THE SCRAMBLE FOR SPACE

by Walter A. McDougall

A thumbnail definition of a great power between the two world wars might have been: "A nation that builds its own airplanes." The updated version would be: "A nation that launches its own spacecraft." While the United States and the Soviet Union are still the Big Two, and remain the only nations capable of orbiting satellites at will, the diffusion of space technology has already begun.

Leaving aside the United States and the Soviet Union, five nations (France, Britain, China, Japan, and India) have developed rockets to launch payloads into orbit. Six other states (West Germany, Italy, the Netherlands, Spain, Canada, and Australia) have constructed entire spacecraft for launch by others. Through participation in such international organizations as Intelsat and the World Meteorological Organization, or by contributing hardware and experiments to joint satellite ventures, almost any regime can now have a "space agency."

Two jolts, one military, the other commercial, prompted third countries to stake out their claims on the high frontier.

The first was the Soviet launching of Sputnik 1, atop an intercontinental ballistic missile, on October 4, 1957. The real significance of Sputnik lay less in the satellite (whose radio transmitter merely went "beep beep" to permit tracking) than in the rocket that put it into orbit. Soviet development of an ICBM poked holes in the Free World's U.S. "nuclear umbrella" and obliged every nation in the world to reappraise the balance of power, the "trend of history," and its own defense posture.

The second jolt was the vigorous American *reaction* to Sputnik. Anxious to leapfrog the Russians and reassure allies and nervous neutrals, Washington helped to underwrite an R&D revolution that, by the mid-1960s, threatened the rest of the industrialized world with a widening "technology gap." The implications were sobering. "History clearly shows," warned France's science minister, Gaston Palewski, in 1963, "that the independence of nations and their ability to survive are intimately bound up with their scientific efforts."

France led Europe into the space age. When Sputnik flew in 1957, France was smarting from the bitter memory of Dien Bien

Phu and the Suez crisis, and the pains of civil war in Algeria. Politically, the country was in turmoil. In 1958, Charles de Gaulle was called out of a restless retirement at Colombey-les-deux-Églises to lead the Fifth Republic.

De Gaulle's *certaine idée* of the future of France encompassed more than *la gloire* and distrust of "the Anglo-Saxons." It depended above all on technological self-sufficiency, both military and economic. Between 1959 and 1963, France's R&D spending quadrupled, with much of the new money going to two new aerospace agencies—the Centre National d'Études Spatiales (CNES) and the Office National d'Études et de Recherches Aerospatiales (ONERA)—and to the Société pour l'Étude et la Réalisation d'Engins Ballistiques (SEREB), which would be responsible for the initial development of both military and civilian rockets.

Dix, Neuf, Huit . . .

The emphasis at first was decidedly military. Declaring the U.S. deterrent unreliable (would Washington really risk New York to save Paris?), de Gaulle pushed ahead on a nuclear missile program of his own—the celebrated *force de frappe* (or "strike force"). The French had begun their rocket program by experimenting with the old German V-2s that had been divided among the allies after the war. Development of homemade launchers under the direction of SEREB came after 1959. By 1972, France was installing nuclear warheads in its atomic-powered submarines, and in silos buried deep in the Massif Central.

By the time France emerged from the Algerian debacle in 1962, national defense had been married to sheer economic survival as the Gaullist rationale for a national leap into aerospace. President Kennedy had embarked upon the Apollo program, and the Americans, as one French economist noted, had discovered the "keys to power": state-supported R&D in "point sectors" to aid in spreading revolutionary new techniques throughout the economy. The technology gap between Europe and America seemed as vast as the Atlantic.

The French set out to replicate American "space age management" and, through SEREB, stepped up development of

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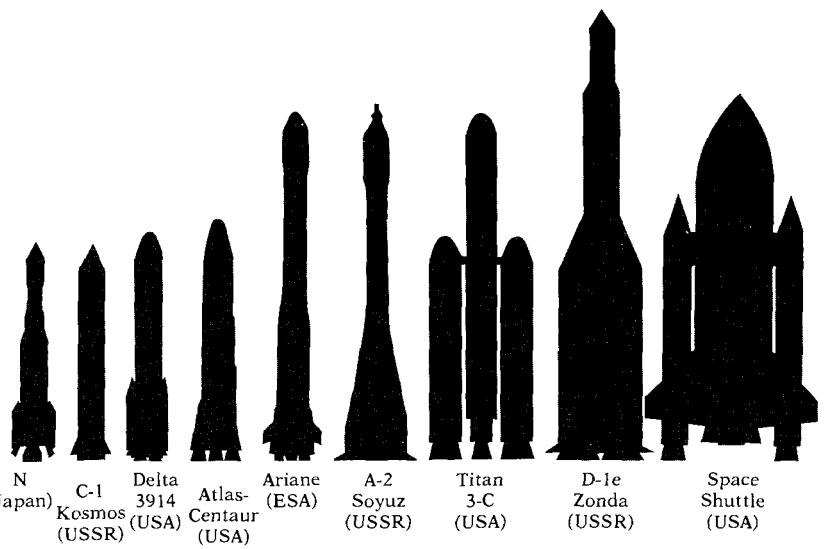
THE WORLD'S ROCKETS COMPARED



Source: European Space Agency.

their "precious stones" series of boosters (Agate, Topaze, Rubis, etc.). France became the world's third space power in 1965 when a Diamant rocket, launched from Hammaguir in the Algerian Sahara, put the satellite Asterix into orbit. The French national effort has continued apace, as have various cooperative ventures. Two French pilots began training last July for a joint space flight with Soviet cosmonauts in 1982.

The goal of a vigorous French space program was not to match the United States or the Soviet Union. As the French saw it, Europe as a whole was destined to evolve away from its economic and technological dependence on the United States, and Gaullist France must be first among European equals. French missile chief General Robert Aubinière promised in 1967 that "the space program will put our industry in a favorable position in relation to the competition that will develop *in Europe*."

That France has largely succeeded in this aim is due in part to the ambivalence of Great Britain. Space research in Britain has suffered, since the late 1950s, from a dizzy bureaucratic roundelay in which responsibility for space programs has been assigned to no less than nine ministries. The incoherence of the U.K.'s space effort reflects a larger confusion over the role of Britain in a postcolonial world, and over the role of R&D in a

postindustrial society. Where the French have sought economic independence in the long term, regardless of the immediate costs, the British have resisted duplication of technology, such as rocket launch service, available from the United States. The foot dragging of the Queen's representatives in joint European space efforts has earned them the sobriquet, "the delegates from the United States."

Britannia Steps Aside

The British, who clung to their status as a nuclear power during the 1950s with their V-bomber force, reacted to Sputnik by throwing in the towel. Britain decided, in effect, no longer to pretend being a great power. Although the British at the time had a headstart among the Europeans in missile development —prototypes of its Blue Streak and Black Knight missiles were nearing completion—the U.K. cancelled its military missile program and chose henceforward to rely on the United States. Instead of using its booster technology to launch a civilian space program, Whitehall offered its unfinished Blue Streak rocket as the first stage of a proposed pan-European space booster. The reasons were predominantly fiscal, partly strategic, and to no small degree political. "The critical lead which Britain should have taken at that moment," Sir Bernard Lovell observed in 1972, "evaporated almost entirely as politicians sought to ingratiate themselves with the European community."*

Admittedly, the idea of a joint space venture seemed to make sense. European politicians were already groping toward some sort of fragile unity through the nascent European Economic Community; surely a cooperative space effort would strengthen the bond. Moreover, financing a go-it-alone space program would be an unbearable burden for most governments on the continent; together, the feat was manageable. Such at least was the thinking behind two agencies established during the early 1960s: the European Launch Development Organization (ELDO) and the European Space Research Organization (ESRO). The two agencies soon became textbook examples of how *not* to run a space program.

ESRO was designed to secure a share of the world's space exploration for European scientists and businessmen. Its 10

*London had a tentative change of heart in 1964 and began development, on a shoe-string budget, of the Black Arrow booster. The program prospered, and in 1971, a Black Arrow rocket successfully launched the satellite Prospero into orbit from Woomera, in South Australia. The Black Arrow project was then cancelled. It has been said, with some justice, that the British notion of R&D is to forget the D.

PUTTING FIRE INTO HEAVEN

The spring of 1978 was not kind to General Mobutu Sese Seko, President of the Republic of Zaire, formerly the Belgian Congo. On May 11, Katangan rebels had invaded his nation's Shaba province. Then, on June 5, flanked by guards, Mobutu watched as a small rocket built by a West German firm called Orbital Transport-und-Raketen-Aktiengesellschaft (OTRAG) rose a few feet off the Split Behind plateau only to plunge 4,000 feet into a river valley below. It was OTRAG's last hurrah and Zaire's last venture into the space race.

OTRAG had been founded in 1975 by engineer Lutz Kayser with (ultimately) $60 million from 1,100 German investors seeking a tax shelter. The rationale behind the world's first private space enterprise was simple: With a low-cost "toy mouse" rocket, Kayser hoped to siphon off Third World demand for satellite launchings from Europe's sleek Ariane and the sophisticated U.S. space shuttle. Using the shuttle to put satellites in orbit, Kayser was fond of saying, "is like transporting bags of cement in a Rolls Royce."

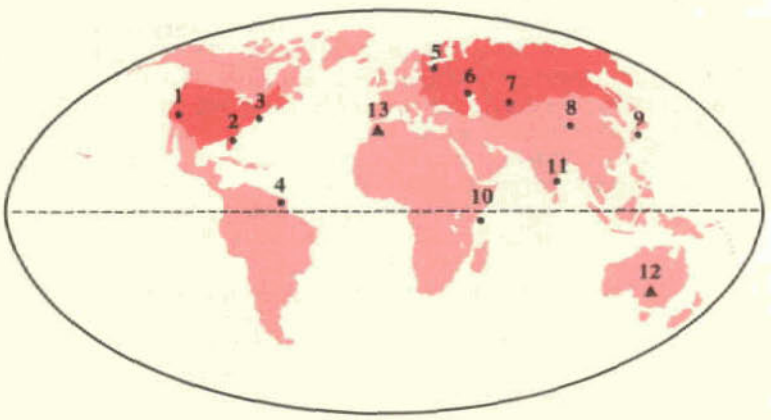
What came to be dubbed the "Volksrocket" resembled a bunch of asparagus, with the number of "spears," or rockets, varying according to the size of the payload. Whenever possible, OTRAG used mass-produced, commercially available components. The motors for opening the rocket fuel valves, for example, were ordinary $20 Bosch automobile windshield wiper motors.

All OTRAG needed was a spacious launch site—and a sponsoring government to circumvent the United Nations' 1967 ban on "freelance" space travel. Zaire's Mobutu, eager to make his country the "Cape Canaveral of Africa," stepped forward in 1976 with an offer of 39,000 square miles of undulating plateaus and lush river valleys—a territory one-half the size of West Germany, within which OTRAG would exercise virtual sovereignty. In return, Zaire was to receive a $50 million annual rental (beginning in 1980), 5 percent of eventual revenues, and one free launch. By 1977, some 240 OTRAG personnel were settled in northern Shaba province. Whenever a launch was imminent, the natives were evacuated to a "big festival." The first two tests were successful, and Lutz Kayser became known locally as "the white friend who puts fire into heaven."

Neighboring Tanzania, Zambia, and Angola, however, were not pleased. There were rumors, never confirmed, that OTRAG was in fact testing Western military cruise missiles. Soviet propagandists warned of "the German spear in the heart of Africa." West Germany's Chancellor Helmut Schmidt regarded the whole affair as "embarrassing." Facing diplomatic pressure from all sides, and stung by the inglorious failure of OTRAG's third launch, in 1979 Mobutu ordered the company to cease all rocket tests. The white friend went home, his "Volksrocket" destined for immortality as a write-off on 1,100 tax returns.

MAJOR EARTH LAUNCHING SITES

Most of the world's spaceports have been located as close to the equator as possible. There are several reasons. Geosynchronous communications satellites must be parked over the equator, and an equatorial launch site eliminates the need to "dog-leg," or correct, a satellite's orbit during flight, which requires substituting additional fuel for payload weight. The Earth's rate of rotation is also greatest at the equator—about 1,000 miles per hour—giving rockets an extra boost. To take advantage of that boost, rockets must be launched eastward. That is why most spaceports are located on an east coast, ensuring that any failures occurring during the first critical minutes after liftoff will happen over the open seas. Military "spy" satellites are not placed in equatorial orbit but rather utilize the "pare the apple" principle: They orbit the poles, their cameras clicking along a broad swatch as the Earth spins beneath them. Thus, military spaceports like Vandenberg in California and Plesetsk in Arkhangelsk have a clear shot to the North. (The Chinese, however, prudently avoid Soviet airspace and launch to the Southeast.)



Orbital Launch Sites:

1 Vandenberg AFB (USA)
2 Kennedy Space Center (USA)
3 Wallops Island (USA)
4 Kourou, French Guiana (ESA)
5 Plesetsk (USSR)
6 Kasputin Yar (USSR)
7 Baikonur Cosmodrome (USSR)
8 Shuangchenzgi (China)
9 Tanegashima (Japan)
10 San Marco Platform, Kenya (Italy)
11 Sriharikota Island (India)

Former Launch Sites:

12 Woomera, Australia (ELDO)
13 Hammaguir, Algeria (France)

member governments proposed to design payloads for sounding rockets and satellites, and to share and analyze data from European experiments aboard NASA (and, eventually, ESRO) satellites.* But getting the birds into the air proved to be unexpectedly difficult. Launches of satellites, all aboard American boosters, did not begin until 1967, had mixed success, and were all of a purely scientific, as opposed to commercial, nature. Bitter wrangling persisted among ESRO governments over the disproportionate distribution of contracts. Between 1965 and 1967, for example, France contributed only 19 percent of ESRO's budget but received 37 percent of all ESRO outlays, a none too subtle tribute to Gaullist technology policy.

The purpose of ELDO was to develop a European rocket, the Europa-1, that would free the continent from dependence on the United States. The plan looked good on paper. Britain would supply the Blue Streak first stage, France the Coralie second stage, Germany the Astris third stage, and Italy the test satellite. But by 1969, eight years after the initial agreement, ELDO had put nothing into orbit and was 350 percent over budget.

ELDO was plagued by the usual bugaboos: poor management, political squabbling, underfunding. Perhaps the most serious problem faced by the European space effort was that of purpose: *"L'espace pour quoi faire?"* For all the boilerplate at ministerial meetings about cooperation, the fact remained that the Europeans were hard pressed to agree on just why it was so important to have a space program.

Even as ESRO and ELDO stumbled through the 1960s, "American hegemony," particularly within Intelsat, the international consortium for communications satellites, gave the Europeans reason to press on. Although a nucleus of 19 nations had formed Intelsat in 1964, the United States, through the federally chartered Comsat Corporation, controlled 61 percent of the voting authority and almost 100 percent of the satellite technology. Comsat, which managed Intelsat under contract, was in turn composed of giant American firms like AT&T, which had little interest in expanding satellite services that might compete with its own oceanic cables. This situation infuriated the Europeans, but there was no way they could compete, since U.S. export licensing rules blocked the sale of American launch technology to Europe, while NASA was under instructions not to launch foreign satellites that might compete with Intelsat. This was precisely the sort of "dependency" the French had warned of. It gal-

*The 10 member countries were Belgium, Denmark, France, West Germany, Italy, the Netherlands, Spain, Sweden, Switzerland, and the United Kingdom.

vanized the European space community.

In 1972, the European Space Council merged ELDO and ESRO into a new European Space Agency (ESA). ESA has made a fresh start on a heavy launch vehicle, and, for payloads, has put more emphasis on profitable "applications" satellites rather than on purely scientific ones. Financial participation in ESA is largely on an à la carte basis, meaning that member countries may buy into only those programs that interest them. Major programs, moreover, are now under the direction of a single country. France's giant Aerospatiale, the semi-public corporation that absorbed SEREB, is the prime contractor for the Ariane booster, which should be in operation by 1982, and which should enable ESA to launch whatever it likes, regardless of what Washington thinks.* West Germany has led in constructing the sophisticated Spacelab, which is ready and waiting to be hoisted aloft by the U.S. space shuttle. Britain is designing the new Marots marine navigation satellite. Meanwhile, a revised "permanent agreement" on Intelsat has broken U.S. control, allowing Europe to compete for all contracts.†

Italian Styling, German Skill

Despite its growing pains, European space cooperation now appears to be a going concern. Not the least of its achievements is that it has tapped the ingenuity of countries that, for reasons of size or constitution, could never have supported a full-fledged space program on their own. Italian space research, for example, has been limited to cooperative scientific programs, but Italy has made a unique contribution to space history with its San Marco launch platform in the Indian Ocean, three miles off the coast of Kenya. West Germany's space program is also largely subsumed under ESA. Germany was forbidden after World War II to continue its pioneering rocketry experiments, whose military application during 1944 and 1945 destroyed parts of London. But Bonn has been an active partner in various European and American projects, and, having mastered satellite electronics, is seeking to satisfy some of the demand for sophisticated spacecraft from such places as Brazil and Egypt.

*The Ariane successfully boosted a test satellite into orbit on Christmas Eve, 1979—15 years after the formation of ELDO—but a second test last May was a failure. There is a certain competition between the Ariane and the U.S. shuttle: Third parties have booked space aboard one or the other depending on price, politics, and which they believe will first be operational.

†CNES officials hope to capture 20 to 25 percent of the global booster satellite market, including Intelsat 5 launches after 1982, ESA missions, and third party launches, such as the Arabsat communications satellite.

During the first decade of the space age, references to "third powers" in space generally meant France and Europe. During the second decade, the more ambitious nations of Asia began building space programs with quiet determination.

The Japanese, like the Germans, have shunned military rocket research during the postwar era. Until 1969, the Japanese space program rested solely in the hands of professors at the University of Tokyo's Institute for Space and Aeronautical Sciences (ISAS). After the Allied ban on all rocket work was lifted in 1954, ISAS slowly developed its relatively inexpensive "Greek letter" series (Kappa, Lambda, Mu) of rockets. After many disappointments, in 1970 the professors finally boosted a tiny 24-kg. satellite into orbit on a thin, four-stage Lambda rocket. Japan became the world's fourth space power, proud to have beaten out the neighboring Chinese.

A Great Leap Upward

Pressure from Japanese industries such as Mitsubishi and Ishikawajima-Harima, eager to penetrate the aerospace market, soon brought a shift in emphasis. Even as the Apollo 11 crew explored the moon in July 1969, American and Japanese negotiators were concluding an unprecedented agreement for the sale of U.S. technology enabling the Japanese to build a space booster comparable to the American Thor-Delta. The pact prohibited transfer to third parties or competition with Intelsat, but it nevertheless represented a degree of American largesse the Europeans could only envy.

Japan's new National Space Development Agency and its modern launch site on an island south of Kyushu, the Tanegashima Space Center, now support the fastest growing space program in the world. (Since 1970, Tokyo's annual space budget has grown by 600 percent, to about $469 million in 1979.) American businessmen anticipate heavy competition from the Japanese in the world market for communications satellites. Crowded, economically aggressive, militarily passive, Japan has opted, in a sense, for "vertical expansion."*

China is also in the second rank of space powers, alongside France and Japan, but little firm information on the PRC's space program is available. During the past year, U.S. scientific delegations have visited Chinese research and launch facilities. Chinese teams, anxious to tap American space technology, have in

*Scientific missions will also increase. The Japanese plan to launch their first interplanetary probe in 1985, in time to catch Halley's comet before heading on to Venus.

THE SOVIETS: FROM SPUTNIK TO SALYUT

The Russian space program began in 1902, the seventh year of the reign of Tsar Nicholas II, when a penurious and half-deaf young mathematician named Konstantin Tsiolkovsky recorded his thoughts ("Consider a cask filled with a highly compressed gas. . . .") on the possibilities of rocket propulsion. Tsiolkovsky's ideas received little attention at first, but after the 1917 October Revolution, the Bolsheviks seized on space travel as a symbol of socialist uplift. Rocket research flourished in the Soviet Union during the 1920s and '30s. After World War II, when Josef Stalin became intrigued with the possibilities of an intercontinental missile to help offset America's long-range bombers, Sputnik became only a matter of time.

The global furor attending the initial successes of the Soviet space program emboldened the Kremlin as much as it surprised the White House. Yet, while the new Soviet Sapwood (SS-6) booster was considerably larger than any U.S. rocket prior to the successful test of the Saturn C-1 in 1961, this was in fact the *only* area of space technology in which the Russians were superior. (One reason for the size of the SS-6: It was designed before the Russians had developed advanced "light" hydrogen bomb warheads.)

During this first phase of the Soviet program, which corresponded roughly with the reign of Premier Nikita Khrushchev and his spacecraft designer, the brilliant Sergei Korolyov, the Russians concentrated on achieving prestigious "space firsts" of marginal scientific use but considerable propaganda value: e.g., the first man in space (1961), the first woman in space (1963), the first "space walk" (1965).

The accession of the Brezhnev regime in 1964 and the death of Korolyov one year later ushered in Phase Two. While feasibility studies for a lunar landing probably continued, the Soviets, in effect, conceded the moon race to the United States and shifted their attention to practical "applications" satellites in earth orbit (for military reconnaissance, mapping, communications, and so on) as well as unmanned exploration of the moon and planets.

The U.S.–Soviet "space race" since 1957 has become something of a tortoise and hare proposition. Since they leaped ahead during the

turn toured NASA sites; China's vice-premier Deng Xiaoping in 1979 spent several happy minutes at the controls of a space shuttle simulator in Houston. Yet the origins, goals, and funding levels of the Chinese space program are unknown.

Chinese satellites have probably been launched on military IRBMs and limited range ICBMs (a real ICBM, the CSS-X4, comparable to the U.S. Titan 2 and Soviet SS-9, was successfully tested last May) fired from their desert base near Shuangehenzgi in the Kansu region. Modern Chinese missile expertise

mid-1960s, the Americans have been napping while the Soviets have gradually developed sophisticated manned and unmanned space techniques. Thus, their 36 manned Soyuz flights (as of August 1980) have centered on long-term supply and occupancy of six Salyut space stations and have permitted intensive research in manned reconnaissance, biomedicine, and agriculture and manufacturing in space. Moscow's space program continues to absorb 1.5 to 2.0 percent of Soviet GNP (the U.S. figure is 0.3 percent) and provides employment for an estimated 600,000 workers.

The Kremlin has also exploited showpiece "cooperative" launches featuring token East European cosmonauts. The only Soviet venture undertaken in cooperation with the United States was the 1975 Apollo-Soyuz "handshake in space," which, though it seeemed a good idea during that moment of detente, amounted to a U.S. giveaway of some technology and mission control techniques.

In the unmanned categories, veiled by the cryptic "Kosmos" label that has been applied to more than 1,200 Soviet spacecraft to date, the Soviets have experimented with several generations of spy satellites, possibly a reusable shuttle-type vehicle (the Kosmolojot or Raketoplan), killer-satellites, and fractional orbital bombardment systems. The Soviets put something up in the sky, on average, every other day, in part because some Soviet spacecraft lack the longevity and versatility of their American counterparts.

Nevertheless, in the 1980s, the United States faces a steady, competent, and broad-based Soviet space effort that America, with its space shuttle, *may* be able to match. If not, the Soviets could lead the "third industrial revolution" in space manufacturing; build the first permanently occupied "space colony"; and, ultimately, stun the world, Sputnik-style, with an operational laser weapons system capable of "neutralizing" American military spy satellites.

How can the USSR afford it all with a GNP half that of the United States? "There will always be funds set aside to resolve the problems of the universe," Premier Aleksei Kosygin has explained. "We don't have any contradictions in the Soviet Union between appropriations for space research and the needs of the population."

—W. A. McD.

apparently stems from technology shared with the People's Republic by the USSR in the 1950s, and from the knowledge carried to China in the head of Dr. Qian Xueshen, a top scientist at Cal Tech's Jet Propulsion Laboratory, who was deported by the United States in 1955 as a security risk. The Chinese missile program achieved maturity of sorts in 1970 with the launching of an earth satellite that broadcast the melody of "The East is Red" to the world at large.

By the mid-1970s, a larger Chinese rocket was boosting pay-

loads in the 4,000-kg. range, possibly including recoverable capsules. This led to speculation, apparently in error, that China was moving directly to a manned space program. It is more likely that the Chinese are pursuing a vigorous spy satellite program—using detachable film packs that can be dropped to Earth—to augment their fledgling ICBM deterrent force.

Since President Nixon's visit to Beijing (Peking) in 1972, the United States and the PRC have inched toward a formula for future space cooperation. China has tentatively reserved space on the U.S. space shuttle for 1982, and is cautiously exploring offers of American and Japanese aid in developing earth resources and communications satellites. Unlike the Japanese effort, China's great leap upward is not coherently integrated into the national economy. "You come away from a fairly modern facility with good looking computers," noted a recent American visitor, "then run into a water buffalo dragging a wooden plow."

The same might be said of India, likewise a miserably poor country investing in "precocious" technology. Harish Agrawal, a leading Indian scientist, explained New Delhi's rationale: India, he observed, "must master the latest achievements of space science and nuclear technology so that it can leap from its backwardness and resolve its problems of poverty and development." Off the record, Indian officials seem to be more taken with the political and military implications. India has cooperated extensively with the Soviet Union and last July launched the satellite Rohini into orbit on a homemade booster.

Space during the 1980s is something like Africa during the 1880s—dark, vast, only partly mapped. Like Africa then, space has only just begun to be explored, even as exploitation, for some countries, has become almost a matter of routine. Greater and lesser powers, meanwhile, scramble for a foothold, their motives a mix of military, economic, scientific, and prestige considerations. While international agreements bar national appropriation of orbital space or heavenly bodies (i.e., "colonialism"), space law is by and large limited to vague principles defining an essentially laissez-faire regime. That, coupled with the limitless promise of space and continued national rivalries on Earth, virtually ensures a growing club of spacefaring nations, disunited in purposes and loyalties.

It has always been thus on Earth. Why should space be any different? As Robert McNamara was fond of pointing out, space is not a mission, not a technology, not a cause. It is just a place.