U.S.–Japanese Space Relations at a Crossroads

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The relations between Japan and the United States in space form a microcosm of the complex, multidimensional interactions between these two powerful societies. Cooperation and competition exist side by side, and the future balance between them is uncertain. The United States needs to develop a strategy with respect to future U.S.–Japanese space relations that balances national security, political, scientific, and economic interests. Crafting such a strategy is particularly difficult while both the United States and Japan debate the goals and content of their future space programs and while the two nations try to assess their broader interests and roles in the rapidly changing geopolitical environment. Essential to a productive approach to U.S.–Japanese space relations is an accurate understanding of the character and content of the Japanese space effort.

THE UNITED STATES AND JAPAN HAVE COOPERATED IN space at both the governmental and industrial level for the past two decades. But the objectives of such cooperation have been different for the two countries. The U.S. government has seen space cooperation as a means of demonstrating in a highly visible way its claims to global political and technological leadership; Japan has used cooperation (and not only in space) as a way of learning from a more advanced partner as an interim step to independent, often competitive, Japanese capabilities. Japanese industry worked with U.S. firms in the early stages of developing its space capabilities; after acquiring as much U.S. technology as possible through licensing and other forms of technology transfer, a Japanese firm typically reduces the interactions with its U.S. collaborator and tries to improve on the imported technology. To date, the benefits to U.S. firms have come from the revenues generated by technology transfer, not from access to Japanese or world markets through alliances with Japanese collaborators.

Both the United States and Japan recognize that the "leader-follower" relationship that has characterized their space relationship so far requires revision, particularly because Japan is developing world-class capabilities in critical areas of space technology and could emerge both as a significant competitor to the United States for economic payoffs from space and as a major partner in collaborative space undertakings. From the U.S. perspective, a strategy is needed for Japanese–U.S. space relations that balances national security, political, economic, and scientific interests. Key to such a strategy is the balance sought between cooperation and competition.

It is in the U.S. interest to stress cooperative interactions (*1*). As one high-level group recently commented, an "increasingly cooperative U.S.–Japan relationship" would have "a strongly constructive" effect,

> strengthening the general trend that existed from the late 1940s through the 1970s toward a more open, multilateral trading regime, alignment of security policies, and cooperation in minimizing the instabilities produced by massive capital flows and the loosening of fixed exchange rates. . . . Partnership and competition need not be mutually exclusive (*2*, p. 1).

To develop such a productive strategy, one needs a clear understanding of the current state and likely future character of the Japanese space program. Unfortunately, there is substantial confusion on these two topics. For example, last year an aerospace trade publication reported on Japan's "commitment to an aggressive development program that will position it as a major space power in the 21st century" (*3*, p. 37). In contrast, the Tokyo correspondent of the *New York Times* observed that "Japan is entering its third decade in space more confused than ever about where to proceed next, and deeply uncertain whether it wants to commit the money or scarce talent needed to turn the world's second largest economy into a spacefaring nation" (*4*, p. C1).

The reality is that Japan is still in the process of reaching a national consensus on its long-term purposes in space and on the appropriate level of public and private investment justified by the potential benefits of space activities. The United States can exert some influence on that consensus, but more importantly, the United States needs to understand its emerging outlines so that it is well prepared for future interactions. This article is intended as a contribution to such an understanding.

An Overview of Japan in Space

Compared to the United States, the Japanese space program is modest in size, if not in scope (*5*) (Table 1). Japan's current government space budget (Table 2) is approximately $1.3 billion [168.2 billion yen (*6*)], less than 10% of the $13.9-billion budget of the National Aeronautics and Space Administration (NASA); while the United States allocates almost 0.6% of its gross domestic product to space, the Japanese allocate 0.04% (*7*). Japan's space budget in 1991 was the fifth largest in the world, trailing the budgets of the United States, the former Soviet Union, China, and France (*8*). Japan, unlike those other countries, does not have a military space program to bear a share of the costs of its space development; the U.S. national security space program has a budget some 50% or more larger than that of NASA, and the technology developed under military auspices finds its way into both NASA and private sector space efforts. There are just under 9,700 people working on space in Japan, including both government and corporate employees; the NASA civil service roster alone totals almost 24,000 (*9*).

A number of Japanese government agencies are involved in space (Fig. 1). They operate under a policy framework developed by the Space Activities Commission, a group of senior individuals chaired by the Minister of Science and Technology that was established in 1968 to advise the Prime Minister on space policy and to coordinate

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government space activities. The most recent Space Activities Commission statement of Japanese space policy, issued in 1989, stresses both autonomy and international cooperation, noting that "Japan has now a promising future in establishing its own technology equal to that at an international level" (*10*, p. ii) and calling for increased private sector investment in space development while also stating that "Japan, as a member of the international society, is expected to make an appropriate contribution consistent with its international status. Japan will promote international cooperation in this field. . . ." (*10*, p. 4). This dual emphasis is perhaps the most significant feature of Japanese space policy from a U.S. perspective; there appears to be an opportunity to influence Japan toward cooperative rather than competitive interactions.

The bulk of Japan's government space activities are carried out by the Institute of Space and Astronautical Sciences (ISAS) and the National Space Development Agency (NASDA). ISAS is a National Inter-University Research Institute under the jurisdiction of the Ministry of Education, Science, and Culture, and it concentrates primarily on space science; its annual budget is $129 million (16.8 billion yen), and its staff numbers fewer than 300. NASDA is a public corporation (that is, its employees are not civil servants) that operates under the primary policy guidance of the Science and Technology Agency but also receives direction and funding from the Ministry of Transport and the Ministry of Posts and Telecommunications. The NASDA mission is to develop Japan's technological and system capabilities in satellites and launch vehicles for applied science and application missions; its current budget is $1097.6 million (142.7 billion yen), and its staff numbers 955 (*11*). The third main actor in Japanese space, a relative newcomer to the sector, is the Ministry of International Trade and Industry (MITI), which is concerned with those areas of space relevant to Japanese competitiveness in the global marketplace. The Space Industry Division of MITI, which was established only in 1987, has a staff of fewer than ten and a budget of $118 million (15.4 billion yen): most MITI funds are spent on projects carried out in its laboratories or in collaboration with other government agencies.

Most of Japan's government-funded space work is carried out by industry. But there is a fundamental difference between the structure

Table 1. Approved Japanese space missions. Source: ISAS and NASDA.

Mission	Sponsoring agency	Scheduled launch date	Launch vehicle	Description
Earth Resources Satellite-1	NASDA, MITI	1992	H-I	Land observations focusing on resource exploration; carries synthetic aperture radar.
Fuwatto (First Materials Processing Test)	NASDA	1992	Shuttle	Much-delayed Spacelab mission with first NASDA astronaut; focus on materials processing experiments.
Geotail	ISAS	1992	Delta	Japanese contribution to International Solar Terrestrial Project; focus on fields and particles in Earth's magnetotail.
Vehicle Evaluation Payload–Orbit Reentry Experiment	NASDA	1993	H-II	Test payload for first H-II launch and reentry experiment to collect data for design of reusable space plane HOPE.
Astro-D	ISAS	1993	M-3SII	X-ray astronomy mission; focus on intense cosmic x-ray background.
Engineering Test Satellite-VI	NASDA	1993	H-II	Two-ton, three-axis stabilized platform carrying advanced fixed, mobile, and intersatellite communications experiments.
Geostationary Meterological Satellite-5; Space Flyer Unit	NASDA, ISAS, MITI	1994	H-II	Dual payload: (i) an operational geostationary meteorological satellite, and (ii) the Space Flyer Unit, a recoverable platform carrying ISAS infrared instrument and MITI, NASDA, and industrial technology and space utilization experiments. Developed and controlled by ISAS; shuttle recovery arranged by NASDA.
Very-long Baseline Interferometry Space Observatory Project (VSOP)	ISAS	1995	M-5	Radio telescope to be operated as part of a worldwide very-long baseline interferometry network.
Advanced Earth Observing Satellite (ADEOS)	NASDA	1995	H-II	Next-generation observation platform with Japanese ocean scanner and infrared radiometer. U.S. and French instruments also aboard. Data relay through satellites.
Lunar-A	ISAS	1996	M-5	Lunar orbiter with three surface penetrators.
Tropical Rainfall Measuring Mission (TRMM); Engineering Test Satellite-VII*	NASDA	1996	H-II	Dual launch. TRMM is a joint Japanese–U.S. project with U.S. spacecraft and Japanese rain radar; ETS-VII will demonstrate rendezvous, docking, and on-orbit unit replacement using robot arm.
Communications and Broadcasting Satellite (COMETS)	NASDA	1997	H-II	Replacement for CS-4 mission; carries experimental payloads for advanced communications applications.
Japanese Experiment Module (JEM)	NASDA	1998 or 1999	Shuttle	Pressurized module to be attached to Space Station Freedom.

*The TRMM–ETS-VII mission is in the final stages of approval for development within Japan.

of the U.S. and the Japanese space industries; Japan, lacking a large military establishment, has no equivalent to U.S. aerospace firms such as General Dynamics, Lockheed, or Martin Marietta, which operate almost exclusively under government defense or space contracts and lobby the U.S. government to maintain high levels of aerospace spending because that is their only line of business. Rather, space work forms only 1 to 2% of the business of such giant Japanese firms as Mitsubishi Heavy Industries or NEC, even though these firms and several others are the major recipients of NASDA and ISAS contracts. Space interests per se are not a powerful force in Japanese politics, though the firms performing space work are certainly among the most influential in the country.

In the United States, government policy drives the space program; in Japan, the interests of the private sector are the key determinant. Japan gives much more priority to achieving tangible technological and economic benefits from space than does the United States, which sometimes seems almost obsessed with the politically driven concept of space leadership. Crucial to shaping Japan's future in space is a judgment, not yet made, by the influential leaders of major Japanese industries about whether to emphasize space as an area of business development and consequent corporate investment in preference to other high technology sectors.

Like the United States, Japan has on the table ambitious space plans for the next several decades; also like the United States, Japan may or may not have the political will to carry out those plans. Confusing Japanese space "wish lists" with what is most likely to take place is a major problem in an accurate assessment of future Japanese space plans. One example of proposed but not yet approved missions can be found in the 1987 report of the Consultative Committee on Long Term Policy of the Space Activities Commission (*12*). The Committee recommended developing a diverse infrastructure including a Japanese space station and a reusable space plane early in the 21st century (Fig. 2). This infrastructure would be employed for visionary, but still payoff- rather than exploration-oriented, projects such as in-orbit manufacturing, lunar resource utilization, and energy transport from space to Earth. The Committee suggested that space development become a Japanese national project toward which the combined resources of the public and private sectors would be focused. The Consultative Committee estimated that to achieve its vision, the Japanese government's space budget in the 1985 to 2000 period would have to total approximately $46 billion (6 trillion yen) and that another $23 billion (3 trillion yen) would have to come from private investment (*12*).

The vision of the Consultative Committee stands as a statement of what space advocates in Japan suggest should be done if a consensus that space development is of high national importance were reached. However, there is no indication that either the Japanese government or the private sector is prepared to make a commitment of this scale to space development, which would require more than doubling current budget allocations by the year 2000. The government's space budget would have to be growing at an average of almost 13% a year to achieve this target. Actual budget growth in recent years (Table 2) has averaged just over 7%.

Table 2. Recent Japanese space budgets [in billions of yen (and millions of dollars in parentheses)]. Source: Space Activities Commission.

Fiscal year	Science and Technology Agency*	ISAS	MITI	Others	Total	Rate of increase from prior year
1987	94.6 (728)	11.8 (91)	8.3 (64)	8.5 (65)	123.2 (948)	5%
1988	98.4 (757)	19.8 (152)	14.1 (108)	9.5 (73)	141.8 (1091)	15%
1989	109.1 (839)	20.8 (160)	14.6 (112)	10.5 (81)	155.0 (1192)	9%
1990	119.4 (918)	13.8 (106)	14.9 (115)	4.0 (31)	152.1 (1170)	−2%
1991	131.8 (1013)	16.8 (129)	15.4 (118)	4.2 (32)	168.2 (1294)	11%

*More than 90% of Science and Technology Agency funding goes to NASDA, which also receives funding from other Japanese agencies and from revenue generated by facility rental and data sales.

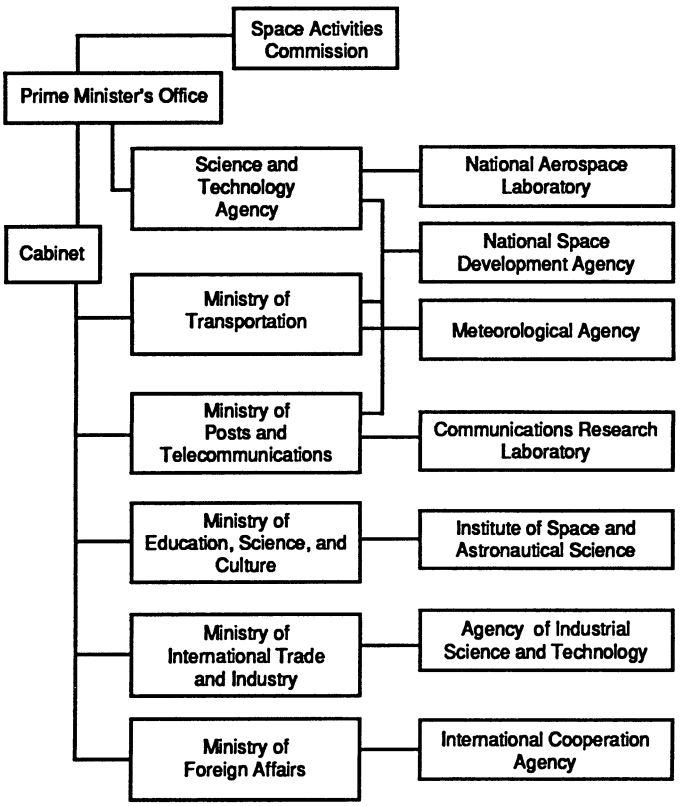

Fig. 1. Organization of Japanese space activities. Several organizations with minor roles in space are not shown.

Space Science in Japan

Cooperation in space science between the United States and Japan is likely to increase, whatever future course in space Japan chooses. Such cooperation has its own dynamics, driven primarily by the

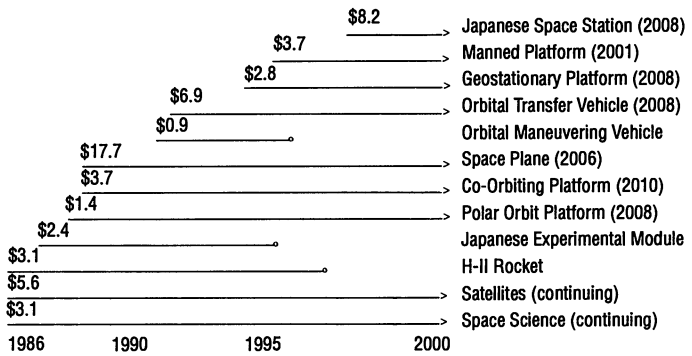

Fig. 2. Proposed schedule (completion date in parentheses) and estimated costs (in billions of dollars) for Japan's space program [from (*12*)]. Total costs of the proposed developments were $59.5 billion over 15 years ($1 = 130 yen). This "wish list" represented the aspirations of space advocates within Japan, but to date the government has not accepted this ambitious plan.

desire of scientists for more and better data, and usually occurs independently of more visible and politically charged forms of cooperation and competition.

Unique among the spacefaring countries of the world, Japan has organized much of its space science program separately from other areas of space activity; this is an approach that the U.S. space science community has sometimes advocated, particularly when it perceives its programs threatened by the budget demands of human space flight. But if Japan's overall spending on space is modest in comparison to that of the United States, its spending on basic space science (*13*) is very modest, and that may be a necessary condition of independence. The 1991 ISAS budget is approximately one-twentieth that of NASA's Office of Space Science and Applications. Within this budget, ISAS not only develops scientific spacecraft, it also operates its own launch vehicles, launch site, and mission control center. Similar expenses are not charged against the NASA space science budget.

The academic, research-oriented operating style of ISAS dates to its origins in the 1950s as scientists and engineers at the University of Tokyo planned Japanese participation in the International Geophysical Year. When Japan in the late 1960s reorganized its institutional structure for space to pursue space development more aggressively, ISAS fought hard and successfully to retain its independence. The Institute stayed affiliated with the University of Tokyo until 1981, when it became a national research institute.

There are pressures for change, however. The Space Activities Commission is pushing for more ISAS-NASDA cooperation, and ISAS is working with MITI on several projects, including a German-Japanese effort to develop an automated reentry capsule for returning experiments from orbit and an ISAS-NASDA-MITI retrievable (by the U.S. shuttle) platform, the Space Flyer Unit, for microgravity research in orbit. As ISAS budgets, capabilities, and involvement with other agencies grow, it is likely to become more integrated into the mainstream of Japan's space development activities rather than remain a self-sufficient enclave of pure research.

Although ISAS has launched 20 missions in 21 years, concentrating on x-ray astronomy, upper atmosphere studies, and solar physics, these missions have been low in cost and simple in concept and design. There is a sense within Japan that such simple missions may be reaching the point of diminishing scientific returns. Spurred on by Japanese scientists interested in solar system exploration, ISAS has recently been successful in pressuring the government to allow it to develop a larger launch vehicle capable of carrying out lunar and planetary missions. This vehicle, called the M-5, is scheduled for a first launch in 1995 and will allow ISAS to launch spacecraft up to three times heavier than before. One 1996 flight will launch the recently approved Lunar-A mission, which will send several penetrators into the lunar surface at different locations for geological measurements; other solar system missions are also being planned, including one in 1996 to investigate the Martian atmosphere. ISAS scientists in areas other than solar system exploration are also designing larger missions to take advantage of the M-5 capabilities, and there is talk of even more ambitious post-2000 science missions that would require the use of the H-II launch vehicle under development by NASDA. These missions will be possible only if ISAS obtains a significantly larger budget, which is not likely, or combines less frequent launches of its own missions with more participation in international cooperative undertakings than has been the case in the past.

To be sure, there has been some limited international involvement on the part of ISAS, and the United States has been the primary cooperative partner, mainly through exchanges of data, scientists, and occasionally instruments on spacecraft; the Japanese Solar-A mission launched in August 1991 carried a U.S.–supplied soft x-ray telescope as one of its two major instruments. ISAS has also been part of the multilateral planning for and conduct of missions such as the 1986 encounter with Comet Halley and the upcoming International Solar Terrestrial Physics (ISTP) program. An important change in past ISAS behavior is the Geotail mission, planned for a 1992 launch as part of the ISTP. Both U.S. and Japanese instruments will be mounted on a spacecraft developed and controlled by ISAS but launched by the United States. This kind of mutual dependence is unusual for ISAS, and it may set a precedent for more intimate cooperation in space science between Japan and the United States (or Europe or Russia) in the future.

Japan's Strategy for Space Development

Japan has followed in space the strategy that has been successful in other high-technology areas—identifying the leader in technological capability and learning as much as possible from its accomplishments, then building on that learning to develop a strong indigenous technology base. This approach has saved Japan both time and money, because it did not have to make the research and development investments necessary to achieve the level of technology it could acquire through commercial licensing, government-to-government and firm-to-firm cooperative projects, and other forms of technology transfer.

Operating under a 1969 agreement between the U.S. and Japanese governments that allowed Japan to work with U.S. industry to transfer selected launch vehicle and satellite technologies, Japan made rapid progress in the 1970s in developing its space capabilities. This agreement was motivated in the United States by the political objective of assisting Japan in its postwar reconstruction; it was advocated by the Department of State but opposed by NASA and the Department of Defense and ran counter to the policy of denying Europe access to U.S. space technology that was in place during the same period. By 1978, the Space Activities Commission was able to announce that "Japan has completed its first phase of space development activities, during which the emphasis has been on the establishment of a firm foundation" (*14*, p. 1) and that

> Japan has so far been to a large extent dependent for space technology on advanced nations or has been greatly influenced by them. However, Japan has to develop its own technological resources so that it may be able to carry out the various space development activities steadily. . . . Further, Japan has to maintain advanced technological resources so that it may be able to proceed with its space development activities properly and freely (*14*, p. 5).

This declaration of the need for technological autonomy and the development of indigenous capabilities has been a centerpiece of Japanese space policy since 1978. The instrument for carrying out the policy has been NASDA, which has used government funds to nurture the Japanese space technology base in a variety of areas. The Japanese commitment to developing indigenous capabilities was likely accelerated by U.S. refusal to license the export of state-of-the-art technologies in areas such as inertial guidance, spacecraft stabilization, and cryogenic propulsion; although the United States had been willing to help Japan get started in space development, it soon recognized that it was not in U.S. interests to assist Japan in developing advanced space capabilities. In practice, then, the technology transfers facilitated by the 1969 agreement largely came to an end a decade or more ago. Japan has gone on to develop world-class capability in these three and other component and subsystem areas, in a few cases on the basis of technology transfers from European rather than U.S. firms (*15*), but in most cases on the basis of its independent efforts (*16*).

Japan by the late 1970s also recognized that it could not be autonomous in space without a launch vehicle that it could use at its

own discretion. The licensed technology on which the first three generations of NASDA launch vehicles were based came with U.S. restrictions on its use. After several years of debate, Japan decided in 1984 to invest in the technological leaps needed to develop both geostationary satellites as large as any being planned around the world and an advanced launch vehicle capable of boosting them to orbit. This vehicle, known as the H-II, is to use cryogenic fuel in both of its stages and to have a first-stage engine based on high-pressure, staged-combustion technology. The Space Shuttle Main Engine (SSME) is the only other rocket motor in the world to use this approach. At the time the decision to go ahead with H-II development was made, the over $1-billion project was the most expensive ever undertaken by Japan; first launch was scheduled for 1991 or 1992.

Developing the H-II engine has proven a difficult challenge; the project has been beset by technical difficulties, and first launch of the H-II has slipped to 1993 or perhaps even 1994. Without access to SSME technology, Japan has been forced to repeat much of the trial-and-error learning that U.S. engineers went through during the 1970s.

The spacecraft that most determined the performance requirements for the H-II was the planned two-ton CS-4, the fourth-generation Japanese communication satellite. But under strong trade pressure from the United States, Japan decided in 1990 to abandon the CS-4 project. Using the "Super 301" authority contained in the 1988 revision to the Omnibus Export Act, the United States singled out the satellite area as one in which Japanese policy created an unfair barrier to free trade. An example of what the United States objected to was the mixture of funding of the CS-4 project. Japan claimed that the satellite was partly research-oriented and that government funding of approximately 25% of its development costs was therefore appropriate; however, Nippon Telephone and Telegraph (NTT), only recently privatized, was planning to make extensive use of the satellite and was paying for the rest of its development costs. The United States claimed that the satellite was primarily operational in intent and that government funding and the accompanying "buy Japanese" policy constituted a unacceptable barrier to free trade (*17*). The Ministry of Posts and Telecommunications, the primary government sponsor of the CS-4 satellite, was unhappy when Japan gave in to U.S. pressure, cancelled the project, and agreed to open the Japanese market for operational communication, broadcasting, and meteorological satellites to non-Japanese bidders. NASDA and the Science and Technology Agency were not as upset, because cancelling CS-4 provided an opportunity to use scarce funds for other projects of greater technical interest.

The cancellation brings to an end, at least for the time being, Japan's plans to use a closed domestic market as a step in developing large point-to-point communications satellites to sell to non-Japanese customers. If Japanese firms are to compete with U.S. and European industry in marketing complete space systems or space services, it will have to be in other areas.

Some suggest that one such area for competition might be launching satellites on a commercial basis with the H-II rocket. This possibility seems far in the future, given the booster's development problems and projected high costs per launch; only one to two launches per year for government missions are currently planned. To pursue launch contracts, and in the interim to lower the costs of manufacturing and launching the H-II for Japanese missions, a number of Japanese firms have formed the Rocket System Corporation, and it is already preparing a proposal to launch future satellites for Inmarsat, the International Maritime Satellite Organization. This organization is explicitly modeled on the successful European firm Arianespace, which both manufactures and launches Ariane boosters for the European Space Agency and markets Ariane launches on a commercial basis around the world; it may be a harbinger of the approach Japan will pursue in privatizing its emerging space capabilities, once they have been developed with public funds. Just as U.S. industry has had difficulty competing for launch contracts with the government-industry partnership upon which Arianespace is based, it may find future competition with similar Japanese entities a challenge.

Those in Japan's private sector most involved in space projects have been increasingly critical of the government's approach to space development, arguing that current budgets are too small to allow industry to complete all approved programs and to undertake new ones and that too much emphasis has been given to developing successive generations of advanced technology and not enough to transferring already developed technology to Japanese industry for use as the basis for goods and services offered on a commercial basis in the international marketplace. The primary forum for articulating industry's perspective is the Space Activities Promotion Council of the Keidanren, the influential economic federation of Japanese firms. In a recent report, the Council criticized the Space Activities Commission and NASDA for pursuing an approach that "has focused almost entirely on technological development" (*18*, p. 2) and called for "a more balanced approach that addresses the need for practical uses of space, as well as technological development" (*18*, p. 11) and "an industrial policy for space development" (*18*, p. 3). It is likely that in the future NASDA will be required to focus more narrowly on cutting edge research and development projects and that innovative mechanisms such as the Rocket System Corporation will be used to transfer new space technologies to the Japanese private sector so that they can be brought into commercial utilization.

Keidanren firms have close ties to the MITI and appear to share the MITI view that the NASDA-dominated approach to space development that has been pursued to date has not served Japan's commercial interests well. To NASDA's discomfort, MITI is advocating a changed focus, away from communications and broadcasting satellites and toward areas with long-term economic potential in which international competitors are not already well entrenched, such as materials processing, Earth observation, and robotics. MITI's emphasis also appears less narrowly nationalistic than that of NASDA; the Ministry is open to strategic alliances and other forms of cooperation between Japanese and non-Japanese firms as a means of gaining access to the global space market for Japan and of easing trade tensions. A struggle between the Science and Technology Agency and MITI for influence over the direction of Japanese space activities is likely to continue over the next few years; its outcome will help shape the balance between the goals of commercial payoffs in the global marketplace and politically driven international cooperation as determinants of Japan's future approach to space.

It should be noted that although less than 20% of the current sales of the Japanese space industry is in the form of exports, Japan already does well in some areas of the international space market, such as components and subsystems for various civilian satellites and ground stations for communications and Earth observation satellites, an area in which Japan has been the market leader for several decades; sales of satellite parts in 1989 totaled $642 million (83.4 billion yen), and ground equipment sales totaled $999 million (129.9 billion yen) (*9*, p. 1).

The MITI approach could present an opportunity for U.S. (as well as European and other Asian) firms to create relationships with Japanese counterparts that involve a two-way flow of technology and teaming for various satellite and other space system contract bids around the world, including both the U.S. and Japanese markets. This approach also offers a policy opportunity for the U.S. government to work with Japan to develop a framework to replace the 1969 U.S.–Japanese agreement, one that both encourages such

industrial cooperation and strengthens U.S.–Japanese ties overall. Consideration of the possible character of such an agreement has been under way within the U.S. government and aerospace industry for several years, but no consensus has emerged on its content; indeed, no consensus has emerged even on whether it is in U.S. political and economic interests to seek a new space agreement with Japan.

It is also possible that Japan could choose to go its own way in space development. If Japanese government and industry, with MITI as the coordinator, were to adopt an integrated approach to space development, as they have in other high-technology sectors, the United States could face in the not too distant future a powerful rival in another sector in which it has long held a leading position. Once again, an increased emphasis on cooperative relations could help minimize the chances of Japan's following such a course.

There is a unique constraint on Japan's exporting space products. The 1969 Diet (the Japanese parliament) resolution establishing NASDA mandated that the agency be involved only in undertakings for peaceful purposes. To date, this has been interpreted as blocking the export of any government-funded technology or hardware using that technology if it is to be used in military or even dual use applications. For example, preliminary discussions between McDonnell Douglas and Mitsubishi about the use of a newly developed Japanese rocket motor for an improved upper stage of McDonnell Douglas's Delta launch vehicle floundered because a primary mission of the Delta is to launch the Department of Defense Global Positioning Satellites, which also have civilian applications. If Japanese industry is ever to play a major role in the world's space markets, a more permissive interpretation of this constraint will have to be adopted (*19*).

Humans in Space—Test Case for Cooperation

The most expensive current Japanese space project is the Japanese Experiment Module (JEM), a combined pressurized and unpressurized laboratory to be attached to the U.S. Space Station Freedom; the cost of developing this module is estimated to exceed $2.5 billion, and Japan is committed to sharing with the United States and other international partners the costs of operating the station over several decades. In this undertaking, Japan is totally dependent on the ability of the United States to deliver on its promise to develop a space station core to which the JEM can be attached.

The Japanese decision to participate in the space station was primarily political in character. It was not preceded by the typical consensus-building process, although there had been several years of studies of potential participation by the Japanese space community (*20*). When President Ronald Reagan announced approval of the space station program in the 25 January 1984 State of the Union Address, he also said that the United States would invite its "friends and allies" to participate. By the time that NASA Administrator James Beggs arrived in Tokyo seven weeks later to present the President's invitation in person, he was told by Japanese Prime Minister Nakasone that Japan would certainly take part. Japan had passed up a 1970 invitation to participate in the Space Shuttle program and had regretted that decision because it meant that Japan had missed an early chance to be exposed to the technologies associated with human space flight. When the United States again offered that opportunity in the form of participation in the space station effort, the reaction was "Japan—politicians included—does not want to miss the boat" (*21*, p. 65).

With respect to human space flight, Japan is following its traditional approach of associating with the leader in the area, at least until it decides whether to develop the indigenous capability to be able to proceed alone. However, Japan is not yet convinced that developing such a capability is worth the cost. For example, no decision has been made to proceed with the costly development of HOPE, the H-II Orbiting Plane, which has been under study for a number of years. HOPE would be an initially unmanned, reusable, winged space plane launched by the H-II booster that would dock with the JEM and other orbiting platforms and would be a major step toward Japan's developing the ability to launch its own crews into space. The most recent statement of Japanese space policy notes that "the conducting of independent manned space activities is a long-term issue. For the time being, Japan will actively participate in international collaboration projects and will learn and develop basic technology related to manned space activities" (*10*, p. 10).

Unlike the situation created by the 1969 U.S.–Japan agreement that facilitated Japanese licensing of U.S. technology, space station cooperation is being carried out in accordance with traditional NASA guidelines that stress "clean interfaces" and minimal technology transfer (*22*). The U.S. government will approve only limited technical assistance agreements and the licensing of off-the-shelf U.S. technology. Thus, the Japanese government and the Japanese firms involved in the JEM project are having to invest substantial research and development funds to develop the technological capabilities required to take the early steps toward human space flight.

Having committed itself to a space station partnership with the United States, Japan has not found the experience to date totally satisfying. During the difficult negotiations to create the partnership agreements, Japan was disturbed, given the long-standing political requirement that NASDA be involved only in peaceful activities, by the U.S. insistence that Department of Defense access to the station not be precluded. In 1989 NASA made significant changes to the station program without consulting its partners, much to their distress, and in 1990 the Congress mandated a restructuring and stretch-out of the program, again without taking the interests of U.S. partners into account. In recent months, the threat of station cancellation brought a strong reaction from top Japanese officials. Japan's Foreign Minister Taro Nakayama wrote Secretary of State James Baker, saying, if the space station were canceled, "major joint efforts which the international partners have made so far would be nullified, Japanese Space Development Programs would be significantly impaired, and furthermore, I fear that the credibility of the United States as a partner in any major big science effort would inevitably be damaged" (*23*, p. 2).

The success or failure of station cooperation is critical to the overall future of Japanese–U.S. space relations, at least at the government-to-government level. The United States and Japan worked closely together in the most recent station restructuring and in beating back congressional threats to cancel the program, and it appears that station cooperation is now on a positive path. The challenge is to keep it there. If the partnership were once again to sour, Japan would be likely to combine increased emphasis on its drive toward space autonomy with enhanced cooperation with Europe or perhaps even Russia.

Conclusion

Japan is best seen as an emerging space power, still unsure of how it wants to put to work the technological capability it is developing. In the interim, it is positioning itself to take advantage of any economic, political, or security opportunities to use the capability that might emerge.

In its discussion of international cooperation, Japan's most recent statement of space policy noted that "Japan will establish and accumulate space technology equal to that at an international level.

Japan will provide the results for global space development and will positively promote international cooperative activities consistent with Japan's status as an international society" (*10*, p. 18). The United States should be doing all it can to encourage Japan to move in this direction, rather than to use its developing capabilities in a competitive manner.

Historically, Europe and the former Soviet Union have been the transatlantic partners for most major U.S. cooperative space initiatives; given the growing importance of transpacific relations, the United States should seek additional opportunities to make Japan a primary partner in new space undertakings. Engaging Japan in regional and global cooperative space undertakings may be one way to build the kind of stable relations in the Asia-Pacific area that are essential to 21st century world order.

There are many questions that must be answered for the United States to develop a coherent approach to space relations with Japan. Perhaps the most fundamental is how best to balance U.S. security, political, and technological interests in dealing with another society that is pursuing a space program for reasons that to date have been very different from those shaping the U.S. effort in space. Is Japan likely to increase the emphasis on international uses for the public good of its space capability, as its recent policy pronouncements suggest, or will its space priorities continue to be driven primarily by anticipation of technological and commercial payoffs? Without an answer to that question, it is difficult to recommend a particular approach to U.S.–Japanese space relations. For the time being, the United States should remain flexible in its strategy toward Japan while trying to exert its influence toward collaboration rather than competition.

There are a number of scientific, Earth observation, and public service communication missions under discussion between the U.S. and Japanese technical communities and governments as candidates for future cooperative projects. Japan appears particularly interested in contributing its space capabilities to the worldwide global change effort. Moreover, the United States has announced its intention to open an exploratory dialogue with potential partners regarding international collaboration in the human exploration of the solar system; Japan's interest in lunar exploration and exploitation makes it a logical candidate for a major cooperative role if a U.S. exploration program gets under way.

Japan's private sector is also proposing ambitious international space projects. An example is the World Environmental and Disaster Observation System (WEDOS), which Japanese industrial leaders are promoting in various forums around the world. WEDOS would be composed of numerous Earth observation satellites linked by a series of data relay satellites (*24*). Presumably, most of these satellites would be manufactured by Japan, thereby giving it the opening into the world market it has been seeking, and combining cooperative and commercial impulses in a single undertaking.

As both the United States and Japan engage, each in its own national style, in a debate over future goals in space, there are opportunities to create broader cooperative space relations between the world's two richest societies. Although space collaboration is by itself certainly not a solution to tense relations between the two nations, it can, if well conceived and implemented, serve as one means of stressing positive interactions. Thus, it would be wise for the United States to take seriously this passage from the 1989 statement of Japanese space policy: "The time is . . . ripe for global space development and for cultivating close international relationships" (*10*, p. i).

REFERENCES AND NOTES

1. For an argument of why space cooperation can serve U.S. interests, see J. M. Logsdon, *Issues Sci. Technol.* **IV**, 43 (summer 1988).
2. The Johns Hopkins Foreign Policy Institute, "The future of U.S.–Japan relations," Policy Consensus Report (The Johns Hopkins University, Baltimore, August 1991). The group that produced this report included several former Secretaries of State, Secretaries of Defense, and National Security Advisers.
3. C. Couvalt, *Aviat. Week Space Technol.* **133**, 36 (13 August 1990).
4. D. Sanger, "Japan eyes space with uncertainty and confusion," *New York Times*, 26 June 1990, p. C1.
5. For additional information on Japanese space policy and programs, see D. R. Wells and D. E. Hastings, *Space Policy* 7, 233 (August 1991); (*3*); C. Couvalt, *Aviat. Week Space Technol.* **133**, 63 (20 August 1990); and *Le Developpement du Secteur Spatial au Japon* (Euroconsult, Paris, September 1989). For another review of U.S.–Japanese space relations, see M. R. Oderman and H. Yoshida, "U.S.–Japanese cooperation in civilian space programs: a review of past cooperative efforts and a consideration of future opportunities," paper presented at the 4th Space Technology, Commerce, and Communications Conference, Washington, DC, 10 January 1991.
6. The exchange rate used in this article is $1 = 130 yen.
7. *World Space Industry Survey, 1991* (Euroconsult, Paris, 1991).
8. For information on comparative space spending, see (7) and *The U.S. Aerospace Industry in the 1990s: A Global Perspective* (Aerospace Industries Association of America, Washington, DC, 1991).
9. The Japanese data are from the "Report on present status of the Japanese space industry" (Society of Japanese Aerospace Companies, Tokyo, October 1990).
10. Report of the Space Activities Commission, *Fundamental Policy of Japan's Space Development* (Space Activities Commission, Tokyo, 28 June 1989).
11. *Fact Sheet* (National Space Development Agency of Japan, Tokyo, 1991).
12. Report of the Consultative Committee on Long Term Policy, Space Activities Commission, *Towards a New Era of Space Science and Technology* (Space Activities Commission, Tokyo, 26 May 1987).
13. It should be noted that several of the planned NASDA missions, particularly those related to Earth observation and microgravity research, are scientific in character. The actual division of labor in Japan is as much on the basis of the size of a mission as it is on the basis of the science or the applications involved. ISAS carries out the smaller, more basic science missions; NASDA carries out the larger, more applied science undertakings.
14. Report of the Space Activities Commission, *Outline of Japan's Space Development Policy* (Space Activities Commission, Tokyo, 17 March 1978).
15. In one example of European technical assistance, Mitsubishi Electric Company was able to gain access to three-axis stabilization technology for use in the Engineering Test Satellite V program from the German firm MBB [*Le Developpement du Secteur Spatial au Japon* (Euroconsult, Paris, 1989), p. 120].
16. See the article by Wells and Hastings in (*5*) for a comparative assessment of U.S. and Japanese space technology.
17. See hearings of the U.S. Senate, Committee on Commerce, Science, and Transportation, *Japanese Space Industry—An American Challenge*, 4 October 1989, for a discussion of the U.S. position in these trade negotiations.
18. *Ensuring a Viable and Productive Future for Japan's Space Programs*, report of the Space Activities Council of the Keidanren (Federation of Economic Organizations, Tokyo, 25 October 1988).
19. There are those in Japan who suggest that in the future, and perhaps even today, the Japanese government would be willing to accept a broader interpretation of the "peaceful purposes" requirement and that its current posture may be a bargaining position to get the best possible terms for access to Japanese space technology. Indeed, some recognize that in the future Japan may wish to use space capabilities such as Earth observation systems and even launching systems to meet its own national security needs and that the current Japanese civilian space program is a politically acceptable way of developing such dual-use capabilities for Japan's own future national security use.
20. For more details on the Japanese decision to participate in the space station project, see J. M. Logsdon, *Together in Orbit: The Origins of International Participation in Space Station Freedom* (NASA, Washington, DC, 1991). This study was prepared under contract to the NASA History Office, and copies can be obtained from that office.
21. Interview with N. Arino, Executive Managing Director of TRW Overseas [*Aerosp. Am.* **23**, 64 (March 1985)].
22. See K. Pedersen [in *Economics and Technology in U.S. Space Policy*, M. K. McCauley, Ed. (National Academy of Engineering, Washington, DC, 1986), pp. 173–198] for a thoughtful and informed discussion of NASA's approach to international cooperation.
23. Letter from Minister for Foreign Affairs T. Nakayama to Secretary of State J. Baker III, 24 May 1991.
24. For a discussion of this and other opportunities for U.S.–Japanese cooperation, see the workshop report for "Japan–U.S. cooperation in space." This workshop was held from 30 November to 1 December 1990 at the East-West Center, University of Hawaii. Its primary organizer was Burton Edelson of the Johns Hopkins Foreign Policy Institute, 1619 Massachusetts Avenue, NW, Washington, DC 20036; copies of the workshop report can be obtained from him.
25. In addition to the sources already cited, this article is based on a series of interviews conducted with Japanese space officials in Tokyo from 10 to 16 May 1991 and on conversations with officials of NASA, the Department of Commerce, and the Department of State. Research on the history of Japanese–U.S. relations was carried out in preparation for the 1990 Workshop on U.S.–Japan Space Cooperation cited in (*24*); I am grateful to B. Edelson for getting me started on this topic. I have greatly benefited by the analyses of Japanese space policy and programs carried out by CSP Associates of Cambridge, MA, and CSP Japan in Tokyo, and I have particularly benefited from the work of senior analyst H. Yoshida.