N85-35149

SPACE ACTIVITIES IN THE SOVIET UNION, JAPAN, AND THE PEOPLE'S REPUBLIC OF CHINA*

Edward C. Ezell

The launch of *Sputnik 1* by the Soviet Union on October 4, 1957, began the era of modern spaceflight. Within four months, the United States had joined the "space club" with the successful orbiting of *Explorer 1*. Seven and a half years passed before a third nation joined this exclusive association; France put its *A1* satellite into orbit on November 26, 1965. Japan and the People's Republic of China became Asia's representatives in space in 1970; the Japanese *Osumi* and the Chinese *East Is Red* were orbited on February 11 and April 24, respectively. The final member of the "Space Six," the United Kingdom, launched the satellite *Prospero* on October 28, 1971. Comparative data for these satellite launches are given in table 1. In 1981, the European Space Agency will likely become the seventh organization to boost its own payload into orbit. As the number of spacefaring nations grows, we should look back and examine what common and divergent motivations have sparked this thrust into space. For the purposes of the Yale University National Aeronautics and Space Administration (NASA) Conference on the History of Space Activity, this paper will concentrate on the space programs of three of the six nations that have undertaken their own space programs—the Soviet Union, Japan, and the People's Republic of China—examining briefly the types of launch vehicles they have used and the classes of spacecraft they have launched.

Motivations

To understand why six countries have engaged in such a costly enterprise as spaceflight, we must realize that for each country there existed a complex set of motivations for taking that first step. For the purposes of analysis, these motivations can be broken down into three basic categories—political and military, scientific, and practical. These categories are certainly not exclusive compartments, and I have not attempted to rate one country's justifications for undertaking a space program as more socially acceptable than another's.

It would seem that most nations made the commitment to space

* The opinions expressed in this paper represent those of the author and in no way should be interpreted as an official expression of the National Aeronautics and Space Administration.

once their public leaders came to see it as an acceptable and valuable activity within the context of domestic and international politics and then approved the expenditure of public funds necessary to support the venture. However, the first artificial satellite projects grew out of scientific proposals made for the International Geophysical Year (IGY) of 1957–1958, a multinational effort to study the entire planet. Several participants believed that the IGY would be enhanced by using satellites to gather geophysical and astrophysical data from above the atmosphere, and only two nations had the wealth and technology to answer the challenge of spaceflight at this early stage, the United States and the Soviet Union. The scientists involved in the IGY knew that more than scientific riches would come from the first successful flight of a manmade moon; political and psychological prestige with military overtones would be the extra bonus.

Competition between the Soviet Union and the United States for international prestige was an extension of Cold War attitudes that had existed between them since the immediate postwar years. Their alliance to defeat the Axis powers in World War II had been, in many ways, an uneasy one, and with victory over the common enemy, they had begun to view each other with increasing apprehension and mistrust. In the resultant rivalry, technology as translated into industrial capacity and military hardware became a major indicator of national prestige and power. The Soviets and Americans had emerged as victors from the World War in part because the industrial sectors of their respective societies had provided their troops in the field with the machines of war in quantities that Germany industry could not match. Among this hardware were two new weapons that would become critical in the postwar world. One was the atomic bomb developed by the United States; the other was the V-2 rocket created by Germany. The significance of the first atomic weapons was immediately apparent after Hiroshima and Nagasaki, but the promise—or threat—of ballistic rockets was seen less clearly, perhaps because the V-2 had been a less than perfect weapon. But the Soviet and American military establishments wasted no time in developing this new technology in the decade following the war, and both countries put military rockets and nuclear research on their high-priority lists.

The results of this postwar competition between the Americans and the Soviets are well known. The Soviets were the first to orbit a satellite, which was damaging enough to America's national ego; but more worrisome, they did it with an intercontinental ballistic missile that could be used to deliver a decidedly more lethal payload. The Soviets had obtained a highly visible and indisputable technological first. Americans not only

Table 1. Comparative Data for the First Satellites Launched by the Soviet Union, the United States, France, Japan, the People's Republic of China, and the United Kingdom

Date of Launch	Country (launch vehicle)	Name of Satellite (international designation)	Weight kg (lbs)	Apogee km (statute miles)	Perigee km (statute miles)	Period minutes	Inclination degrees
October 4, 1957	Soviet Union (Raketanosytel "Sputnik")	Sputnik 1 (1957-Alpha)	83.6 (184.3)	947 (588)	228 (142)	96.2	65.1
January 31, 1958	United States (Jupiter-C)	Explorer 1 (1958-Alpha)	14 (30.8)	2,530 (1,573)	360 (224)	114.8	33.3
November 26, 1965	France (Diamant)	A1 (1965-96A	42 (92.5)	1,767 (1,098)	525 (326)	108	53
February 11, 1970	Japan (Lambda 4S)	Osumi (1970-11A)	38 (84)	5,136 (3,191.4)	525 (326)	116.1	31.4
April 24, 1970	People's Republic of China (Long March 1)	East is Red (1970-34A)	172.8 (381)	2,387 (1,483.2)	439 (272.8)	114	68.4
October 28, 1971	United Kingdom (Black Arrow)	Prospero (1971-93A)	65.8 (145)	1,540 (957)	552 (343)	106.4	82

perceived the challenge of this accomplishment but also saw it as a threat to their security and their place as the world's leading military power. As the Soviets reaped political, military, and scientific returns from their new star, American leaders embarked upon a period of deep, worried self-examination. The obvious response to the Soviet feat was an intensification of the American programs to launch a satellite and an increase in the tempo of military rocket research. Declared or not, a bilateral technological competition had begun in this new arena. The "space race" of the 1960s, at least for the United States, also became a visible civilian—and peaceful—surrogate for the more secret military arms race. It has been argued that NASA's Apollo program could be interpreted as America's way of telling the Soviet Union and the world that it was still a technological giant to reckon with. "If we can land a man on the moon, . . ."—would-be adversaries were invited to complete the sentence. The message was clear: The sophisticated technology applied to the lunar exploration project could be easily translated to military systems.

The French, under the leadership of General Charles DeGaulle, clearly understood this fact of life. Caught between the Scylla and Charybdis of Soviet and American nuclear armament, DeGaulle was convinced that the French must develop a nuclear military capability independent of the two superpowers if they hoped to maintain credibility as a military and political power. The French began development of their Diamant (Diamond) launch vehicle in the early 1960s as a nuclear weapons delivery system. Taking advantage of the first test launch of the three-stage missile, the French also orbited their first satellite on November 26, 1965 (with NASA launching another French-made satellite, the *FR1*, a few days later.) Because it had no scientific mission and carried only limited radio instrumentation, the *A1* satellite was criticized by the world's scientific community, but French military authorities readily admitted that the primary objective for the mission had been to test the missile. Here was proof that the French nuclear *force de frappe* was indeed genuine. The French could also play the game of surrogate technology.

Japan became the fourth nation to develop the technology necessary to join the space club, but unlike the Soviets, Americans, and French, the Japanese did not use a modified military launch vehicle. Their postwar constitution forbade the construction of such offensive military hardware, allowing them only defensive military equipment. Civilian organizations interested in the scientific and practical utilization of space served as the catalysts in Japan for the development of launchers and satellites. While not as technologically advanced as the Soviets or the Americans and still not economically recovered from the Second World War, the Japanese had shared the interests of the world powers in space exploration since the IGY period. Through the Institute of Industrial Science at Tokyo University, Japan participated in the International Geophysical Year in 1958 by launching small sounding rockets capable of taking various measurements in the upper atmosphere and went on to launch successively more powerful sounding rockets in 1961, 1965, and 1966. On February 11, 1970, the Institute of Space and Aeronautical Science (formed from the merger of the Institute of Industrial Science and the Tokyo University Aeronautical Laboratory) orbited its first satellite. Japan's Lambda 4S launch vehicle was domestically developed, as was its successor M-rocket. The N-rocket launcher is a hybrid made from the McDonnell-Douglas-manufactured Delta (Thor) booster and an upper stage developed in Japan with technical assistance from Rockwell International. Mitsubishi Heavy Industries serves as the National Space Development Agency's prime contractor. The Japanese satellite program is divided between so-called practical and scientific projects; the former are conducted by the National Space Development Agency, the latter by the Institute of Space and Aeronautical Science.

Two and a half months after the Japanese launched their first satellite, military and space specialists of the People's Republic of China launched theirs. It was called *East is Red*, because it broadcast that revolutionary anthem as it orbited the Earth every 114 minutes. As had the Soviets, Americans, and French, the Chinese adapted an intermediate range ballistic missile called Long March 1 to carry their less-lethal space payloads. The last country to date to develop its own satellite and launching capability was the United Kingdom. The Black Arrow launcher, created for just this purpose, boosted the satellite *Prospero* into orbit on October 28, 1971. It was the only satellite launched with this British-made rocket. Since then, the British have relied on NASA launch vehicles for their various space projects.

All six countries entered this exclusive club to some extent for political reasons; for some practical and scientific motives were more important. For the Soviet Union, the United States, and the People's Republic, military reasons certainly figured highly. In the Soviet Union, there are two space programs, one military and one scientific. Military organizations apparently control the manufacture of all launch vehicles and supervise the launch facilities and operations. America's space program is more neatly compartmentalized. The National Aeronautics and Space Administration was created in 1958 as a civilian space organization, with the congressional mandate to promote the peaceful exploration and investigation of space. The Department of Defense, primarily through the Air Force, was left to conduct the country's military space program, the full details of which are not generally understood because of national security restrictions on the release of information. France, the People's Republic, and the United Kingdom all operate their spaceflight programs through the military, but civilian agencies develop much of the hardware and conduct most of the research. In Japan, of course, the entire program is in the hands of civilians.

Space Activities

Spaceflight, especially with orbital spacecraft, has opened entirely new vistas for the world's scientific community. Table 2 presents a record of space launchings successful in attaining Earth orbit or beyond. Although perhaps no radical changes in our theories about the creation and design of our solar system have resulted from our explorations of space, scientists do have a wealth of new data by which to understand planet Earth, its Moon and sister planets, and the medium of interplanetary space. Hundreds of investigations—astronomical, biological, geophysical—have been launched since the late 1950s. In addition to serving the scientists as information gatherers, satellites have been put to other uses. Surveying the planet from high altitudes, satellites serve as a tool for specialists who hope to improve the management of our natural resources and to increase the efficiency of agricultural practices. But it is sophisticated weather forecasting and communications that particularly attract new customers to the spacefold and keep them there.

Long-range weather predictions and high quality communications over long distances are two important, highly visible, practical contributions the space age has brought us all. The Soviet Union, Japan, and China in particular have important requirements for improving their communications and meteorological systems. Russia's and China's huge land masses make it difficult for them to develop adequate land-based communications systems and weather reporting networks at reasonable costs. Widely scattered communities can be connected through satellite communications links and weather patterns for large areas observed more efficiently from Earth orbit than from the ground. Both countries hope to bypass the complex ground-lines communications systems that serve the United States, Europe, and Western Russia by investing in satellite systems instead. For a crowded island population like Japan, reliable weather prediction is critical to agriculture, fishing, and personal safety. The Japanese have already developed an advanced communications

Table 2. World Record of Space Launchings Successful in Attaining Earth Orbit or Beyond*

Year	United States	USSR	France	Italy	Japan	People's Republic of China	Australia	United Kingdom	European Space Agency
1957		2							
1958	5	1							
1959	10	3							
1960	16	3							
1961	29	6							
1962	52	20							
1963	38	17							
1964	57	30							
1965	63	48	1						
1966	73	44	1						
1967	57	66	2	1			1		
1968	45	74							
1969	40	70							
1970	28	81	2	[1]1	1	1			
1971	30	83	1	[1]2	2	1		1	
1972	30	74		[1]1	1				
1973	23	86							
1974	22	81		[1]2	1				
1975	27	89	3	1	2	3			
1976	26	99			1	2			
1977	24	98			2				
1978	32	88			3	1			
1979	16	87			2				1
Total	743	1250	10	8	15	8	1	1	1

[1]Includes foreign launchings of U.S. spacecraft.
*Note: This tabulation enumerates launchings rather than spacecraft. Some launches did successfully orbit multiple spacecraft.

satellite network that enhances their undisputed success in the fields of electronics and automation. In both the U.S. and Japan, business and industry have increased their use of facsimile and computer data transmissions, creating the so-called electronic office. Satellites play an essential role in this latest communications revolution.

The Soviets launched their first communications satellite, *Molniya 1-1*, in April 1965. Since that time through 1979, they have orbited 45 *Molniya-1*, 17 *Molniya-2*, and 12 *Molniya-3* class satellites, all of which had 12-hour orbits. In addition, they have sent three Gorizont, four Ekran, and three Raduga type communications satellites into 24-hour orbits to use for telephonic, telegraphic, television, and radio transmissions. In 1978, two amateur radio communications satellites called *Radio* were boosted into orbit. These two spacecraft were similar in purpose to the American ham radio satellite series known as *Oscar*. In 1978 and 1979, the Soviet Union also launched 54 military communications payloads as part of the Kosmos program; 48 of these were launched in groups of eight with six launch vehicles (Kosmos 976-983, Kosmos 1013-1020, Kosmos 1034-1041, Kosmos 1051-1058, Kosmos 1081-1088, and Kosmos 1130-1137). During the same time period, nine Kosmos navigation satellites were deposited in Earth orbits. The Meteor weather satellite program has included 27 Meteor-1 and 5 Meteor-2 class spacecraft.

By comparison with the Soviet Union and the United States, Japan is just beginning to build up its applications—or practical—satellite program, but it is moving ahead steadily. Japanese goals include the development of launch vehicles capable of placing satellites into geostationary orbit, the necessary tracking and control technology for such spacecraft, and the perfection of attitude control systems technology. NASA has launched two geostationary communications satellites and one geostationary meteorological satellite for the Japanese. Their first two attempts to orbit their Experimental Communications Satellite with the N-rocket in February 1979 and February 1980 resulted in failure. Concerned but undeterred, space agency managers and designers will continue with their program for a more advanced communications satellite system. A second Geostationary Meteorological satellite, GMS-2, is scheduled for launch by an N-rocket this year. In another applications program, the Japanese recently conducted an experiment in processing materials (an alloy, in this case) in space.

Space activities in the People's Republic of China are moving slowly from the initial stages of experimental launches and satellites to a more comprehensive program that will stress the practical applications of space technology, especially in communications, meteorology, and Earth resources management. In November and December 1978, Chinese and American space officials met in the U.S. (the American delegation led by NASA Administrator Robert A. Frosch and the Chinese team by President of the Chinese Academy of Space Technology Jen Hsin-min) to explore ways in which the two countries could cooperate in the field of space technology. A key topic in these discussions was the development of a civil communications satellite system for mainland China. Involved is the purchase by the Chinese of an American satellite communications system, including the associated ground receiving and distribution equipment. NASA would launch the satellites into geostationary orbit, and China would take over once the system was operational. A similar cooperative agreement was reached concerning the sale to China of a ground station capable of receiving Earth resources information from the NASA-National Oceanic and Atmospheric Administration Landsat remote-sensing satellites, including the Landsat-D scheduled for launch in the last quarter of 1982.

Since the first round of visits in 1978, the Chinese and Americans have had additional traveling exchanges involving government space agency officials and industry representatives. It is important to note that having successfully orbited domestically built satellites with their own launch vehicles, neither the Chinese nor the Japanese find it unacceptable to acquire foreign assistance with projects of immediate importance as they work to advance the state of their own technology—a very pragmatic attitude. China's most immediate goals are to develop a more powerful, efficient launch vehicle, advanced solid-state electronic components, and sophisticated communications and meteorological satellites.

China's new three-stage launch vehicle, called Long March-3, is expected to be flown this year, probably with an experimental communications satellite. The third stage of this vehicle will have a liquid-hydrogen and liquid-oxygen fuel system similar in concept to the American Centaur upper stage. These cryogenic fuels are difficult to handle, and the mastery of such technology by the Chinese will be a great leap forward. A 19-member delegation from the American Institute of Aeronautics and Astronautics visited China's aerospace facilities in November 1979 and made some candid assessments in their *China Space Report:* "We conclude that the Chinese are serious about their stated goal of an independent capability in communications satellites in the next decade, and are making good technological progress toward it. Their own frequently cited description of their technology as "primitive" is excessively modest. "Advanced, but simple," would be more apt. What they do lack, want, and expect to get from the U.S. is integrated know-how or "how to put it all together." They do not have experience or skills in systems engineering and program management. They do not seem to know much, for example, about designing to conflicting goals, such as performance, weight, power, cost, etc. They need information about reliability modeling and quality assurance techniques, and about scheduling and project control. To some extent the Chinese economic and social system has insulated designers from the concept of cost, at least for their own developments." Unfortunately, the Chinese have been forced by economics to postpone for several years the acquisition of the American-built satellites (two operational and one backup at about $150-250 million), but they will undoubtedly continue with their own research and development, even if at a lower level than before. Likewise, they have had to push back plans for their manned program until the 1990s (the first flights had originally been planned for the late 1980s).

If we tally up the total number of spacecraft launched from 1957 through 1979, we see that the USSR has a clear lead at 1,250. The U.S. follows at 743; then France 10, Japan 15, China 8, and the United Kingdom 1. Because of the Soviets' use of the catchall designation "Kosmos" (1147 of which had been launched through 1979) and the secrecy surrounding military satellites, we cannot classify all 2027 satellites by payload (scientific, meteorological, communications, etc.), but we can see certain trends (see tables). There has been an increase in communications and meteorological payloads over purely scientific investigations. Military payloads also—presumably many of these are communications and reconnaissance satellites—have been popular with the Americans and the Soviets. As public funds available for expensive space projects become scarcer in the years immediately ahead, it is probably safe to assume that ventures with some practical application that can be easily justified—like communications, weather forecasting, or military reconnaissance—will be funded more readily than scientific or experimental advanced systems payloads.

The Future

It can be dangerous for historians to venture into the field of projections: our crystal balls are as foggy as everyone else's. But the comments presented here are based upon projections made by Soviet, Chinese, and Japanese space experts. Clearly, there will be only five major space powers during the remainder of this century: the Soviet Union, the United States, the European Space Agency, Japan, and the People's Republic of China. And they will all apparently be concentrating their efforts on

Earth orbital operations for the foreseeable future, with occasional planetary probe missions for scientific investigation. All five powers look forward to their first manned or next-generation manned projects. The Soviets will continue with their *Soyuz-Salyut* missions, building toward a large Earth-orbiting space station. Americans hope to enter a new era of manned spaceflight next month with the launch of the first Shuttle orbiter. Shuttle flights will give European mission specialists assigned to ESA's Spacelab an opportunity to experience spaceflight, and the Japanese, among others, plan to send their payloads aloft via the new American space transportation system. Although the Chinese and Japanese cannot expect to conduct their first manned missions until late in this century, Chinese publications illustrate astronaut training in spacecraft cabin mockups, simulators, and centrifuges.

In the sphere of satellite projects, the Soviet Union will continue with its scientific, communications, meteorological, and military projects, with greater emphasis on Earth resources and oceanographic investigations. *Bhaskara*, launched on June 7, 1979, was a joint Soviet-Indian Earth resources satellite, and *Kosmos 1096*, launched on April 15, 1979, was believed to have been a partially successful ocean reconnaissance satellite (orbit decayed November 24, 1979). The Japanese are committed to launching increasingly advanced communications and meteorological spacecraft, but they also plan to become more deeply involved in Earth resources investigations and other practical missions, like material processing. For the mid-1980s, they have plans for biological payloads and limited lunar and planetary exploration with spacecraft of their own design and construction. Chinese plans call for the launch of their experimental communications satellites in 1981 and an experimental meteorological satellite the next year (the Chinese weather satellite has been described as roughly equivalent to the American Improved Tiros Operational Satellite—ITOS). This spacecraft will be placed in a 900-kilometer polar orbit. It is also likely that the Chinese will continue work with military reconnaissance satellites, and it has been suggested that their manned "Skylab" will have a military reconnaissance function, the same thing has been said for the Soviet *Salyut*. Manned observation craft could precede the availability of spacecraft equipped with remote-sensing devices by several years. A "box score" of space activity through December 31, 1979 is given in table 3.

Obviously, spaceflight is here to stay, and we will see the tempo of activity increase considerably in the coming decades. As Walter A. McDougall has noted, just as aircraft were the measure of a nation's technology between the two world wars, space technology has become the

Table 3. Space Box Score Through December 31, 1979

Country	Manned Activities		Unmanned Activities						
	Earth Orbiting	Lunar	Physics and Astronomy	Lunar and Planetary	Life Sciences	Meteorology	Communications and Navigation	Earth Resources	Military
Soviet Union	41	0	31[2,3]	52	6	29	74	1	Kosmos 1,147
United States (NASA and USAF)	22[1]	9	218[4]	39	8	47	114	4	374
France	0	0	15[5]	0	0	0	0	0	0
Japan	0	0	14	0	0	1[6]	3[6]	0	0
China	0	0	7	0	0	0	0	0	1
United Kingdom	0	0	1	0	0	0	0	0	0

Notes. All categorizations are approximate For example, the Soviet Kosmos series includes *many scientific spacecraft*, but the Soviets generally have not given details on their projects.

[1] Includes 2 Mercury-Redstone suborbital missions.

[2] Includes engineering test spacecraft, but does not include scientific satellites flown in Kosmos series.

[3] Includes joint missions flown with France, India, and the Warsaw Pact Nations.

[4] Includes joint missions flown with Australia, Canada, ESRO, Federal Republic of Germany (FRG), France, Italy, Japan, NATO, Netherlands, and Spain.

[5] Includes joint missions with USSR, USA, and the FRG.

[6] Includes 1 meteorological and 2 communications satellites launched for the Japanese by NASA

post-1945 symbol of technological prowess. Although the spaceflight enterprise began as an extension of Cold War competition and scientific inquisitiveness and grew mightily because of the power and prestige it brought its backers, it has been sustained for its practical values, for its everyday utility. To be certain nations will continue to measure one another by what they have or have not accomplished in certain technological arenas, and space will be one of them. But individual nations will examine their own activities in terms of the practical benefits their space programs are bringing their own people and socioeconomic system. Space may still be the "high frontier"—with all the hope and adventure that that term implies—but it is the dividends delivered back to Earth that will keep the adventure going.

Source Notes and Recommended Reading

Soviet Space Program:

Riabchikov, Evgeny. *Russians in Space*. Translated by Guy V. Daniels. Garden City, NY, 1971 (an official view of the Soviet space program prepared under the direction of the Novosti Press).

Smolders, Peter. *Soviets in Space: The Story of the Salyut and the Soviet Approach to Present and Future Space Travel*. Translated by Marian Powell. Guildford and London, 1973.

Japanese Space Program:

Keidanren (Federation of Economic Organizations). *Space in Japan, 1978-79* (Tokyo, 1979).

Kuroda, Yasuhiro. "Overview of the Japanese Space Activities," paper presented at the 1979 Australian Astronautics Convention (Perth, August 20-25, 1979).

Chinese Space Program:

Pritchard, Wilbur L., and James J. Harford, eds. China Space Report: An Eyewitness Account of China's Space Activities by a Delegation from the American Institute of Aeronautics and Astronautics, November 1979 (New York, 1980).

General References:

TRW Defense and Space Systems Group. *TRW Space Log*. Published by TRW's public relations staff. (Redondo Beach, California, 1960).