the prospects for cooperation not only for IEOS but also for NASA's Earth Science Enterprise.

Epistemic community theory seems well suited to explain dimensions of space cooperation when it corresponds with conditions favorable to a coordination outcome—equitable terms of exchange between cooperating partners that focus on issues of science. In instances where political issues of authority, decision-making and symbolic preferences become factors, the ability for these communities to influence outcomes diminishes. The failure of IEOS and the foreign policy drivers that compelled NASA to forgo its functional preferences for cooperation in the Space Station case illustrate this point. This implies that political conditions, in addition to science and technology, may be critical variables for inclusion within epistemic community theory.

An additional fault with epistemic community theory is the assumption that it is an autonomous force that can be distinguished conceptually from other political actors. The case studies show that an epistemic community role is dependent upon the extent to which state-governments allow them to be part of the cooperative policy process. Epistemic community influence is present in the coordination outcome since governments acquiesce. With the Space Station Task Force and IEOS, this was possible since no formal governmental commitments were present. This suggests that the role for epistemic communities is marginalized when governments become directly involved in the cooperative policy process. NASA's attempts to involve governments through multilateral agreement on IEOS marginalized the role that "Earth science" epistemic communities could have played in fostering a more successful outcome.

"Crucial" Variables

There are several "crucial" variables worthy of consideration for theories of international cooperation. These variables include (a) the distribution of power resources as expressed in terms of exchange among cooperating partners; (b) perception of risks; (c) compatibility of preferences; and (d) functional and political arrangements that are present in international relations. The asymmetrical distribution of power resources promotes cooperation by allowing for functional and political preferences to be realized. When political actors perceive low risk, the likelihood of cooperation is enhanced. Concomitantly, even in cases where risk is high, cooperation can be initiated and sustained by serving as a quid-pro-quo for functional and political concerns. The extent to which compatible functional and political preferences exist determine the feasibility of multilateral cooperative efforts. Last, both functional and political arrangements frame the possibilities for cooperation. These arrangements directly affect the distribution of power resources and perception of risk.

FUTURE RESEARCH

The late professor and astronomer Carl Sagan makes the case that political forces will largely dictate future missions in space. There exists a symbiotic relationship between technology, science and policy:

> The lesson to me seems clear: there may be no way to send humans to Mars in the comparatively near future, despite the fact that it is entirely within our technological capability. Governments do not spend vast sums just for

> science, or merely to explore. They need another purpose, and it must make real political sense.[14]

With this in mind, academic scholars can play a role in explaining political, economic, organizational, scientific and technological forces that determine space policy now and in the future. It is important to elucidate how space political processes work and what are the "crucial variables" influencing space policy outcomes in the US and abroad. This particular study identified variables that influence cooperative outcomes in space and looked at the implications of those variables on extant theories of international cooperation.

Future research is suggested in the following areas to enhance our understanding of international space cooperation:

•Systematic evaluations of additional case studies, including ones directly applicable to integration, should be undertaken to test for the plausibility of the candidate dependent variables (i.e., cooperation outcome-types) and framework of analysis.

•Additional case study evaluations should be used to better specify cooperation outcome-types, the dynamics of cooperation and the relationships between them.

•Findings and results of additional case study evaluations should be applied to search for cause-effect relations in international space cooperation.

•Independent and dependent variables characterizing cause-effect relations should be operationalized to empirically test for plausible models of international space cooperation.

The overall goal of future research efforts should be to develop a working model that can explain international space cooperation to sustain Missions for Exploring Space and Protecting the Earth. It is hoped that such a model could then be applied to ensure cooperative efforts in space— human-tended lunar base, human missions to Mars and continued efforts in spaceborne global change research— into the twenty-first century.

NOTES TO CHAPTER SIX

[1]It should be noted that augmentation as viewed from NASA's cooperating partners brings about functional dependence. This implies that the functional and operational workability of a cooperating partner's hardware contribution is dependent upon the particular NASA project to which it is enhancing.

[2]See Joseph M. Grieco, "Anarchy and the Limits of Cooperation: A Realist Critique of the Newest Liberal Institutionalism," *International Organization* 42, 3 (1988): 485-507.

[3]See Robert O. Keohane and Joseph Nye, *Power and Interdependence* (Boston, Massachusetts: Scott, Foresman, and Company, 2nd edition, 1989), 3-37.

[4]See John G. Ruggie, *Constructing the World Polity, Essays on International Institutionalization* (New York, New York: Routledge, 1998), 41-130.

[5]See Andreas Hansenclever, Peter Mayer and Volker Rittberger, *Theories of International Regimes* (Cambridge, England: Cambridge University Press, 1997).

[6]See Ruggie, *Constructing the World Polity*, 41-130; and Peter M. Haas, Robert O. Keohane and Marc A. Levy, eds., *Institutions for the Earth: Sources for Effective International Environmental Protection* (Cambridge, Massachusetts: MIT Press, 1993), 3-24 and 397-426.

[7]See James Caporaso, "International Relations Theory and Multilateralism: The Search for Foundations," in John G. Ruggie, ed., *Multilateralism Matters, The Theory and Praxis of an Institutional Form* (Ithaca, New York: Cornell University Press, 1993), 51-90; and John G. Ruggie, "Multilateralism: The Anatomy of an Institution," in *Multilateralism Matters*, 3-47.

[8]See John G Ruggie, "Collective Goods and Future International Cooperation," *American Political Science Review* 66, 3 (1972): 874-893.

[9]See Ruggie, *Constructing the World Polity*, 62-84; and John G. Ruggie, "International Regimes, Transactions, and Change: Embedded Liberalism in the Postwar Economic Order," *International Organization* 36, 2 (1982): 379-415.

[10]See Ruggie, *Constructing the World Polity*.

[11]See Ernst B. Haas, *Beyond the Nation-State: Functionalism and International Organization* (Palo Alto, California: Stanford University Press, 1964); and David Mitrany, *A Working Peace System* (Chicago, Illinois: Quadrangle Books, 1946).

[12]See Haas, *Beyond the Nation-State.*

[13]See Peter M. Haas, ed., *Knowledge, Power and International Policy Coordination* (Columbia, South Carolina, University of South Carolina Press, 1997).

[14]Carl Sagan, *Pale Blue Dot: A Vision of the Human Future in Space* (New York, New York: Random House, 1994), 268.

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