Perspectives on Improving United States International Space Cooperation

James D. Rendleman
USAF, Retired

and

J. Walter Faulconer
President, Strategic Space Solutions, LLC

This chapter was previously published in Space Policy, Vol 26 Issue 3, August 2010, p 143 under the title, "Improving international space cooperation: Considerations for the USA."

There is a powerful case to be made for the United States to conduct international space cooperation activities. In this chapter, we will discuss how cooperation allows a nation to leverage resources and reduce risk;

improve efficiency; expand international engagement; and enhance diplomatic prestige of engaged states, political sustainability and workforce stability. Unfortunately, although the case for international space cooperation is powerful, the obstacles and impediments to cooperation are substantial, and are manifested through various anti-collaborative behaviors. From a US perspective, cooperation is successfully achieved only after the undertaking and absorbing great expense, and understanding and confronting other obstacles and impediments. To that end, we will examine the challenges posed by technology transfer constraints, international and domestic politics, and exceptionalism perspectives. Finally, depending on the circumstances, four frameworks of cooperation can be employed to overcome these impediments: Coordination, Augmentation, Interdependence, and Integration. This chapter will detail these frameworks and their issues.

The Case for Collaboration

TABLE 1. FACTORS SUPPORTING INTERNATIONAL COOPERATION / COLLABORATION
Cost sharing – not enough money to go alone
Foreign policy goals – space cooperation is part of a larger package
Building political support
Insight into partner capabilities, approaches & plans
Expand scientific/instrument spaceflight opportunities – open the door to more launch opportunities for "ride-sharing"

Interest in international cooperation on space missions is not new. Successful elements of international collaboration have been around since the beginning of the space age. This sentiment to support international cooperation and collaboration is growing. The factors driving a desire for international cooperation are shown in Table 1. Reflecting the desire, the new United States National Space Policy declares international cooperation to be among its key goals, stating in pertinent part:

> "[T]he United States will pursue the following… in its national space programs:… Expand international cooperation on mutually beneficial space activities to: broaden and extend the benefits of space; further the peaceful use of space; and enhance collection and partnership in

sharing of space-derived information."[1]

The new National Space Policy is striking — it expresses strong interest in cooperation throughout the document, and more so than in past policy declarations. As we will discuss, there is considerable justification for this emphasis. The hope and desire in international projects is that one plus one will equal three—that the diverse resources, skills, and technologies of the partners will achieve synergy, adding up to more than the sum of their parts.[2] NASA, commercial, and Europe space activities have already achieved considerable success with their cooperative efforts.

NASA

As an institution, NASA believes in the promise of cooperation. Indeed, its Administrator, Charlie Bolden, has announced that greater international cooperation is coming, affirming "[t]hat's what the president wants to do, and he didn't have to tell me that, because that's what I've been doing all my life." NASA has had a long-standing emphasis on cooperation, as more than half of its forty-two ongoing space and Earth science missions have international participation. Of missions it has under development, nearly two-thirds involve international contributions and participation. Much of the astronomy and astrophysics community is pleased to see NASA leveraging and expanding international investments in its great science enterprise.[3]

Commercial

A trailblazer in international commercial space cooperation, the International Telecommunications Satellite Organization (INTELSAT) has achieved great success. INTELSAT began in 1964 with 11 participating countries; INTELSAT launched the first commercial international geosynchronous communication satellite the following year. By 1973, there were 80 signatories (member nations of INTELSAT), and the organization was providing service to over 600 Earth stations in more than 149 countries, territories, and dependencies.[4]

---

1 National Space Policy of the United States of America, Fact Sheet, June 28, 2010, p. 4.

2 See "International Cooperation: When 1+1=3", Toshifumi Mukai, ASK Magazine, NASA, Summer 2008, pg. 8.

3 Remarks by Shana Dale at AAS/AIAA Seminar on the Importance of International Collaboration in Space Exploration, Nov 1, 2006.

4 Ryan Zelnio, "A model for the international development of the Moon," The Space Review, December 5, 2005.

INTELSAT's early substantial financing came from participating national governments. It developed none of its own hardware; instead, INTELSAT purchased system capabilities from global aerospace commercial companies.[5] By the end of the 20th Century, its resource sharing and administrative scheme helped launch and usher in a huge global telecommunications market era. Commercial entities involved in entertainment, news, Internet, government services, and other telecommunications services now spend more on space than all the world's governments combined. With its early quasi-governmental and tax-exempt aspects, complaints arose from competitors, and INTELSAT was pushed to evolve into a purely commercial entity in 2001, Intelsat, Ltd., and it continues to thrive and expand.[6]

Europe

The nations of Europe have developed the European Space Agency (ESA) to pursue space activities. It currently has eighteen member states, and integrates countries and their respective space programs to work collaboratively toward common goals.[7] Since 1975, ESA has focused on supporting commercial companies within Europe, doing this by investing in and developing technologies to enable it to compete in the global space market.

---

5 Ibid.

6 Recently it consolidated its global dominance in satellite communications by acquiring rival PanAm Sat.
"During the 1990s, there was considerable criticism from new commercial satellite companies focused on the difficulty of competing against an organization with INTELSAT's advantages. The Open-Market Reorganization for the Betterment of International Telecommunications (ORBIT) Act, which was enacted in 2000, provided for sanctions to be imposed upon INTELSAT if it did not privatize in a manner consistent with the terms of the act. On July 18, 2001, INTELSAT transferred substantially all of its assets and liabilities to Intelsat, Ltd.—a holding company incorporated by INTELSAT under the laws of Bermuda—and its wholly owned subsidiaries. By so doing, INTELSAT lost its tax-exempt status, along with other privileges it had been granted as an international organization and under international agreements." "Tax Policy: Historical Tax Treatment of INTELSAT and Current Tax Rules for Satellite Corporations," GAO-04-994, September 2004, p. 1.

7 ESA is not an agency or part of the European Union (EU) and has non-EU nations as members, though some think that ESA is the de facto space agency of the EU. There are ties between the two and the member states, and moves are afoot to better define the status of the ESA with respect to the EU. As security dimensions to European space activities grow, some believe ESA will become more fully integrated into the EU governing structures.

ESA

> The United States has made clear that it does not seek to "dominate" space and, in fact, has led the way in securing international cooperation in this field.
>
> Letter from President Lyndon B. Johnson
> May 13, 1963

The European joint venture began in earnest once its founding nations concluded they had no other alternative but to cooperate. Other than France, Germany, Italy and the United Kingdom, individual nations in Europe are generally too small to individually develop a sound and comprehensive space program. The ESA confederation has leveraged resources and proven valuable to its members. Reflecting on this, Jean-Jacques Dordain, Director General of ESA, has stated: "…after more than 30 years we are glad to cooperate because we learned that beyond the difficulties of cooperating, there is the success of cooperating. We know now that it is always easier not to cooperate, but that it is always more difficult to succeed alone."[8]

ESA's complex governance structure has worked; it has rationalized European space efforts, usually allocating expenditures among members based on their relative technical strengths. It has also helped foster standardization and interoperability among Europe's space systems. This success, however, has not always been easy. Member nations have had to reconcile their industrial space priorities with those emphasized by ESA's leadership. The priorities may differ. Mutually destructive squabbles have generated problems. ESA's spending priorities have been criticized; some sniff that expenditures made the framework unfairly favors French, German, and Italian interests in spending; then again, these nations are also among its larger contributors. France's space agency receives a budget which is double the amount it contributes to ESA. However, without the ESA funding framework, France arguably would never have been able to resource the immense Ariane rocket system and fund development of the French spacecraft buses used by Europe's EADS Astrium and Alcatel Alenia Space. Cooperation has been a tremendous boon to France's national space aspirations, as well as for the rest of Europe. ESA has created an environment for space activities in which a wide variety of European consortiums and industrial concerns are able to participate.

The NASA, commercial and European space successes in

---

8 Jean-Jacques Dordain, "International Cooperation in Space," remarks at 40th Anniversary of the Universities Space Research Association (USRA), March 26, 2009.

international cooperation have a number of bases. International cooperation allows states to leverage resources and reduce risk; improve efficiency; expand international diplomatic and other engagement; and enhance prestige of engaged states, political sustainability and workforce stability.

Resource and risk sharing

Cost motivations dominate the calculus on whether a state or commercial entity should engage in international space efforts. Why? Most space endeavors are terribly expensive and capital intensive, and as a result, are highly debated, especially the returns on investment, except in the most authoritarian states. International cooperation offers the potential to reduce the burdens to gain access to space by even the poorest of nations.

With cooperation, a spacefaring state can draw in outside resources. Given the large costs involved in accessing the space domain—satellite system research, concept development and system design, manufacture, launch and operation—cooperation is needed by all but the largest spacefaring nations. Cooperation spreads the resource investments and expenditures among nations and entities. Cooperation also reduces exposure by spreading the risk of failure. Per-partner utility of international cooperation invariably increases as per-partner costs decrease.[9] There is therefore a strong incentive to engage in cooperative activities when they provide this savings and leverage. This is especially compelling for nations whose resources are insufficient to achieve any substantial space operational and technical goals. As an example of this reality, even ESA has engaged the United States and Japan to join them in what were previously traditional European-only science missions as a way to rescue the European mission portfolio from increased cost growth.[10]

Efficiency

International cooperation offers the opportunity to improve the efficacy of expenditures, which is a significant cost consideration. With cooperation, resources can be rationalized, standardized, and made interoperable to bring about the best and most efficient use of research,

---

9 D. A. Broniatowski, G. Ryan Faith, and Vincent G. Sabathier, "The Case for Managed International Cooperation in Space Exploration," Center for Strategic and International Studies, Washington DC, 2006.

10 "Fighting Inflation, ESA Science Candidates Pushing the Cost Curve Could be Saved by U.S. and Japanese Roles," Aviation Week and Space Technology, December 7, 2009, Pg. 46.

development, procurement, support, and production resources. Cooperation can also foster more effective operations. Thus, if a hypothetical space partnership involves two nations, one with sophisticated remote sensing engineering capabilities, and the other, spacelift, a rational approach would allocate program activities in accord with these strengths. As an example of this allocation, the two primary instruments to help locate water and other resources, onboard Chandraayan, India's first satellite to the Moon, were contributed by the United States. Incredibly, the US payloads cost more than what India spent building and integrating the launch vehicle and the balance of the spacecraft. Still, the United States benefited because it saved on its launch costs and was able to join in India's scientific mission to the Moon.

International cooperation can rationalize resources and provide for much needed programmatic redundancy. For example, following the 2002 loss of the Space Shuttle Columbia, the International Space Station (ISS) program was able to continue on track by leveraging the transportation capabilities of the Russian Soyuz spacecraft system. Without this, the ISS program could have failed in the midst of the second extended US space shuttle program's mission stand-down.[11] Programmatic redundancy can reduce per-partner cost by creating a higher net reliability than that would otherwise result by depending on a single resource provider.[12]

Standardization of hardware, software, procedures, and the like also helps achieve close practical cooperation among partners, and improves programmatic efficiency. This enables an efficient use of resources and reduction of operational, logistic, technical, and procedural obstacles. International partnerships usually begin their efforts by standardizing administrative, logistic, and operational procedures, and originators of standardizing systems and procedures often become the de facto leaders of collaborative efforts. It is for these reasons that the United States, and sometimes the Europeans, exercise leadership among cooperating major spacefaring nations by defining standard interfaces for space systems.[13]

Finally and closely related to standardization, interoperability is essential. "Designing for programmatic redundancy provides a strong argument for interoperability between nations' space exploration assets, as this would allow nations to substitute each other's critical capabilities with

---

11 The other stand-down began in 1986 after the explosion of the Space Shuttle Challenger.

12 D. A. Broniatowski et al., "The Case for Managed International Cooperation…," supra.

13 Ibid.

relative ease."[14] Nations whose space systems are interoperable can operate together more effectively. Designing for interoperability enables spacefaring partners to substitute each other's critical capabilities with relative ease.[15] This also provides much needed redundancy in event one nation cannot supply a key service or component for any number of reasons.

In the end, rationalization, standardization and interoperability provide important capabilities. Space programs can use them to: efficiently integrate and synchronize operations; enable data and information exchanges; share consumables and resources; enhance effectiveness by optimizing individual and combined capabilities of equipment; increase efficiency through common or compatible support and systems; and assure technical compatibility by developing standards for equipment design, employment, maintenance, and updating them. With rationalization, standardization, and interoperability, nations that are likely to join a partnership can better prepare to perform their respective responsibilities.

Figure 1. *US President Barack Obama escorts Indian Prime Minister Manmohan Singh to a White House meeting.*

International Engagement

International cooperation on space activities presents a unique opportunity to develop dependencies among nations that may obviate conflict. Such cooperation may foster the understanding, and, indeed, friendship, that can reduce the perceived need to prepare for doomsday scenarios where one imagines or projects the technologies that an adversary could develop, regardless of the technical merit or reality of the paranoia.

International cooperation now extends to a whole range of scientific endeavors. This sharing and cooperation among space programs harkens back to the best spirit and intentions of the Outer Space Treaty, in which

---

14 Ibid.

15 Ibid.

the preamble calls for space to be used for "peaceful purposes."[16] This objective has been the hope expressed by many nations since the beginnings of the space era.

> "The space program plays a positive role in enhancing American influence and prestige, especially with our Pacific and European allies… It also serves to demonstrate America's continuing commitment to technological, economic and political leadership. The space program is an excellent vehicle for cooperation with longstanding allies, such as Western Europe and Japan, and for the development of new ties to Eastern Europe and the Soviet Union. Space cooperation with the Soviet Union…can play a positive foreign policy role by contributing to better East-West relations…."
>
> "State Department Helps US Space Program Meet Future Challenges," State Dept. Dispatch, Reginald Bartholomew, Under Secretary for International Security Affairs, December 24, 1990.

The full realization of cooperation's promise began to be more fully realized with the end of the Cold War. Space and Earth science research and space exploration activities were no longer bound and subjugated by an overarching competition between two superpowers. Capitalizing on the opportunities and leveraging the expertise of other nations, the global scientific community rushed into the new post-Cold War, multi-polar world creating numerous international space alliances and partnerships.[17]

The United States is continuing this trend by reaching out to large global space (and nuclear) powers like India and China, both growing economic and engineering powerhouses, in the hope such engagement shapes their future space and engineering activities in positive directions. Reflecting on the growing spirit of collaboration, President Barack Obama and India Prime Minister Manmohan Singh agreed November 24, 2009 to expand cooperation to civil space, less than a week after Obama returned from Beijing, where he and Chinese President Hu Jintao pledged to expand dialogue between US and Chinese space agencies.

---

16 See generally, Treaty on Principles Governing the Activities of States in the Exploration and Use of Outer Space, including the Moon and Other Celestial Bodies, other known as the Outer Space Treaty (1967). Article III of the Treaty declares that states parties must conduct their space activities "in the interest of maintaining international peace and security." The treaty's preamble also recognizes "the common interest of all mankind in the progress of exploration and use of outer space for peaceful purposes."

17 Approaches to Future Space Cooperation and Competition in a Globalizing World, National Research Council, 2009, pg. 1.

Diplomatic Prestige

Cooperation provides opportunities for a nation to demonstrate its organizational, educational and technical prowess. For example, India has used its recent launches to host payloads from a number of international partners, and has been recognized for leadership.

South Korea is leveraging Russian launch technology in attempt to join the small and select group of nations that have successfully launched and orbited satellites. This cooperation is an important part of fulfilling a national dream to become a "top ten" space fairing nation. Russia and China work with much of the global spacefaring community to launch satellites.

Ultimately, support for cooperation and collaboration increases when the perceived utility and diplomatic prestige derived from cooperation increases. A demonstration of the utility and diplomatic prestige gained from space cooperative endeavors can be seen in the 1975 Apollo-Soyuz space link-up, the 1995 Space Shuttle - Mir docking, and ISS programs. According to James Oberg, these programs' true and complex diplomatic utility was not made apparent for many years:

> Only with the Soviet program at a standstill did Moscow agree to fly a joint orbital mission. Its fallback position was that if it couldn't be Number One in space, it could at least pose as the equal partner of the new Number One, the United States. It was better than letting on how far behind its space program had fallen.
>
> The cooperation resumed only as the USSR was collapsing in the early 1990s. Shuttle-Mir and the critical role of Russia in the International Space Station were enabled by the rise of a freer, more democratic Russian society, not by inertia from decades-old space handshakes.[18]

Political Sustainability

International cooperation provides a wonderful capacity to increase a nation's political will to sustain and fund space programs and associated budgets. As noted, cooperation provides a spacefaring state the basis to draw on additional resources when its own are not adequate to achieve desired space goals and visions. Cooperation also enables a space programs to hunker down and increase chances to survive attempts to be reined in even when faced with contentious and devastating cost-growth or budget realities (something nearly all space programs invariably face). Thus, within the United States, a civil space program can usually win a bit of

[18] James Oberg, "The real lessons of international cooperation in space," The Space Review, July 18, 2005.

sanctuary from cancellation threats or significant budget reductions to the extent that Congress and the administration feel compelled to not break, stretch, or withdraw from international agreements the program is associated with.

Significant political good will is often generated by funding these programs. To find an example of the power of this good will, one only need look to the politics surrounding NASA's manned programs. Money has continued to be allocated to the program even when the perceived justification for a substantial or expansive manned program has collapsed. Similarly, some argue the political and diplomatic integration of Russia into the ISS program may well have saved the ISS and Space Shuttle programs from cancellation.[19] The pressure to continue international cooperative efforts is often tremendous.

Once cooperation has commenced, canceling a program becomes inconsistent with political sustainability as long as the utility cost associated with the loss of diplomatic benefits and the negative effects on reputation of terminating an international agreement is larger in magnitude than the utility cost that must be paid to maintain the system… The corollary to this is that there is a high cost to be paid by any nation that chooses to unilaterally withdraw from an existing cooperative endeavor. This cost comes in the form of damage to the departing nation's reputation or credibility. In general, any unilateral action sends a signal that the actor is an unpredictable and therefore an unreliable and possibly disrespectful partner. This tends to sabotage the possibility of future cooperation. As such, there is a long-term benefit to maintaining cooperation, even when the immediate cost may seem to call for terminating it.[20]

Of course, if significant cooperation has never occurred, commencement of a new or improved relationship is thought to be a defining moment, delivering specific political rewards and diplomatic utility. This is why the pronouncements on space cooperation made by President Obama and Chinese officials during his November 2009 visits have been watched with special interest. The same attention is being paid to the overtures made with the Indian government and its space community.

---

19 In the year before Russia was introduced as a partner, the ISS was saved by a single vote in Congress. See D. A. Broniatowski et al, "The Case for Managed International Cooperation…," supra.

20 D. A. Broniatowski et al, "The Case for Managed International Cooperation...," supra.

Obstacles: If international collaboration makes sense, why is it so difficult to achieve?

TABLE 2. Barriers/Factors Detracting from International Cooperation
Expense
National pride, prestige
National security
Economic development
Complexity - different languages/cultures make complex projects even more difficult
Government vs. commercial interest

International civil space cooperation is admired as a noble and worthy goal, but space program managers confront a far different reality from that facing the diplomats and national policymakers as they seek to shape such efforts. Hopes for cooperation can be overwhelmed by competing interests and priorities, and also reduced or constrained by budgets. These anti-collaborative behaviors and factors shown in Table 2 are demonstrated by two cases.

Case 1

"Fly me to the moon": Over the last several years five different spacecraft have been sent to the moon by the United States, European Space Agency, China, Japan and India; each mission essentially has performed the same basic science missions.[21] Expenditures for these repetitive efforts totaled between $2 and 3 billion dollars. More astounding, scientific data from several of the missions hasn't been shared. Were these just expensive stunts—or better characterized as lost opportunities? Perhaps better science

Myth :
- International cooperation saves money

Reality :
- It costs time, manpower, and other resources to deal with partners
- There are significant obstacles and impediments to international partnerships

[21] See for example, India – Chandrayaan; Europe – Smart-1; China – Cheng'e; United Kingdom – MoonLite; Russia; Japan – Selene.

and exploration could have been achieved if these activities had been consolidated into a single mission, with the excess funds spent on other scientific objectives. Now we hear the South Koreans, Brazilians, Iranians, and others want to launch their own moon missions; the rationale for these moon missions are draped in the words of great tribal patriots, and described in hushed reverent tones, emblematic of the best expressions of national pride.

Case 2

"Up, up, and away": The international launch market is well over capacity for launching the current and foreseeable demand for communications, remote sensing and navigation satellites. Yet eight different countries continue to subsidize their own launch capability and other nations are developing their own launch capability. The United States prohibits US civil and commercial spacecraft from being launched on Chinese launchers. The European Space Agency demands that European satellites be launched on the Ariane launch vehicle. These directions are driven by important national or regional interests. However, there may be no easy way to foster improved international cooperation if such "protectionist" behaviors stand in the way.

Of course, regardless of the potential for success, the cynic knows that a nation's decision to engage in space cooperation is very much a political decision. Nations pick and choose if, when, where, and how they expend their national treasure. They choose the manner and extent of their foreign investments for reasons both known and unknown to other nations. Most states make their choices based on perceptions of their own national interests. The only constant is that a decision to "join in" cooperation is, in every case, a calculated political decision by each potential member of a commercial partnership or alliance, or inter- or quasi-governmental structure. Indeed, large private commercial investments are nearly always controlled at a national level, usually by the force of domestic (municipal) law, regulation, or licensing.[22]

National decision-making influences and shapes commercial and government entity governing structures. Accordingly, some space capabilities will be funded, developed, and offered, if and only if, they are strictly operated and controlled under specific national direction and within

---

[22] The Outer Space Treaty and associated Convention on International Liability for Damage Caused by Space Objects(1972) also known as the Liability Convention provide an underlying basis for this regulation, to address liability issues of launching states arising out of their activities.

strategic national guidelines. Reflecting these interests, military space cooperation tends to occur only when overarching national security military and intelligence community interests are satisfied. In contrast, international civil cooperation generally wins internal national political support for a different set of reasons: that is, if the cooperation generates national diplomatic prestige, provides for political sustainability, or enables workforce stability.[23]

The obstacles and impediments to cooperation are substantial. They include cost, technology transfer constraints, international and domestic politics, and exceptionalism perspectives.

International cooperation can be too expensive. Despite desires to save money, international cooperation successes are often secured only at a tremendous expense. For example, one can point to the ISS as a stunning blend of international politics, technology, and cooperation. While the ISS' research capabilities and benefits have been much ballyhooed and trumpeted, the system has turned out to be a very expensive offering on the altar of international cooperation. Billions of dollars have been squandered on it. The ISS success has been forged only at the detriment of other much more scientifically productive projects such as robotic spacecraft missions, space exploration, and aeronautics science and technology programs. Unfortunately, very little scientific research on the Station has been planned and executed.[24] The technical deficiencies in the ISS design limit its utility. The station has a need for high levels of dangerous and risky, crew-based maintenance, accomplished via recurring extra-vehicular activities (spacewalks). The high inclination of the station's orbit has also led to a higher cost for US-based Space Shuttle launches to the station.[25]

The need to support the ISS has gobbled up moneys needed by other programs, and at the same time helped justify continuing other NASA

---

23 D. A. Broniatowski et al., "The Case for Managed International Cooperation…," supra.

24 "The world's most expensive scientific laboratory installed additional solar panels yesterday, capable of producing 100 kilowatts or so of additional power for experiments. The panels cost $372 million to build, and about three times that much to send up to the ISS. Stand by for important new results. The only unique feature of a space environment is micro-gravity. One of the things you could study in micro-gravity is cavitation in spherical drops of water. A paper just published in Phys. Rev. Lett. reports important new insights from such studies except the experiments weren't done in space. They were done on a European Space Agency aircraft flying in parabolic arcs." Robert Park, "Space: International Space Station Unfurls New Solar Panels," What's New, September 15, 2006.

25 The U.S. space shuttle launches were used to support heavy lift requirements, bringing up key elements to the station during its construction.

programs that provided only marginal value for the investment. For example, during the 1990s, to continue its success in obtaining funding for the Shuttle program and manned spaceflight, NASA switched from funding rationales that argued the reusable Shuttle spacecraft provided flexibility and cost savings to new ones that emphasized that the system was vitally needed to service and supply the ISS. This funding strategy had the unfortunate effect of siphoning off staggering amounts of moneys that could have been used to fund cutting-edge astronautics and aeronautics science and technology programs. Senior technologists within NASA saw the damage that was being done to its science and technology portfolio but could do little to fight the machinations of the manned spaceflight cabal.

Had NASA abandoned the Shuttle program, declined to help form the ISS as it was conceived and is being executed, and instead flown traditional government and commercially available expendable boosters, significant and draining spending might have been avoided, or, more realistically, better used. This would have freed the then unused funds for other initiatives and perhaps spawned a more balanced, scientifically-based civil space program.[26] Similarly, by using expendable rocket options, the US domestic commercial booster industry could have been stimulated, with more resources directed to lowering the cost of space access.[27]

First Launch	Country
1957	Russia
1958	United States
1970	Japan
1970	China
1979	European Space Agency
1980	India
1988	Israel
2009	Iran
soon	Brazil

26 See generally, "Criticism of the Space Shuttle program," Wikipedia, the free encyclopedia, http://en.wikipedia.org/wiki/Criticism_of_the_Space_Shuttle_program, citing Roger Handberg, Reinventing NASA: Human Spaceflight, Bureaucracy, and Politics, Greenwood Publishing Group (2003).

27 Ibid. See also Launius and Howard E. McCurdy, Spaceflight and the Myth of Presidential Leadership: and the myth of presidential leadership, University of Illinois Press. (1997), pp. 146–155.

As it turned out, Space Shuttle features that have been argued and described as vital to the ISS support have proved superfluous. The Russians have demonstrated that its expendable launch vehicles and unmanned supply systems have sufficient flexibility and robustness to sustain much of the station's needs.

In response to some of these arguments, true-believers for manned space activities argue that criticism of the ISS is plainly short-sighted. Some of these proponents are satisfied proffering a minimalist argument that just achieving human spaceflight is a singular wonderful end in itself. More pragmatic advocates countenance a more balanced view that manned space research and exploration, and the international cooperation efforts, have produced billions of dollars' worth of tangible benefits for all of mankind. Indeed, NASA's Innovations Partnership Program distributes a wonderful and glossy annual report, Spinoff, that trumpets and celebrates space technologies that, "through productive partnerships with industry, entrepreneurs, universities, and research institutions have resulted in products and services that elevate health and public safety; augment industrial productivity, computer technology, and transportation; and enhance daily work and leisure."[28] NASA argues the many benefits and indirect economic return from spin-offs of human space activities has been many times the initial public investment. These claims are not without their detractors; the authors only remember drinking Tang™ as an orange juice substitute during their childhood.[29]

Other US space programs with significant international content, such as the James Webb Space Telescope (JWST), suffer resource and expenditure problems. ESA will provide the Ariane V launcher to lift the JWST to orbit, instead of a domestically produced Evolved Expendable Launch Vehicle (EELV) nominally procured through the United Launch Alliance.[30] Launching on the Ariane V was originally intended and

---

28 Spinoff, National Aeronautics and Space Administration, 2009, p. 7.

29 Of course, let's be honest. The authors would probably feel differently about Tang if they were selected for service with the astronaut corps. Yum!

30 The JWST is a partnership between ESA, NASA and the Canadian Space Agency. Formerly known as the Next Generation Space Telescope (NGST), the JWST is due to be launched in August 2013, and it is considered the successor of the NASA/ESA Hubble Space Telescope. The ESA financial contribution to JWST will be about 300 million Euros, including the launcher. Other European institutions will contribute additional Euros, all in return for flying the Mid Infrared Camera Spectrograph (MIRI) payload. According to a formal agreement, ESA will manage and co-ordinate the whole development of the European part of MIRI and act as a sole interface with NASA, which is leading the JWST project. MIRI will be built in cooperation between Europe and the United States (NASA),

described as a way to help NASA avoid costs. Unfortunately, the expected savings will never materialize. They have been lost because the JWST prime contractor did not contemplated use of the Ariane system. As a result, costs to integrate the JWST on that launch system have skyrocketed.[31]

Though cited approvingly in this paper, the admirable success enjoyed by ESA has not come cheap. The Ariane V spacelift system, while proficient, is very expensive to build, sustain, and push through a launch campaign. Of course, getting the 18 member governments of ESA to set common objectives, pool resources and make their industry work together has been a never ending task. Wise space professionals know the reality behind the motivation for Europe's cooperation— much of ESA's successes are really about ensuring full employment within Europe, especially among France's aerospace workforce.

Finally, the costs associated with terminating cooperation can be huge. Such moves can risk alienating key allies.[32] This all serves as a logical consequence to the rule that cooperation improves a program's political sustainability and the space community's workforce stability. There is no easy way to back out of cooperative relationships once they have been initiated.[33] The end result of this is that one may choose to endure the high price and continue even failed cooperative efforts.

---

both equally contributing to its funding. MIRI's optics, core of the instrument, will be provided by a consortium of European institutes. In addition to MIRI, Europe through ESA is also contributing the NIRSPEC (Near-Infrared multi-object Spectrograph) instrument.

31 The program's funding crisis surfaced when Northrop-Grumman advised NASA that it would need an additional $270 million to make changes to the program as requested by the agency. Those changes included adjustments to the telescope's instrument module and ground test equipment, Mohan said. NASA had also advised Northrop-Grumman to plan to launch Webb on a European Ariane 5 rocket rather than a U.S. Evolved Expendable Launch Vehicle. In the case of Webb, "changing one thing tends to ripple more than it does on other programs," Mohan said. Ben Iannotta, "Webb Telescope Cost-Control Effort Focuses on Schedule, Requirements," Space.com, August 22, 2005, https://www.space.com/spacenews/archive05/Webb_082205.html.

32 Such happened when the United States nearly a decade back suspended an exception to the International Trafficking in Arms regulations (ITAR) that Canada enjoyed for many years. The exemption was only regained after considerable effort by the Canadian Government.

33 "If it were necessary to cease cooperation, a mutual choice to do so would likely mitigate many of the negative reputation effects, because there would be no unilateral actor to whom one could assign blame." D. A. Broniatowski et al, "The Case for Managed International Cooperation…," supra.

Technology transfer constraints

Designing, manufacturing, and operating increasingly interoperable platforms, performing cooperative planning, and executing satellite operations are complicated by US law and policy that imposes controls on the release of sensitive technologies and operations. Indeed, important technologies and information relating to some space operations and technologies are often determined by the US government to be non-releasable, even to allies and close partners.[34] This is not just a US phenomenon; other nations have their own laws and policies that clamp down on technology transfers and specific relations with other nations.

> "Politically and technologically, the United States could gain from leading an international cooperative program to advance in space exploration. But for such a space program we will have to learn how to pursue 'shared' goals, which would give the United States less latitude in setting the program objectives…"
>
> Exploring the Moon and Mars: Choices for the Nation, Office of Technology Assessment, July 1991

Important portions of US technology transfer "releaseability" law and policy arise out of the Arms Export Control Act (AECA).[35] The AECA governs the sale and export of defense articles and services and related technical data, and serves as part of a statutory scheme to ensure compliance with technology control regimes. The regimes seek to slow the proliferation of missile and other technologies used to deliver weapons of mass destruction. Designated controlled articles, technologies and services are identified in the US Munitions List (USML), which is contained within the fearsome International Traffic in Arms Regulations (ITAR). Under the AECA, spacecraft, space related articles and services are specifically designated to be subject to export control. Exports of space articles, services and related technical data must therefore meet US national security interests. Proposed recipients must offer assurances they will protect them before transfers are made. Approvals usually require substantial paperwork and training.

Unfortunately for the United States, the export and technology control rules are driving small suppliers out of the export marketplace as they lack the economies of scale to properly respond to legal requirements.

---

34 Other nations also secure their technologies for comparable diplomatic, military and economic reasons.

35 See Arms Export Control Act of 1976, Section 38, as amended, P.L. 94-329. The AECA's 22 U.S.C. § 2778 provides the authority to control the export of defense articles and services.

This is damaging US economic security interests since small companies are usually the engine of innovation within the US economy and especially its space community. International partners are also wary of the legal rules and procedures. Nearly all members of the space community, foreign and domestic, find that the AECA rules are quite burdensome and onerous. The requirement for the assurances, and the threat for US criminal liability and prosecution arising out of them, is generally agreed to have cost US industry billions of dollars in sales in the international space marketplace. The US communications satellite industry is losing significant market share to international competitors who claim their systems, products and services are "ITAR-free."

Of course, other US laws, regulations, and policies apply to exports of space data, hardware, and services.[36] The new administration and the Congress are reviewing them along with the AECA releasability rules. Some believe the President will push approvals for some transfers back to the Commerce Department, where approvals were issued for communications satellite technology transfers until the Chinese scandals of the late 1990s.[37]

Volatility in international and domestic politics

National political processes can bring uncertainty to international agreements. For example, in 2004, President George W. Bush unveiled his Vision for Space Exploration, which put a near-term emphasis on returning

---

36 See generally, National Security Decision Memorandum (NSDM) 119, "Disclosure of Classified United States Military Information to Foreign Governments and International Organizations" and Executive Order (EO) 12958, "Classified National Security Information," April 17, 1995, as amended by EO 13292, "Further Amendment to EO 12958, as Amended, Classified National Security Information," March 25, 2003, and by other executive orders.
See also, the Export Administration Act of 1979, P.L. 96-72. The Export Administration Act of 1979 (EAA) governs the export of most dual-use unclassified articles and services (having both civilian and military uses) not covered by the AECA. The EAA controls exports on the basis of their impact on national security, foreign policy, or supply availability. With the expiration of EAA in 1994, the President declared a national emergency and exercised authority under the International Emergency Economic Powers Act (P.L. 95-223; 50 U.S.C. 1701 et seq.) to continue the EAA export control regulations then in effect by issuing EO 12924 on August 19, 1994.

37 See Final Report of the Select Committee on U.S. National Security and Military/Commercial Concerns with the Peoples' Republic of China, May 25, 1999 (the Cox Report). Technology transfer abuses identified within the Cox Report caused the Congress to tighten space systems export rules in with the Strom Thurmond National Defense Authorization Act, Fiscal Year 1999, P.L. 105-261, October 17, 1998.

humans to the moon. International partners, especially in Europe did not immediately adopt this policy because they were more interested in performing Mars missions. However, after four years of international workshops, bilateral meetings, then intense hectoring and haggling, a collective "global vision" was forged with the US prospective partners, especially ESA. ESA then cajoled its members to support the Vision. Then, just as ESA was announcing that its membership had synched its planning and programming roadmap to match the Bush Vision, the United States led by a newly elected internationalist President, announced interest in a radically different space vision, that is, the one recently identified and described by the Augustine committee. The United States has now abandoned the Vision's "lunar base" concept and moved to a "flexible path" to manned space exploration. The change devastated the ESA partners.

Similarly, after the fall of the Soviet Union, US companies were encouraged to work with Russia to help them on their course to capitalism. The US Government was motivated to ensure the Russian scientists and engineers were working on non-threatening, yet productive, activities. When the RD-180 Russian rocket engine was selected by Lockheed Martin to serve as the first stage engine for their new Atlas V rocket as part of US Air Force's EELV program, US Congress hailed the choice as a great achievement in international cooperation. Several years later, however, when the Atlas V was being looked at as a launch vehicle to support human missions to the ISS, NASA was criticized for considering a vehicle with Russian engines. The new-found opponents to the RD-180 decried the possibility that Russia could stop selling the engines to the United States; they argued that US designed and manufactured engines should be selected.

The volatility problem cuts both ways in terms of US partnerships — not all partners work predictably with the United States. For example, NASA Administrator Sean O'Keefe cancelled the Crew Return Vehicle (CRV) initiative in 2001 after explaining it was cheaper in the long run to buy Russian Soyuz capsules as escape pods for the ISS, instead of investing $1.5-3.0 billion to develop and build a US rescue capability.[38] Once the Space Shuttle program came to an end in 2011, the United States was obliged to rely on the Russians to transport astronauts to the ISS for at least

---

[38] Hearing Addresses NASA Budget Request, Shuttle Investigation, American Institute of Physics Bulletin of Science Policy News, March 25, 2003. Bruce Moomaw, "The Science of Spending Billons," Space Daily, Sept 21, 2002. Congressman Criticizes O'Keefe, Space Today.net, April 18, 2002.

seven years (according to the Augustine Committee's Report).[39] Now a number in Congress are unhappy to find out Russia has nearly doubled the cost of an escape pod capsule to almost $65 million each.[40] Soviets rebranded as Russian capitalists have learned the lessons of capitalism all too well.

Exceptionalism

Exceptionalism is the perspective that a country, or society, holds that it is unusual or extraordinary in some way.[41] Many nations throughout history have made claims of or exhibited the hubris of exceptionality: the United States, China, India, Britain, Japan, Iran (Persia), Korea (both South and North), Israel, the USSR, France and Germany.[42] The term "exceptionalism" can also be used to describe a nation's desire to remain separate from others.[43] There is oftentimes a strong and intense political and cultural pressure to go it alone, to demonstrate a nation's prowess and strength—to show a nation has joined the leaders of the world. That may explain the following news report:

> SEOUL (Reuters) - South Korea plans to launch a lunar probe in 2020 and make a moon landing by 2025 under a new space project that will develop indigenous rockets to put satellites into orbit, the Science Ministry said on Tuesday. The lunar probe program will be based on a rocket South Korea is developing at a cost of 3.6 trillion won ($3.9 billion) in the next decade. South Korea is behind regional powers Japan and China in the space race. China became only the third country to launch a man into space on its own rocket in 2003 and put its first lunar probe into orbit in early November. Japan's first lunar probe began orbiting the moon in October, four years

---

39 Seeking a Human Spaceflight Program Worthy of a Great Nation, Review of U.S. Human Spaceflight Plans Committee, Final Report, October, 2009, p. 10.

40 The cost of Soyuz was $50M per launch (1999 dollars) - www.astronautix.com/lvs/soyuz.htm. Russian is now charging NASA $51M per seat per astronaut. Tudor Vieru, "Russia Wants $51 Million for Seat on Soyuz - NASA will have to pay to get to the ISS," Softpedia.com, May 14, 2009.

41 "Exceptionalism," Wikipedia, http://en.wikipedia.org/wiki/Exceptionalism, accessed December 5, 2009. See also, Michael Kammen, "The Problem of American Exceptionalism: A Reconsideration," American Quarterly, Vol. 45, No. 1 (Mar., 1993), pp. 1-43.

42 Ibid.

43 Ibid.

behind schedule due to technical glitches.[44]

> Cooperation vs. leadership:
> During one panel discussion at the International Space University's 13th Annual Symposium, members argued that the United States should provide more leadership with regards to space "traffic control" to prevent satellite collisions. Only moments later, however, during the next panel, its members complained that the United States "took charge" much too often instead of working as a collaborative member (e.g., comparable to a member of the European Space Agency).

The desire for exceptionalism accounts for this above report's stated national objective for the Republic of Korea. The South Koreans are working hard to achieve success with their space programs; indeed, their space community leaders have told the authors that they take great pride in the successes they have already gained, and hope to gain. We take them at their word. Note, however, how the Reuters article puts the Korean space effort in juxtaposition with its traditional rivals and enemies, China and Japan.

Exceptionalism also explains a desire by China for a national manned spaceflight, space station, and moon programs; the desire by a wide variety of nations to develop spacelift and on-orbit capabilities; and, of course, the desire by other overachieving states and individuals to launch their own missions to the moon.

Unfortunately, exceptionalism pressures can cause inefficiency, with tremendous duplication and overlap occuring in global space science and other missions. The reported problems can also generate considerable mistrust. For example, there has been much discussion about inviting China to participate on the International Space Station. Unfortunately, in its single-minded zeal to forge a unique world-class military and space program China has generated considerable angst and distrust among the international community. This is underscored by China's program's secrecy and the recent, alarming ASAT test that contaminated low earth orbit with thousands of pieces of space debris that will pose a threat to space systems for well over a hundred years.

---

44 Jack Kim, "South Korea eyes moon orbiter in 2020, landing 2025," Reuters, November 20, 2007, http://www.reuters.com/article/scienceNews/idUSSEO24596320071120, accessed November 29, 2009.

When attempting to achieve success with cooperative efforts participants must find utility arising out of their efforts. To maximize this utility it is important to consider the types of cooperation frameworks that exist. According to Ryan Zelnio, there are four framework types: coordination, augmentation, interdependence, and integration.[45]

Coordination

Each country operates a separate program independent of others but coordinates on technical and scientific matters. According to Zelnio, "This model of cooperation is inviting in that it is easy for people to agree to, as it allows each country to maintain its total independence and manage its own contributions. The disadvantage of this is that often countries push programs that greatly overlap the efforts pursued by other countries, causing much duplication of efforts."[46]

Coordinating groups exist, and they have achieved success in improving international dialogue on scientific efforts. For example, both the Committee of Earth Observing Satellites (CEOS) and Global Earth Observation (GEO) promote sharing of earth observation data and coordination of such missions. In important moves, some coordination activities are now occurring and expanding on US, European, Russian, China, and other proposed global precision navigation and timing satellite programs (GPS, Galileo, GLONASS, etc.)

The recent duplicative, overlapping and expensive missions to the moon serve as imperfect examples of this framework. Worthwhile cooperation has failed to occur on several of the missions and some participants have yet to share the data gleaned from their observations, even though the data appears to involve no real national or economic security matters. The problem in failing to share occurs many times as an outgrowth of the exceptionalism, xenophobia, and paranoia some countries exhibit about their technology programs.

Augmentation

Cooperating countries provide important elements of the project of the prime country but are not on the prime's program critical path.[47] The United States often employs the augmentation framework. The new US

---

45 Ryan Zelnio, "A model for the international development…," supra.
46 Ibid.
47 Ibid.

National Space Policy states that a fundamental principle of US space activity that it is "committed to encouraging and facilitating the growth of a US commercial space sector that supports US needs, is globally competitive, and advances US leadership in the generation of new markets and innovation-driven entrepreneurship."[48] Consistent with this policy and its predecessors, the United States has led the world in space exploration for five decades. The augmentation framework is consistent with this leadership imperative and, more importantly, reflects the country's tremendous resource investments in space activities.

The disadvantage of the augmentation framework is that the bulk of the costs fall upon the prime country. The United States usually accepted these burdens because it nearly always assumes the prime risks of each mission and wants to control them. Using the augmentation framework allows the United States to exercise centralized control over a mission's critical resource, schedule, technology development, and operational paths. Given the allocation of risk, marginal or minimal contributors to space efforts are not usually given veto power over the mission decisions. US space exploration efforts like the JWST and Cassini follow this model, with MIRI and Huygens payloads only being contributed by ESA, respectively. They do not control the essential mission activities and decisions. The framework has also been followed with Space Shuttle program, however, with only small payloads and invited international astronauts being flown on-orbit.

Some question whether the augmentation framework really provides for true cooperation. For example, D. A. Broniatowski, G. Ryan Faith, and Vincent G. Sabathier contend:

> …[T]here are diplomatic drawbacks to insisting on sole control of the critical path. By restricting international partners to noncritical-path items, a nation is sending a signal indicating a lack of trust and confidence in the partner's capabilities and unwillingness to rely on that partner. Rather than committing to work through problems, the nation is hedging bets in case the partner "fails." This sort of partnering is, in effect, not truly cooperative, because the requirement that one nation possess all of the critical-path capabilities is an implicit statement that such a nation can complete the system under its own power and therefore does not need its partners. As such, there is no true programmatic incentive for the cooperation to happen. From a practical standpoint, this structure endows the nation that

48 National Space Policy of the United States of America, supra., p. 3.

> maintains the critical path with all of the decision-making power, thereby making the partner nations utterly dependent and essentially irrelevant… [T]he argument that international cooperation reduces cost must also be seen within the context of the critical path. A partner who provides a component that is off the critical path is not genuinely reducing the cost for the integrator nation. On the other hand, such cooperation does not negatively affect the employment associated with the space exploration system. Instead, this nation is providing a capability that is, by definition, unnecessary to the minimal operation of the system. It is an extraneous capability… [I]t is receiving a capability that it would not have had otherwise. This form of cooperation therefore creates a natural hierarchy of partner nations among those who have the most control of the critical path; the most de facto decision-making power; and those who provide the extraneous capabilities but have little in the way of programmatic utility and contribute little in the form of decision-making.[49]

Interdependence

Cooperation occurs on the critical path as well as on functional systems with each participant still controlling their component part of the project.[50] The United States and Russia employ the interdependence framework to cooperate on the ISS program. Each serves as a prime resource contributor, and this has satisfied each nation's desire to exercise leadership over the enterprise and protects equities. Unfortunately, as noted earlier, the ISS framework has proven to be extremely costly. With the ISS, neither principal is able to keep the other from slipping their contributions and causing significant delays and cost increases. For example, the ISS partnership suffered a lengthy stand-down in Space Shuttle flights after the disintegration of the Columbia Shuttle.

The European Union's Galileo precision navigation and timing satellite constellation program also suffers from using an interdependence framework. Its partner nations have, from time-to-time, unilaterally withheld contributions causing the overall program to slip. This brings to mind an observation by Broniatowski et al.: "A nation should not be "held hostage" by the policy, schedule, or budgetary difficulties of its partners…

49 D. A. Broniatowski et al., "The Case for Managed International Cooperation…," supra.

50 Ryan Zelnio, "A model for the international development…," supra.

Too many cooks spoil the broth."[51]

Integration

Full cooperation with a pooling of resources on shared and joint research and development. This framework spreads the financial costs, and can utilize the industries of multiple nations while maintaining a single entity to control the critical path."[52] Both ESA and Intelsat successfully employ the integration framework, with the latter doing the better job of it. While ESA has had some failings, its successes have attracted partners in and outside of Europe, including NASA. According to Jean-Jacques Dordain:

> "Inside Europe we have developed a strong cooperation with the European Union (EU) of 27 countries. Together with Norway and Switzerland, which are not members of the EU, but members of ESA, there are today 29 European countries cooperating in space. These countries approved a European Space Policy in 2007 and two flagship programs: Galileo and GMES (Global Monitoring for Environment and Security). Connecting ESA with the EU means connecting space with the European citizens, because the EU is in charge for European policies for European citizens. The two "children" of the ESA/EU relationship, Galileo and GMES, are connecting space with European Transport Policy (Galileo) and with European Environment and Security Policy (GMES)."

> "Outside Europe, ESA is practically cooperating with every space faring nation in the world. Obviously with the USA, which formed the "technical culture" of our space activities, but also with Russia (in science, the ISS program and launchers), with Japan, China (in science), India or Canada. ESA also cooperates more and more with non-space powers in order to share some data with those that have pressing needs and no space capabilities. ESA and the French Space Agency CNES are co-founders of the Charter on Natural Disasters. The members of this Charter make their space systems available to civil protection organizations across the world in case of natural disasters. This European initiative has now become a global initiative since Canada, Japan, India, the USA, Argentina, China have joined

---

[51] D. A. Broniatowski et al., "The Case for Managed International Cooperation…," supra.

[52] Ryan Zelnio, "A model for the international development…," supra.

the Charter."[53]

The primary negative with the integration framework is that it requires acceptance of maximum levels technology transfers. This is often difficult and complex to achieve as national policy makers may disagree with sharing of technologies that offer a unique security or economic edge. The European Union has been able to internally mitigate some of these technology transfer concerns by applying its own unique free market laws and regulations.

Concluding Thoughts

The case for cooperation is strong and powerful. Each nation engages in international cooperative activities because it is in its best national interest to do so. Cooperation enables states to leverage resources and reduce risk; achieve efficiencies; improve global diplomatic and other engagement; and enhance diplomatic prestige, political sustainability and workforce stability. Given these benefits, space leaders must organize their programs to allow for cooperation following some of the recommendations in Table 4.

TABLE 4: Recommendations for Productive International Cooperation In Space
Address technology transfer and releasability concerns early in the process – develop architectures for international environment
Diplomacy, knowledge of partners, and rapport is vital
Employ respect, reciprocity and transparency
Apply patience - build in time for the team to "build trust", "earn trust", "maintain trust" and deal with communications issues

Although powerful, cooperation's success is often achieved only at great expense. The other obstacles and impediments to cooperation are substantial. Releasabiliity constraints, international and domestic political volatilities; and exceptionalism must be confronted early by program

53 Jean-Jacques Dordain, "International Cooperation in Space," remarks at 40th Anniversary of the Universities Space Research Association (USRA), March 26, 2009.

manageres to reduce their risk and expense. Significant harm can occur if these obstacles and impediments are ignored, so a space system architect contemplating cooperative activities helps by developing a program that attacks them up front.

Differences among partners must be understood and respected. Leaders help by attempting to foster conditions that allow for reciprocity and transparency when they can occur, although these conditions will vary. Rapport, knowledge of partners, and patience among the assembled team members will also be essential. Successful international partnerships tend to have unifying attributes—fundamental trust with aligned goals. Without trust and common goals, relationships become inefficient and often fail.

In the end, there isn't single recipe to achieve success. Depending on the relationships, mission needs, and relative strengths of the partners, coordination, augmentation, interdependence, and integration frameworks can each be employed to overcome problems and achieve success. Each of these frameworks requires an early definition of common objectives—this enables participants to successfully develop mission architectures and reduce coordination costs. Partners must define these objectives together and stress the benefits of the relationship that is being built. By keeping the benefits of cooperation in mind, system architects will each achieve solid success.

•••

Colonel James D. Rendleman, USAF, Retired

Col James D. Rendleman, USAF, retired (BS, Chemistry, University of North Carolina - Chapel Hill; MBA and MPA, Golden Gate University; JD, Whittier College School of Law; LLM, University of San Diego School of Law). Mr. Rendleman was commissioned a second lieutenant through the Air Force ROTC at the University of North Carolina - Chapel Hill. He served in a wide variety of science and technology, engineering, management, and policy positions within the Air Force laboratories and space acquisition community, Headquarters, Air Force Space Command, the Air Staff, and the National Reconnaissance Office. He is a level-3 space professional and trained director, space forces. He served as study director for The National Academies study of the US Aerospace Infrastructure and Aerospace Engineering Disciplines. An attorney and member of the State Bar of California, Mr. Rendleman engaged in law practice as a partner, solo practitioner, and associate with firms in Los Angeles, San Francisco, and Napa, California. He is a member of the American Institute of Aeronautics and Astronautics' Legal Aspects Aero and Astro Technical Committee and International Activities Committee, and is an elected member of the International Institute of Space Law. He taught management theory for Cerro Coso Community College and Golden Gate University. He also taught space law, policy, command and control, international cooperation, and missile defense for the National Security Space Institute.

Walter J. Faulconer

Mr. J. Walter Faulconer (BS, Space Sciences, Florida Institute of Technology; MS, Systems Management, University of Southern California). Mr. Faulconer is president, Strategic Space Solutions, LLC. He has spent over three decades in the aerospace industry providing executive leadership, creative program management, systems engineering, and business development to civilian, commercial, and national security space customers. Before assuming his present duties, Mr. Faulconer was business area executive for civilian space at John Hopkins University's Applied Physics Laboratory (APL), leading 500 scientists and engineers on cutting edge space programs such as the MESSENGER Mercury orbiter mission; the TIMED study of Earth's upper atmosphere, ionosphere, and thermosphere; the twin spacecraft STEREO study of the sun and its coronal mass ejections; and NEW HORIZONS, the first mission to Pluto. Before APL, he worked at Lockheed Martin Space Company and Martin Marietta Astronautics Company as a director, program manager, flight test manager, systems engineer, and mission operations lead on a wide variety of classified and unclassified programs dealing with space launch, space control, missile defense, Space Shuttle, and other missions. Mr. Faulconer is an Associate Fellow of the American Institute of Aeronautics and Astronautics, a member of the board of directors for the American Astronautical Society, and a member of the International Astronautical Federation and National Space Society. He has taught graduate level business marketing and strategy at John Hopkins University, Whiting School of Engineering.