# GOVERNMENT VS. FREE ENTERPRISE IN SPACE

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## EXECUTIVE SUMMARY

Until recently, the U.S. had a clear lead in virtually every aspect of space technology. Today, we are in danger of losing that lead to Europe, to Japan, and even to the Soviet Union. Burdensome regulations and vacillating and erratic federal policies have seriously impeded the U.S. space industry in its efforts to take advantage of our greatest asset -- the vitality and productivity of the American free enterprise system. In satellite communications, for example:

- Private companies in the satellite communications industry must answer to 13 federal regulatory bodies, two international organizations, and four international treaties.

- Over the last 30 years there have been seven major policy shifts in the role of NASA with respect to research and development.

Changes in federal policies occur because of changes in administrations and disagreements between presidents and Congress. They also occur because of bureaucratic "turf battles" within NASA and between government agencies. These shifts in policy are not the exceptions; they are the rule.

- There have been eight major shifts in federal policy toward aeronautical communications.

- There have been five major shifts in federal policy toward satellite communications with mobile groundstations.

- In remote sensing from space, there have been at least 11 major policy shifts; in the field of satellite launching services, there have been at least five.

These shifts in policy have had a devastating affect on the willingness of private industry to make long-term research and development commitments. By contrast, European countries have created a stable policy environment that encourages private-sector development.

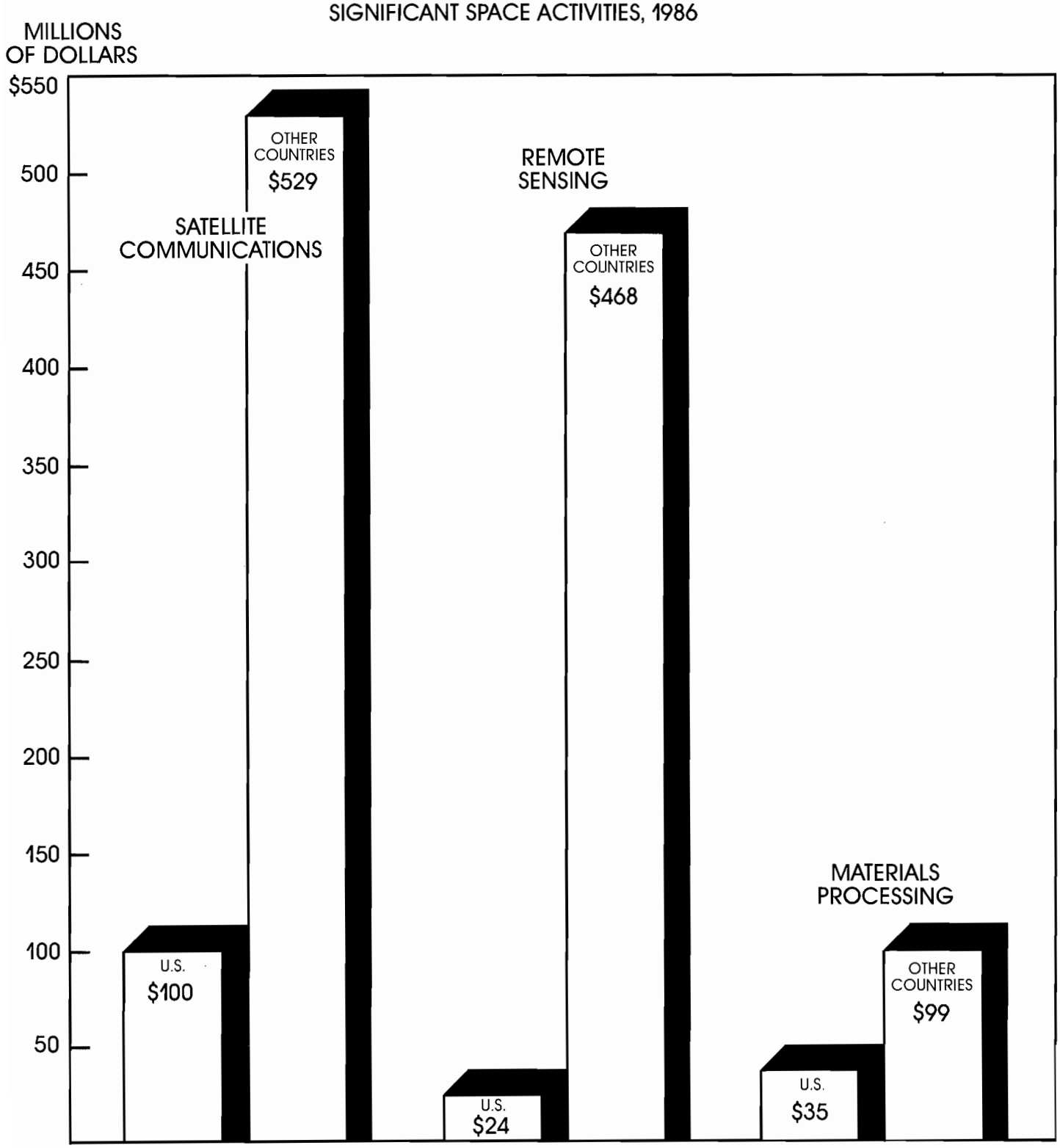
The federal government also has discouraged private sector development by charging prices well below costs for certain space-related services in satellite navigation, remote sensing and satellite launching services. This practice deters private industry from entering the market. As a result, it also has discouraged promising new technology and other innovations.

Federal policies governing the use of the Space Shuttle have penalized U.S. companies in yet another way. Private industry invested millions of dollars in developing Shuttle-dependent technology because seven Congresses and four administrations endorsed the principle that the Shuttle would be the primary means of launching satellites in the U.S. But, as a result of a policy change in 1986, commercial interests must now find some other way of getting their satellites into space.

If this nation loses the race for leadership in space to foreign competitors, the U.S. government must shoulder most of the blame.

# COMMITMENT TO SPACE

GOVERNMENT SPENDING ON COMMERCIALLY SIGNIFICANT SPACE ACTIVITIES, 1986

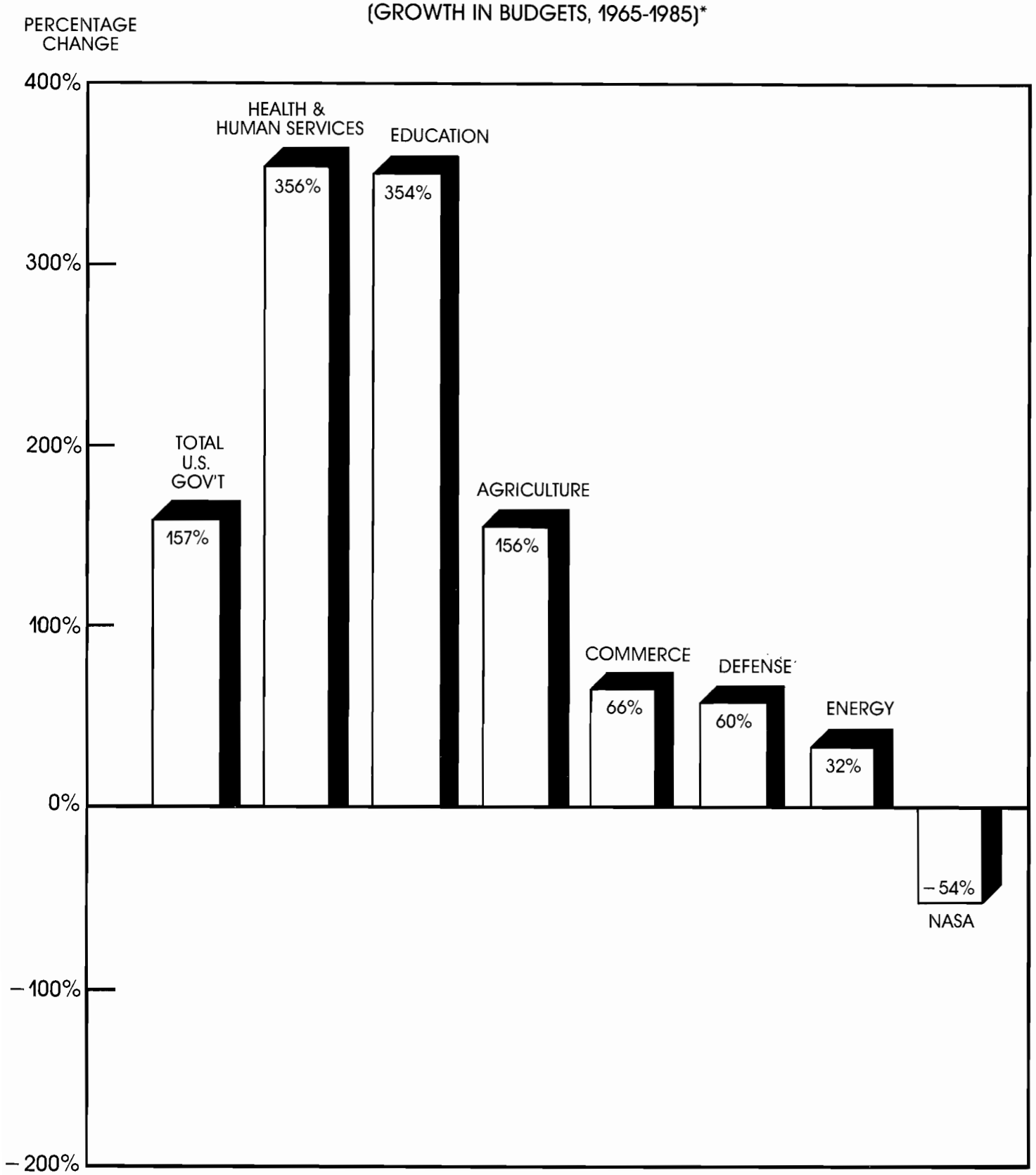



OTHER COUNTRIES: THE EUROPEAN SPACE AGENCY AND THE SPACE PROGRAMS OF FRANCE, GERMANY, JAPAN AND CANADA

*SOURCE: "The U.S. Civil Space Program: An AIAA Assessment," American Institute of Aeronautics and Astronautics, March, 1987.*

# FEDERAL BUDGET PRIORITIES

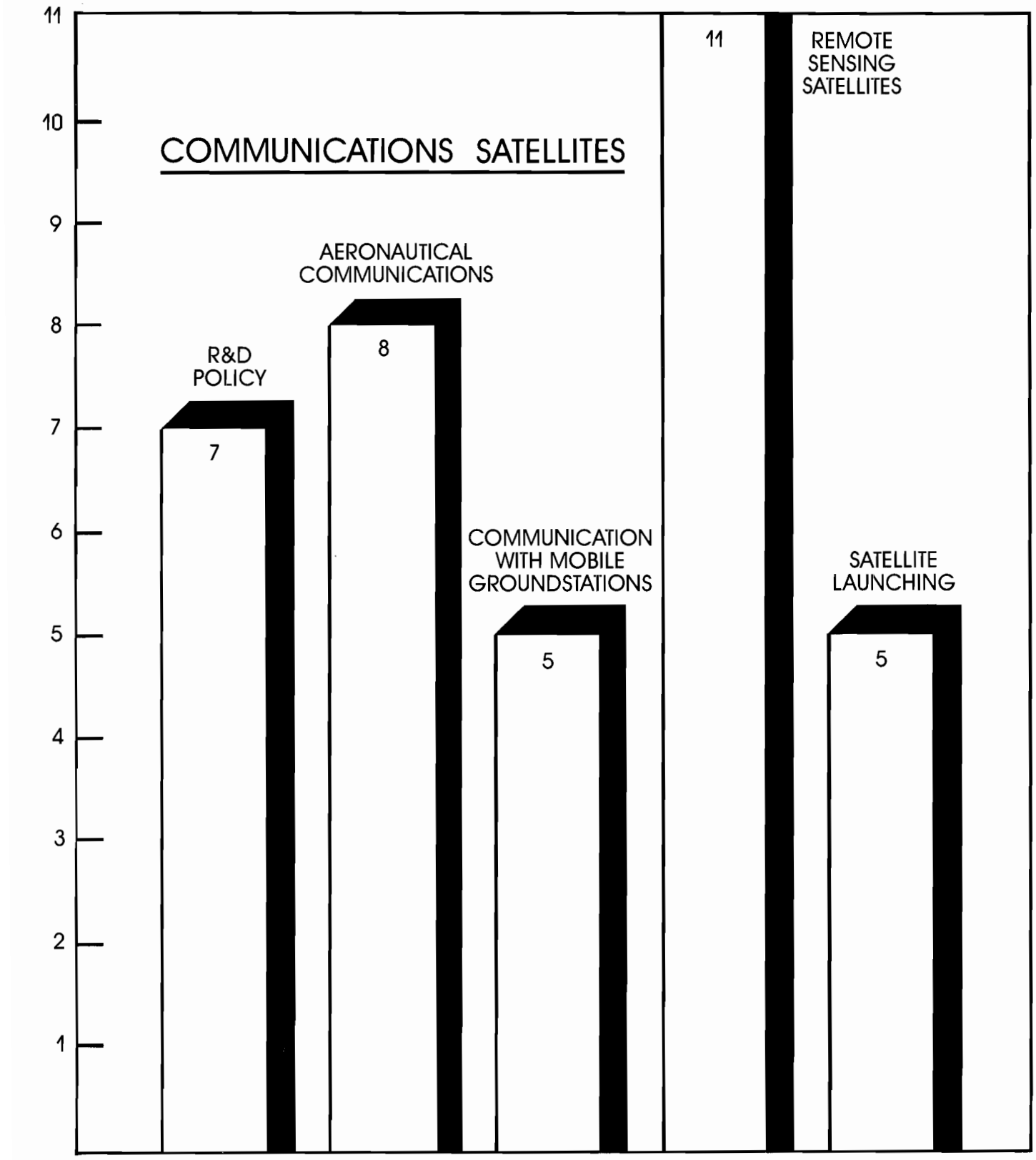
(GROWTH IN BUDGETS, 1965-1985)*




*SOURCE: OFFICE OF MANAGEMENT AND BUDGET*

**Measured in Constant Dollars*

# MAJOR CHANGES IN U.S. SPACE POLICIES
(1957-1987)




*SOURCE: NATIONAL CENTER FOR POLICY ANALYSIS*

## INTRODUCTION

Ever since the birth of the space age, the proper roles of the government and the private sector have not been well-defined. This problem is not unique to space development. It is evident in other sectors of the national economy as well.

However, unlike virtually every other important economic activity, space activities initially were almost wholly funded and operated by the government. Although high costs and high economic risks are important factors deterring private industry from investing in space, unwise federal policies also have contributed to a lack of private sector involvement.

Economists have long recognized that certain kinds of investments create general benefits for the economy as a whole. Because no single investor can capture the economic benefits of these investments, there is a case for government to undertake or subsidize them. Usually, these are investments in basic research. For the kinds of investments that primarily benefit the investor, however, the private sector generally can undertake them on its own and can do so far more efficiently than government. Usually, these are investments in applied research. Yet prior to 1984, this distinction played no role in shaping U.S. government policy toward the commercial development of space.[1]

### Reagan's Privatization Initiatives

Since 1984 the Reagan Administration has directed NASA to explore "privatization" of government space activities wherever practical. The five basic goals of the Reagan program are unassailably logical. The Administration is committed to:[2]

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[1] It was not until 1984, with the enactment of the Commercial Space Transportation Act and the Earth Observations Commercialization Act, along with the establishment within NASA of an Office of Commercial Programs, that there was any formal recognition of the private sector in a role other than that of government contractor.

The policy framework now common to all commercial space activities is enunciated formally in the Reagan Administration's July 20, 1984 directive on "National Policy on the Commercial Use of Space" and NASA's subsequent commercialization plan of October 29, 1984, based on the presidential directive. These actions were preceded by an overall space policy defined by National Security Decision Directive (NSDD) No. 44 of July 4, 1982, which had committed the Administration to "a climate conducive to expanded private-sector investment."

[2] James M. Beggs, NASA Memo, "NASA Commercial Use of Space Policy," October 29, 1984.

- Creating new opportunities for the private sector to work with NASA on commercial projects.

- Avoiding government interference with or intervention in commercial enterprises.

- Encouraging private-sector takeover of government operations wherever practical and efficient.

- Funding research and development facilities that industry is unable or unwilling to pay for.

- Supporting commercial enterprises only when they promise national benefits and when they involve substantial investments of private funds.

One major accomplishment of the Reagan Administration is that regulatory process has been considerably streamlined.

- When Ronald Reagan took office, a private company desiring to launch a rocket into space had to obtain clearance from between 10 and 20 different regulatory agencies--including the Alcohol, Firearms and Tobacco Administration.

- The State Department had succeeded in designating space-bound rockets as "exports," subject to a vast array of export controls. In theory, materials processed in space were subject to import taxes upon their return to Earth.

Many of these regulatory obstacles have been eliminated, and most of the ones that remain have been consolidated under the Office of Commercial Space Transportation in the Department of Transportation. Despite these accomplishments, the jury is still out on whether the Administration has done enough to ensure that the U.S. space industry can compete successfully in world markets.

## Competition from Abroad

As late as 1982, the European Space Agency[3] had launched only three rockets into space and Japan had launched only 21. That compared with 796 launches for the United States and 1,538 for the Soviet Union. Throughout the 1980s, however, the Europeans and the Japanese have made major advances in the economic development of space, and have surpassed the U.S. in a number of areas.

Take materials processing, for example -- a promising new field in which products that cannot be produced on Earth are produced in space. The Europeans

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[3]The European Space Agency is a consortium whose members include Austria, Belgium, Denmark, France, Ireland, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland, West Germany and the United Kingdom. The organization has a special agreement with Canada.

now have spent more money on this type of research and more time in space conducting the research than the U.S. has. The following is a brief summary of where the U.S. stands compared to other countries in terms of government spending on commercially significant space-related activities.

- In 1986, the governments of both France and Japan spent more on communications satellites than the U.S. government did. The European Space Agency spent two and one-half times what the U.S. government spent, and all free world nations combined spent more than five times as much as the U.S. did in this area.

- In the field of remote sensing from space, the governments of Canada, Japan and France all outspent the U.S. government. The European Space Agency spent almost eight times what the U.S. government spent, and all free world nations combined spent almost 20 times that amount.

- In materials processing in space, the U.S. government spent less than the European Space Agency and only slightly more than Japan. All free world nations combined spent almost three times more than what the U.S. government spent in this field.

The governments of other countries are not merely surpassing the U.S. government in terms of their budgetary commitments to space, they also are surpassing this country in terms of creating an environment conducive to healthy private sector investment.

## SATELLITE COMMUNICATIONS

Sending messages across a large land area like the United States used to require a vast network of copper wires, or hundreds of microwave relay towers. Sending a message across the oceans required even more expensive underseas cables. Today, communications satellites have eliminated the need for these cumbersome and costly ground-based systems.

Communications satellites are placed in orbits approximately 22,000 miles above the Earth.[4] These satellites stay in a fixed position over one spot on the ground. They have proved to be a highly efficient means of communication. Live broadcasts of news events can occur from anywhere in the world. Time, Newsweek, USA Today, and the Wall Street Journal all are electronically "mailed" from New York via communications satellites.

Satellite links now handle the bulk of all U.S. long-distance telephone calls, most international telephone calls, all large-area cable television service, virtually all international television transmissions, and the majority of long-distance data and facsimile transmissions, such as national and international newspapers and magazines.

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[4] Such satellites are said to be in "geostationary orbit."

Moreover, satellite communications is by far the most successful example of space commercialization. In part this is true because the communications industry is very different from other commercial space prospects. The telecommunications industry was already mature, and had undertaken substantial satellite-oriented research and development on its own prior to NASA's efforts. Further, a large market for intercontinental communications already existed, as did a tested body of international law. It is not surprising that in such an environment plenty of capital was available, and that a thriving industry developed and grew.

## General Policies

There were, nevertheless, a host of federal policy actions that had adverse effects on this healthy industry. With the rapid growth of international communication links and the advent of foreign manufacturers and service groups in the world market, the formerly clearcut distinction between the government's role and private industry's research, marketing, and production activities began to blur.

**Regulatory Bodies.** Besides the Federal Communications Commission (FCC) and the State Department, new federal agencies that entered the picture included the Office of Telecommunications Policy, the National Telecommunications Information Agency, the U.S. Trade Representative, the National Security Council, the Council of Economic Advisers and the departments of Justice and Defense. In addition, NASA reentered the field of satellite communications research and technology advancement (an activity it had not been involved with since 1973). The Third World also became involved through growing influence in international regulatory bodies such as the International Telecommunications Union and its World Administrative Radio Conference. This complex array of agencies has made the field a veritable jungle for satellite communication system operators.

**Changing Policies on Research and Development.** The private sector also has had to cope with the problem of vacillating federal policies on research and development in the satellite communications field. Here is a brief summary of major policy shifts that occurred under virtually every U.S. president for the last 30 years:

- In 1959, the Eisenhower Administration decreed that research and development in satellite communications should be conducted by private industry.[5]
- Under President Kennedy, the Eisenhower policy was reversed, and these activities were placed under NASA.
- In 1973, under President Nixon, NASA was ordered to phase out satellite communications research and technology advancement on the premise that the industry was mature and healthy enough to conduct its own research.

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[5] AT&T promptly began to conduct such research, and eventually launched the first Telstar satellite (Early Bird) in 1965.

- In 1978, President Carter revived NASA's research and development role through provisions of the Advanced Communication Technology Satellite (ACTS) program.

- For the last four years the Reagan Administration has attempted to kill all funding for the ACTS program in its budget proposals.

- On each occasion, Congress has succeeded in reinstating the ACTS budget.

In such an environment, it is not surprising that private industry has limited its research and development investment to relatively low-cost research that promises early returns rather than high-cost, high-risk research with long-term payoffs.

**Competition from Abroad.** Meanwhile, European and Japanese industries, with strong research and development support from their governments, have forged ahead in the more advanced technologies. As a result, U. S. industry already has lost the bulk of the present world market for groundstations and associated equipment. The size of the current investment in this market is between $20 to $25 billion. It represents about four times the amount invested in satellites and launching equipment.[6]

Other areas in which government policy has impeded or neglected private-sector satellite communications development are aeronautical communications, navigation, and the new field of communication by satellite between mobile ground stations.

## Aeronautical Communications

The concept of a global aeronautical communications system for civilian aircraft has been pursued vigorously since the early 1960s. Such a system promises great benefits. A plane that constantly wanders off-course takes more time and more fuel to reach its destination. Communications satellites can keep a plane informed of its exact location. Satellites also can warn planes of impending collisions with other planes, of storms and other weather hazards, and can provide instant communication in case of emergencies.

Private development of such a system, however, has been deterred by vacillating federal policies. Here is a brief summary of major policy shifts:

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[6]Estimates made by Comsat and presented to the National Academy of Engineering, Washington, D.C., June 24, 1986.

- In 1964, the U.S. Air Transport Association asked Comsat to assess the feasibility of a very high frequency (VHF) system. The results were positive, and Comsat announced plans to launch the first satellites in 1968.[7]

- However, the Federal Aviation Administration (FAA), in an effort to accommodate the United Nations-related International Civil Aviation Organization, insisted that the European preference for ultra-high frequency (UHF) be incorporated into the system and that European companies be awarded 50 percent of all satellite system contracts.

- In 1972, on the prodding of U.S. industry, President Nixon killed a draft memorandum of understanding between the FAA and the European Space Research Organization.

- However, since the Europeans already had committed funds under the agreement, the White House Office of Telecommunications Policy reinstated the agreement.

- But Congress again responded to U.S. industry pressure and deleted funding for the system from the FAA budget.

- This funding subsequently was restored, and, in 1977, a spacecraft procurement contract was signed to build the system.

- Shortly thereafter, the Carter Administration terminated the contract, again responding to U.S. industry pressure.

The concept of a global, civilian aeronautical communications system was subsequently resurrected. In October, 1985, Inmarsat[8] amended its charter to allow it to operate a communications system for aircraft. Meanwhile the Soviets announced that their Glomass system (global navigation satellite system) can provide aviation communications along with its navigation services. Hence it is likely that U.S. industry, which could have dominated the market because of the enormous U.S. space-technology lead in the mid-to-late 1960s, will now take a back seat to overseas initiatives as a direct result of erratic, inconsistent federal policy actions.

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[7]The Communications Satellite Corporation (Comsat) is a "public-private" corporation created by Congress in 1962. Twelve directors are elected by the shareholders and three are appointed by the President.

[8]The International Maritime Satellite Organization (Inmarsat) was created to establish satellite communication links for thousands of ships between shore and each other. The U.S. and the USSR are the two largest shareholders.

## Navigation

In navigation, the U.S. government for years has operated the low-orbit military communications system. This system has been available to civilian users since 1967. (The Soviets operate their own system, called Tsikada.) The U.S. has begun launching higher-orbit Navstar satellites to build a Global Positioning System (GPS) designed mainly for military navigation needs in the 1990s. The Soviets have begun launching their less capable Glomass satellites. Both the European Space Agency and Inmarsat also are preparing satellite navigation systems.

In the U.S., several companies have designed navigation systems but are concerned about direct competition from the government's GPS. Its services originally were to have been made available to civilian users for an annual fee of $370. But current policy is to offer GPS access to civilian users at no cost in the aftermath of the Korean Airlines flight 007 disaster in 1983.

This policy of no-cost access to a government system is a clear deterrent to potential commercial entries. For example Geostar, a private firm in Princeton, New Jersey, says its contractors can produce transceivers[9] at a cost of $500 compared with the government's cost of $10,000. Yet Geostar cannot compete as long as the government is providing data to users free of charge. This federal policy is stifling private, commercial development in a market estimated to be more than $1 billion annually by the early 1990s.

## Mobile Satellite Service

Satellite service to mobile groundstations also is a promising market in the commercial development of space. Currently, cellular phones are useful only in or near large urban areas. But phones in cars and trucks with access to satellite communications can communicate from remote and rural areas. For example, they can allow a trucking company to communicate instantaneously with drivers on highways all over the country.

Unfortunately this is yet another field in which vacillating federal policies have taken their toll on the willingness of the private sector to make the necessary investment.

- Initially, NASA promised private companies a free first launch in exchange for allowing the federal government to use the satellites.
- Then, in February, 1985, NASA announced it would tie another string to any launch agreement: "If a firm returns a profit . . . it will be expected to share any profit . . . with NASA."
- Despite these restrictions, 12 companies submitted land mobile-satellite system license applications in May, 1985.

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[9]Transceivers are ground-based transmitters and receivers.

- They were then hit with another blow when the Federal Communications Commission (FCC), under pressure from the Canadian government, barred commercial users from the most profitable UHF band of the frequency spectrum--forcing them to use L-band hardware, which is more expensive and takes longer to develop.

- A final setback came on August 15, 1986, when NASA announced that all commercial payloads would be banned from the Shuttle.

Currently, five major companies (Mobile Satellite, Omninet, Skylink, Transit Communications, and Hughes Communications) have applications before the FCC for mobile-satellite system licenses. Nevertheless, major shifts in federal policy by the U.S. government clearly have had a negative effect on the industrial development in this field.

## REMOTE SENSING

Observing the Earth from orbit allows one to distinguish economically important features such as the health of crops, the need for more (or less) moisture, the movement of arid-land boundaries, the germination and movement of pest swarms such as locusts, the development of potential flood conditions, the movement of large schools of fish, the change in direction and temperatures of ocean currents, the development and movement of ice cover in navigable waterways, the detection and monitoring of air and water pollution, and the growth and movement of forest fires. The list of potential benefits from such technology is truly endless.

Less than three years after Sputnik was launched (in April, 1960) the first American satellite was routinely observing the atmosphere from space, radioing back unprecedented images of cloud cover, storm tracks, hurricanes, typhoons, and even individual thunderstorms.

One of the programs that developed out of this first use of remote sensing from space, Landsat,[10] is used to observe the land rather than the atmosphere. From a purely operational standpoint, Landsat was phenomenally successful. Images from its satellites turned out to be extremely useful to a whole gamut of users. With no federal policy other than President Eisenhower's "open skies" principle (which made Landsat images available to all who wanted them), a small but healthy business developed to process the raw satellite data in different ways, tailored to derive maximum usefulness for each of the wide variety of users.

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[10] In 1965 NASA established an experimental Earth resources survey program to determine the feasibility of a system to catalogue Earth resources from space. The first Earth Resources Technology Satellite (ERTS-1) was launched in July 1982. Four more were orbited by NASA over the next 12 years, during which time the program name was changed to Landsat.

In his previous term of office NASA Administrator James Fletcher observed, "If I had to pick one spacecraft, one space development to save the world, I would pick Landsat and the satellites which I believe will be evolved from it." That promise has yet to be fulfilled, in good part as a result of inconsistent, obstructive federal policies.

Discussions on privatizing remote-sensing services began in the late 1970s. However, from the beginning, private industry faced two major hurdles: (1) a government policy of providing images to users at highly subsidized prices, and (2) a decade of major policy vacillation.[11]

## Subsidized Prices

A major obstacle to privatization was that private firms are unwilling to make the large capital investment needed to maintain the existing system and to sustain it (by launching and operating additional satellites when needed) without revenue adequate to generate a positive return on the investment. One problem was that the Landsat experiment had been too successful. Although there was a healthy demand for images, NASA had for many years accustomed users to unlimited data access at extremely low (subsidized) prices, typically about $50 per image. Other countries had even built 13 of their own groundstations and paid NASA a minuscule $200,000, one-time-only licensing fee to obtain the images forever. These actions successfully demonstrated the benefits of Landsat data, which was a primary goal of NASA's experiment. But NASA's policies effectively killed the profit-making potential of an unsubsidized remote sensing industry. Customers were accustomed to prices that were not merely low, but substantially below the real costs of providing those services.

Estimates of the new investment required to maintain the system ranged from $100 million to $400 million. Yet, total annual revenues expected under the subsidized pricing scheme were expected to be no more than $15 million. The private capital market understandably was unwilling to finance such an operation.

## Major Shifts in Government Policy

A second major obstacle to the privatization of remote-sensing services was the failure of the federal government to develop a consistent policy. Indeed, we are still in the midst of a 10-year saga of almost ludicrous federal policy vacillation.

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[11]For a general analysis of some of the issues surrounding the privatization of Landsat and the meterological satellites, see "Effects on Users of Commercializing Landsat and the Weather Satellites," General Accounting Office, U.S. Congress, Report No. RCED-84-93, February 24, 1984. A record of the policy vacillations can be compiled from newsletters such as Space Business News, Pasha Publications, July 1983 - February 1987.

**President Carter's Privatization Initiative.** In October 1978, President Carter proposed several alternatives for private-sector involvement in the three Landsat-system functions that at the time were provided by the government: data sensing and acquisition, calibration and preprocessing, and archiving.[12] Value-added processing of the images already was being done largely by commercial firms.

The strongest proponent of privatization was Carter's Office of Management & Budget (OMB), which saw Landsat as a never-ending money sink and insisted that Landsat either be transferred to industry or be terminated.

**Opposition and Compromise.** However, Landsat was so useful to so many users (including the foreign nations who had invested in substantial ground facilities and now depended heavily on an uninterrupted stream of Landsat data) that considerable pressure was brought to bear, mainly by Congress and foreign embassies, to find some way to sustain it.

As an interim compromise measure, in 1979 President Carter transferred the operation of Landsat to the National Oceanic and Atmospheric Administration (NOAA) in the Department of Commerce, which already had the responsibility for operating the nation's weather satellite system.[13] Carter's directive allowed for the launch of Landsat 4 (then under construction) and three more satellites, thereby sustaining the program through 1994 and allowing industry more time for the transfer.[14] The directive did not address private ownership of the meteorological satellite system, sometimes called metsat.

**President Reagan's Privatization Initiative.** In July 1981, President Reagan, under pressure from OMB, ordered the end of Landsat launches with Landsat 5 in 1984, and decreed that if no commercial operator stepped forward by 1988 he would terminate operation of the system.

In March 1983, the Administration proposed transfer of both the Landsat and the metsat systems to the private sector, based on an offer by Comsat to take them over without any subsidy, but on the condition that the government guarantee to purchase metsat data. Comsat believed that the steady revenue stream from metsat would compensate for expected losses from Landsat during the years it would take to make Landsat profitable.

**Congressional Action; Administration Response.** A series of studies conducted under contract to the Department of Commerce unanimously rejected the idea of transferring the metsat system to private industry. Congress reacted by enacting legislation to forbid the transfer of the metsat system to private interests.[15] In response, in 1983 the Administration began to draft a request for industry proposals to take over only Landsat, leaving metsat to be operated by

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[12] Presidential Directive No. 42, October, 1978.

[13] The Weather Bureau traditionally had been a taxpayer-supported service.

[14] Presidential Directive NSC-54.

[15] Public Law 98-166.

the government. The Request for Proposals was issued in January 1984, and by March it had elicited responses from seven companies and consortia. Eventually the competition was narrowed to two: Eosat, a joint venture of Hughes Communications and RCA, and a joint venture by Kodak and Fairchild. But these proposals asked for about $1 billion in federal subsidies over 10 years and were rejected. When asked to accept greater risk and less subsidy, Kodak-Fairchild declined to re-bid. So in the summer of 1984, the Department of Commerce began negotiations with Eosat.

**The Contract with Eosat.** Congress enacted the Land Remote Sensing Commercialization Act on July 17, 1984.[16] Eosat's proposal of August 1984 conformed to the Act's provision of federal subsidies of $250 million in return for Eosat's agreement to construct a Landsat follow-on system and operate Landsats 4 and 5 until their demise. The contract was signed in May 1985, with the additional provision that the Department of Commerce would pay the launch cost of the two new satellites Eosat had proposed (then estimated at about $40 million) in exchange for Eosat's agreement to build and operate them whether or not the market demand warranted it.

So far so good, although there were complaints that many of the stipulations of the agreement violated the principles of free enterprise. Besides the subsidy (which was to compensate for the projected lack of a viable market for perhaps eight to ten years), Eosat was required to conform to the "open skies" doctrine of making data available to all users on a nondiscriminatory basis and to observe the international obligations of the U.S. under the four existing outer space treaties.

**Failure to Consummate the Agreement.** The government's propensity for obstruction reappeared when the Department of Commerce neglected to submit a request to fund the agreement in the 1985 budget. As a result, the Administration didn't request the funds and Congress didn't appropriate them. During the winter of 1984-85, OMB's resistance to releasing <u>any</u> funds for the Landsat transfer stiffened, and the Department of Commerce couldn't issue a contract to Eosat without an appropriation, despite President Reagan's repeated commitments to Landsat's privatization. Then the Department of Commerce and OMB agreed to go along with the $250-million subsidy, provided that Eosat accepted changes in some of the already agreed-upon contract provisions. These included a requirement that Eosat guarantee to launch two satellites rather than one,[17] removal of a guarantee that the government would purchase Eosat data, and acceptance of the $250-million subsidy on a fixed-price basis[18] that guaranteed six years of service. According to Eosat, the government's reneging on the original agreement would have imposed an additional $45 to $60 million cost on the company and would force it to undertake a complete financial restructuring.

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[16] Public Law 98-365.

[17] Although Eosat planned two, the draft contract guaranteed only one.

[18] The original contract contained certain escalation clauses.

**Further Vacillation.** Counter proposals flew thick and fast. In March 1985, OMB director David Stockman dug in his heels and told Congress he wanted the government out of the Landsat business. "If there is a market," he said, "RCA, Hughes, GE, or whomever (sic) should be able to develop it without federal subsidies." Putting the contract out for bid again was out of the question. It was obvious that no other company would bid it on any better terms than Eosat had. But Stockman still refused to approve the Department of Commerce supplemental fund request to Congress, and again Congress would not appropriate funds without an Administration request.

Then powerful lobbies again swung into gear. The Department of Commerce and the Senate Commerce Committee received a hundred or so letters from chief executives of large oil, mineral, and engineering companies who wanted land remote-sensing operations to continue. Along with sustained pressure from Congress, this new pressure eventually brought about Stockman's capitulation. The Congressional appropriations bill was signed in August 1985, and the future of U.S. commercial remote sensing finally seemed assured. In September, 1985 the Department of Commerce and Eosat signed the agreement to transfer Landsat.

But the saga had not yet ended. When the Commerce Department's 1987 budget request went to Congress in February 1986, it contained no provision for the agreed-upon payment, owed to Eosat that year under the contract. OMB's new director, James Miller, either unaware of what had happened or unwilling to adhere to commitments made by his predecessor, declared the payment a subsidy (which it obviously was) and then simply eliminated all government subsidies from the Administration's budget request. He ignored the fact that Eosat, meanwhile, had restructured the company to comply with the agreement signed in September.

Congress came to the rescue again in July 1986, approving $75 million for new Landsat satellites. But since the funds were not tagged specifically for Eosat, the action was really only an expression of support.

The final blow fell on December 5, 1986. That was the date Eosat told NOAA the company could no longer continue to invest its own funds without real assurance that the government would meet its contracted obligations. When that day passed without any action by the government, Eosat began to lay off workers, terminated all construction work on Landsat 6, and notified the government that it could not take over operation of Landsats 4 and 5.

**An Uncertain Future.** As of this writing, Landsat's privatization remains unresolved. Industry observers have cited the U.S. government as a more serious obstacle to U.S. commercial remote-sensing operations than competition from the highly aggressive French firm, Spot Image, whose first satellite was launched in 1985. Indeed, Eosat's travails in Washington tended to mask its losing battle against the French enterprise, which in contrast to Eosat enjoys both heavy government subsidies and "no strings" in the form of regulations or restrictions on its operations. On the other hand, even if the government should eventually honor its contract, Eosat is faced with many limitations on what it can do.

Besides restrictions imposed by Congress, Eosat is constrained by the Department of Defense. The degree of resolution on the images it provides to its customers is limited, to avoid divulging information of military significance. This was not an important consideration in the 1970s, when the cost of processing the enormous amounts of raw data needed for high-resolution images made the exercise impractical. However, current high-speed data-processing technologies make high resolution very attractive commercially. The 10-meter resolution offered by France's Spot Image already exceeds the Defense Department's limits. As Hughes' vice president John McElroy pointed out, "You can't put on a lot of restrictions and then pretend you're commercializing." If the Defense Department limits camera resolution, he said, "They should be prepared to fund that imposition."

## Case Study: Sparx

U.S. government policies already have been directly responsible for putting at least one company (with a promising future) out of business. Sparx, a joint venture of the German company MBB and the U.S. firms Comsat and Stenbeck Reassurance Co., had planned to use new remote sensing equipment that was developed with company funds and flown on the Shuttle in 1983. Sparx's market research revealed that it could supply data to individual countries, tailored to the specific needs of each country, and make a substantial profit. The company booked a Shuttle flight in the summer of 1984. It also was seeking a Joint Endeavor Agreement with NASA. But NASA insisted that any data collected on a U.S.-launched vehicle was subject to the "open-skies" policy requiring that the data be made available to anyone who wanted to purchase it. This policy threatened to destroy the market value of Sparx's data. "No country would ever give away the aerial photo surveys they do. Whether they are having a good or bad crop year could have a big effect on such things as their exchange rate," explained MBB's space-division marketing director Dietrich Davidts. "They would rather not have the information at all than have it and also have to give it to everyone else."

Other U.S. policy stipulations also impeded Sparx's use of the Shuttle. All satellites carried on the Space Shuttle have to be licensed by the Department of Commerce, which gives the agency the theoretical right to restrict satellite flights. This approval was required before Sparx could contract with any non-U.S. customer. Copies of all data collected would have to be put in the Commerce Department's archives. In turn, the department could give it to anyone who requested it. And, the department reserved the right to inspect all satellites, all ground stations in customer countries, and all software used for analysis.

Sparx, therefore, had no choice but to transfer its projected launches to the European company, Ariane. However, this involved several years' delay and cost increases of about $40 million. (Sparx's equipment originally was designed to be Shuttle-compatible). In addition, data would have to be recovered from a free-flying satellite, a task only the Shuttle is able to perform. Using the Shuttle to perform this task, however, would resurrect all of the U.S. policy problems again. Sparx even offered to pay for the entire Shuttle launch if the offensive policies could be abrogated. But the offer was rejected.

As a direct consequence of its inability to fly the type of mission it needed because of U.S. policies, Sparx was forced to close its doors late in 1984. According to the European Space Agency's director of administration, George van Reeth, NASA squelched Sparx's project "in a highly regrettable way." Further, he said, the U.S. policy invoked in this case made joint U.S.-foreign remote-sensing missions using the Shuttle impossible.

## SPACE TRANSPORTATION

In space commercialization, the policies most widely recognized as conflicting and inconsistent are those related to development of a private sector launch industry.

Without transportation to space, there obviously can be no space industry. It was the development of a reliable launch rocket that gave the Soviet Union its initial surge of preeminence in space and created the "missile gap" in the early 1960s. The U.S. finally caught up to the Soviets by developing the Atlas, Delta, Titan, and Saturn expendable launchers, and then the partly reusable Space Shuttle.[19] Subsequently Europe, Japan, and China became "space powers" solely by virtue of their ability to launch payloads into space with their own rockets.

The troubled history of U.S. commercial space transportation development highlights again a fundamental policy problem that cuts across the entire spectrum of commercial space activities: the sensitivity of private industry to a highly unstable government policy environment in which future decisions could upset any firm's plans. This inherent uncertainty is perhaps best illustrated by the upper-stage industry,[20] whose entire capitalization and business planning were based on a policy created in 1972. The policy, that the Shuttle would be the primary U.S. launch system, was supported by seven Congresses and four administrations. That policy was almost totally reversed by the president's announcement of August 15, 1986, (in response to the Challenger disaster), barring use of the Shuttle to commercial customers.

### Major Policy Vacillations

As part of its charter, NASA contracted for and supervised the development and construction of the vehicles needed to launch its spacecraft and satellites. It adapted them largely from military missile launchers. When commercial satellites were first produced in the mid-1960s, NASA agreed to launch them in addition to its own and other government spacecraft. NASA charged private industry the

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[19]Expendable launch vehicles are rockets whose only function is to deliver a payload into space. Unlike the Space Shuttle, they do not return to Earth for reuse on another launch.

[20]This involves boosting satellites from the Space Shuttle to higher orbits.

marginal costs of the vehicles and launch services. In this way, NASA began to invade the operations, as contrasted to the research and development aspects, of space transportation -- just as the agency did in satellite remote sensing.

**Creating a NASA Monopoly.** This policy continued when the partly reusable space shuttle was developed. The only roles for private industry were to serve as contractors to NASA (for development, construction, and various aspects of operation), as service contractors for commercial payload servicing, and as suppliers of transportation-system devices such as upper-stage rockets for the transfer of satellites from low orbit to higher geosynchronous orbits.

Federal policy, beginning with the Nixon Administration's initiation of the Shuttle project, was to phase out the expendable launch vehicles (ELVs) that had been used to launch all spacecraft before the advent of the Shuttle, to encourage private-sector users to design their satellites exclusively for Shuttle launches, to promote commercial launches on the Shuttle by every means available to NASA, and to encourage companies to develop hardware uniquely designed for use on the Shuttle. All of these policies had the effect of encouraging the private sector to invest in NASA-dependent technologies and discouraging the development of technologies for systems that were independent of NASA.

**Encouraging Privatization.** Then, in the late 1970s, the German firm OTRAG was formed to offer commercial launch services. A private U.S. company, Space Services Inc., launched its own rocket in September, 1982, after several false starts. Ariane, a rocket developed by European governments, was successfully launched in December 1979 and was subsequently transferred to the quasi-private company Arianespace. Its first commercial flight was in May, 1984.

The first indication of government interest in establishing a U.S. commercial launch fleet appeared in a presidential directive that formalized the Reagan Administration's space policy.[21] The directive endorsed the concept of eventually transferring shuttle operations away from NASA. It also expressed a commitment to a climate conducive to "expanded private-sector investments." This principle was expanded to the field of space transportation in a subsequent directive that specifically called for privatization of ELVs.[22]

The first manifestation of this new commitment was NASA's announcement that it would seek private-sector operators for Delta and Atlas-Centaur, its two main ELVs.[23] Two companies responded: General Dynamics, manufacturer of the Atlas-Centaur, and Transpace Carriers, Inc., which wanted to market the Delta (manufactured by McDonnell Douglas Astronautics).

**Bureaucratic Rivalries; Policy Impasse.** This apparently healthy start, however, marked the beginning of another saga characterized by federal policy indecision, conflict, and vacillation -- in this case even creating bitter rivalry

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21 National Security Decision Directive (NSDD) No. 44, July 4, 1982.

22 National Security Decision Directive (NSDD) No. 94, May 15, 1983.

23 The Titan was developed and flown by the U.S. Air Force.

among the various federal agencies involved. Indeed, it took a full-fledged tragedy, the loss of the Shuttle orbiter Challenger and its seven-person crew on January 28, 1986, to resolve an impasse in space-transportation commercialization that otherwise probably would never have been surmounted.

The core of this federal policy impasse was straightforward. Ever since the inception of the sorely underfunded Shuttle program in 1972, NASA had been under constant pressure from both OMB and Congressional opponents to guarantee that the Shuttle would "pay back the taxpayers" for its development and construction, by providing launch services not only for federal agencies but also for commercial satellite operators. Hence, NASA launched and maintained a vigorous Shuttle marketing effort, which was in direct competition with the commercial ELV industry.[24]

Moreover, the subsidized prices NASA had been charging commercial customers were much lower than ELV launchers could tolerate. The formulation of a Shuttle pricing policy that would impose a "proper" price for commercial payloads and yet not undercut the new ELV industry turned out to be impossible.[25] After years of acrimonious debate during which absolutely no progress was made, the Administration finally issued a directive[26] establishing a Shuttle pricing policy that was to have become effective on October 1, 1988.

That policy was unacceptable to almost everyone. Customers who had become accustomed to much lower shuttle prices, along with manufacturers of upper-stage hardware designed specifically for use with the Shuttle, complained that the new price was too high. So did all those who were concerned that the high launch price would favor Europe's Ariane and therefore worsen the already serious U.S. trade deficit. The would-be commercial ELV operators, on the other hand, found the new price still too low for them to compete. The shuttle subsidy, they said, still remained a barrier to fair competition.

**Renewed Privatization Initiatives.** Several additional policy actions further complicated the already impossible situation. In 1984, Congress enacted the Commercial Space Launch Act,[27] which created an Office of Commercial Space Transportation within the Department of Transportation. The mission of the new office was to streamline the complex process for commercial launch licensing and "to promote economic growth and entrepreneurial activity." The new agency took its charge seriously. It became the champion of the as-yet unborn ELV launch industry, battling NASA assiduously in a largely unsuccessful effort to create a competitive environment -- "a level playing field" -- for commercial operators.

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[24] See National Security Decision Directive (NSDD) No. 94, May 15, 1983.

[25] See "Pricing Options for the Space Shuttle," Congressional Budget Office, U.S. Congress, March 1985.

[26] National Security Decision Directive (NSDD) No. 181, August, 1985.

[27] Public Law 98-575, October 30, 1984.

In 1984 a new development occurred that further weakened the policy that the Shuttle be the primary U.S. launch system and ELV construction would be phased out. Responding to Air Force unease about relying solely on a single launch system (which turned out to be tragically prophetic), a new presidential directive[28] approved the production of a limited run of "complementary" ELVs for the big Air Force payloads that previously could be launched only by the Shuttle.[29] The directive still identified the Shuttle as the primary launcher, but emphasized that military payloads in the future must be designed to be compatible with both the Shuttle and the Titan 4 ELV rather than the Shuttle alone.

**Aftermath of the Challenger Accident.** The Challenger accident spurred a federal pronouncement that the Shuttle no longer would compete with private-sector launchers and that the government would use ELVs -- a policy that will provide a sound base for the growth of the private ELV market. Yet there has been no clarification of the real nature of Shuttle competition or federal conditions on the private use of launch facilities. Nor has there been a firm policy established for government procurement of ELVs (or launch services), for government payloads, or for a U.S. position on fair trade practices with respect to government-subsidized foreign launchers. Until these points are clarified, private industry will continue to be reluctant to incur substantial financial risk.[30]

## Some Negative Consequences of Federal Policies

There have been many consequences of this policy morass. Only the tip of the iceberg can be revealed in this limited survey.

**Indecision on Prices.** Private investors are understandably wary of entering a field in which the government is in open competition with the private sector. This is especially true in the case of NASA's Shuttle launches at prices that no private firm could match without bankrupting itself. Even after Challenger, when President Reagan finally decreed on August 15, 1986, that NASA no longer would launch commercial and foreign payloads on the Shuttle, he left many loopholes. For example, "shuttle-unique" payloads and those with "foreign policy" implications are still permitted. Yet no new Shuttle pricing policy for these payloads has yet been established. As a result, private industry still has no firm assurance that it will not be competing with the government.

**Uncompleted Agreements.** Despite the positive stance the Administration has taken in support of commercial operations, NASA and the Air Force dragged their feet for years in completing agreements with commercial firms on the terms and conditions for access to, and use of, government launch facilities. The first agreement was not consummated until September, 1986 -- more than three years

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[28]National Security Decision Directive No. 164, August 1984.

[29] Originally designated Titan 34 D7, they are now called Titan 4.

[30]See John M. Logsdon, "Requirements for a U.S. Expendable Launch Vehicle Capability," American Institute of Aeronautics and Astronautics, New York, June 25-27, 1986.

after the 1983 policy was enunciated. And the private company, Space Services, Inc., has yet to receive firm quotations of the terms and conditions it must meet to use NASA's Wallop's Island facilities.

As an example of the difficulties faced by private industry, a draft agreement for use of Air Force launch facilities and services by commercial launch operators was blasted by the Department of Transportation's prestigious Commercial Space Transportation Advisory Committee in February 1987 as being "totally unacceptable to the satellite industry." The committee chairman said the draft "will not in any way encourage the development of the commercial American launch industry."

**Unclear Role of Federal Regulatory Agencies.** There is as yet no clear definition of federal responsibility for the safety and reliability of private-sector launches, such as that provided by the FAA for commercial airline operations and by the American Bureau of Shipping for the merchant marine fleet.

**Uncertainty About the Availability of Insurance.** The insurance industry requires some federal backup to help it recover its resource pool, which was seriously impaired by the string of failures in 1984-86. Insurance is particularly critical to the entire commercial space industry, not just transportation, because no major investor or financier will underwrite a space project without it.

**Resistance From NASA.** Existing policies force NASA to ensure its survival through the establishment of large space-infrastructure projects that involve its taking on responsibility for operations. The Shuttle and the Space Station are two examples. Hence, there is a logical reluctance on NASA's part to allow the intrusion of commercial operators who might undermine these large, survival-insuring programs. A case in point was the sluggishness with which the agency responded to bids by at least two companies (Spacetran in 1982 and Astrotech's General Space Corp. in 1985) to buy and operate a Shuttle orbiter.[31] Although there was some real question as to the advisability of such an action, there was no doubt that despite White House directions to consider these proposals seriously, NASA was not institutionally responsive to such private-sector initiatives.

**Role of the Military.** Another problem has been created by uncertainty about the role of the military in both Shuttle and ELV operations. Both U.S. companies and foreign customers are concerned about the possibility of preemption by a military crisis, withholding of key information on launch-vehicle or upper-stage characteristics, and security constraints on transmission of information. These uncertainties have been a significant factor in driving customers to Ariane. It could prejudice their future consideration of a U.S. commercial ELV operator once they have become comfortable with Ariane practices.

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[31] The point is now moot because of the Challenger accident.

## SPACE MANUFACTURING

In an orbiting satellite or platform, there is an exact balance between the downward pull of the Earth's gravity and the outward centrifugal force on the satellite. The zero-gravity (or, more precisely, "micro-gravity") environment created by that balance cannot exist on Earth. For the first time in all history, therefore, we now have open to us a whole new world. It is one in which we can perform tests on materials and manufacturing processes that in the past could not be considered because of the inescapable gravity chains of Earth. Early research (in Skylab in 1973, in Apollo-Soyuz in 1975, and in Soviet Salyut space stations since 1971) uncovered the possibility for whole new industries. These include manufacturing pharmaceutical products that are impossible to manufacture under full Earth gravity, incredibly pure crystalline semiconductors that can improve computer speed, memory, and performance a hundred-fold or more, new construction and manufacturing materials of enormous purity and strength, diamond-pure industrial glass, and literally hundreds more.

The term "space industry" generally conjures up an image of a ring of orbital space factories, both manned and automated, humming away busily to take full advantage of the unique microgravity, high-vacuum, energy-rich space environment. However, in contrast to the burgeoning satellite communications industry (and even to some degree the remote-sensing and space transportation industries), there is as yet no such thing as space manufacturing. There has been only research on the prospects for manufacturing.

There is no doubt that such an industry will exist someday, and it will be sizable.[32] Right now the primary need is to conduct the research required to establish which products industry will make and how to make them profitably. Federal policies that stimulate and facilitate this research clearly are in the best economic and political interest of the nation. Although there are several bright spots that indicate real promise for the future, federal policy in this area has been weak and uncertain.

### NASA's Budget

Foremost among policy deficiencies in this area is the lack of a strong budgetary commitment to space research. Whereas the early phases of research and technology advancement in launch vehicles, satellite communications, and remote sensing were generously funded, annual budgets for microgravity research and applications (MRA), the NASA budget line for these activities, have been at best parsimonious. Even the General Accounting Office, not known for any bent toward high-risk endeavors, recommended a tripling of MRA budgets several years ago.[33] Because of the long-term, high-risk nature of this research, compounded by the extremely high cost of access to the space environment, it is beyond the

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[32]David Gump, Editor, Space Processing, Products, and Profits 1983-1990, Washington, D.C: Pasha, 1983.

[33]"U.S. Must Spend More to Maintain Lead in Space Technology," Report No. FGMSD-80-32, U.S. General Accounting Office, January 31, 1980.

scope of most private-sector research budgets. Although several companies, notably McDonnell Douglas and 3M, have made multi-million dollar, decades-long commitments, the bulk of research activity in this area will have to be borne by the federal government for years. That commitment has not yet been made by the U.S., in contrast to European and other governments.

The European Space Agency's current annual budget for materials processing research is more than twice that of the U.S. West Germany alone has made an additional annual commitment 50 percent greater than the current NASA budget.

Part of the administration's rationale for such low U.S. research budgets is President Reagan's overriding principle that industry must bear the cost of any activity that leads to commercial profit-making. The government's job is solely to ease the process. Indeed, even research support from federal coffers is considered a subsidy if that research is directly associated with a commercial opportunity.

## Other Policies

The instruments NASA has developed to help commercial firms perform space research (particularly in materials processing) are in themselves excellent, innovative approaches. These include the "Get-Away Special"[34] the Industrial Guest Investigator Agreement, the Technical Exchange Agreement (TEA), and the Joint Endeavor Agreement (JEA).[35] Although these mechanisms were designed to support commercial research activities and although many have done so successfully, private industry in general has claimed them to be unrealistically structured, and in some cases unduly restrictive.

**Uncertain Legal Environment.** In seeking Joint Endeavor Agreements, for example, NASA tends to look not just for research capability but for "partners" who can do everything -- marketing, financing, hardware development, etc. This is a burden only the very largest companies can assume. In addition, the protection of intellectual property rights is uncertain in view of the Freedom of Information Act (which allows a company's competitors to open any unclassified federal file) and NASA's basic charter "to provide for the widest practical and appropriate dissemination of information." A further concern is the impact of international treaties on space-based manufacturing operations. Language in the 1967 outer space treaty, to which the U.S. is a party, subjects U.S. companies to uncertain liabilities under international law, and future legal actions could

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[34]Under the "Get-Away Special" program, five or 10 cubic foot canisters are flown in the Shuttle payload bay, at a very low cost, for companies, universities and other scientific organizations.

[35]Under TEA and JEA agreements, NASA becomes a partner in what is essentially a joint venture. The agreements are designed so that there is no exchange of money. NASA provides certain free flight services; the private sector pays all the research, equipment and development costs.

severely limit some commercial activities. The 1982 Moon Treaty, although not ratified by the U.S., requires future commercial exploitation of space resources to be regulated by an as-yet undefined "international regime."

**Bureaucratic Turf Battles.** Other policy problems that impede the vigorous pursuit of research arose as a result of NASA's internal organizational structure. The MRA program budget line is assigned to NASA's Office of Space Science and Applications. Yet all commercialization responsibilities, including the nine centers for commercial development of space (most of which emphasize microgravity research) are assigned to the Office of Commercial Programs. The resulting "turf battles" (along with the perennial fight for budgets within NASA) send confusing signals to the people and organizations doing the research and further exacerbate the long-standing trepidation with which industry views any association with the government.

**Unclear NASA Priorities.** By far the biggest barrier facing the progress of space manufacturing is the lack of adequate microgravity research and testing facilities. Even when the Shuttle was flying regularly, experimenters were faced with waiting times that ranged up to seven years. NASA's own MRA research contractors, for example, were at the bottom of the priority list for Shuttle mid-deck lockers, behind the Defense Department, commercial users such as McDonnell Douglas and 3M (who were potential sources of future income to NASA), and foreign customers. These delays, according to the MRA office director, cost the office 10 percent of its already minuscule $23 million 1985 budget. The serious problem is further exacerbated by continued Air Force pressure for dedicated mid-deck locker commitments, needed for key SDI and other experiments. With the Shuttle grounded well into 1988, with the backlog for high-priority missions, and with new facility-use requirements being generated at a high rate by the centers for commercial development of space, not only the MRA research program but also higher-priority space processing research under Joint Endeavor Agreements with various companies are on indefinite "hold."

In September 1986, NASA's Office of Space Science and Applications had a cumulative backlog of 35 equivalent Shuttle payloads through 1992, reduced from a pre-Challenger plan for 50 payload bays. The Defense Department had 60 payload-bay cargoes backlogged for the same period.

Private-sector facilities such as Space Industries Inc.'s platform and even Spacehabs Shuttle payload-bay facilities are far too expensive for most researchers, who are unwilling to spend millions (or even hundreds of thousands) of dollars on exploratory research in view of the typically high risk that it will never result in commercially profitable products. Hence, without federal policies to make available low-cost orbital facilities, there will be little or no progress toward a commercial space manufacturing industry for the foreseeable future.

## RECOMMENDATIONS

By far the most important step the government could take to encourage the private industrial development of space would be the development of a long-term national plan to guide NASA and other relevant agencies and to give the private sector a firm basis for investment. A key element of such a plan would be the implementation of the major goals of the Reagan Administration's commercialization program.

As part of the plan, the federal government should redirect its spending priorities. We should phase out government spending in areas where the private sector has indicated a willingness and capability of doing the job on its own. We should increase federal spending in areas which promise broad, national benefits that are too diverse and thinly spread to attract private capital. We should increase federal spending also in areas that provide a sound infrastructure upon which private sector development can flourish. This will require a strong budgetary commitment to a reorganized and streamlined civil space program.

In addition to a stronger budgetary commitment and a sound plan on which to base it, there are many detailed policy actions that could help resolve the problems and ease the impediments to the private development of space.

### General Policies

1. Clear priorities should be established for NASA and for other government agencies with respect to research and development. The federal government's role should be restricted to basic R&D expenditures that promise broad, national benefits and to research facilities that benefit the nation as a whole. Private industry's role is to invest in applied R&D, which promises company-specific benefits.

2. All federal agencies should cooperate in the speedy transfer to the private sector of activities that the private sector is willing and able to manage.

3. Since NASA's proper role is one of conducting basic research and development and providing an infrastructure for private industry, NASA should be relieved of the need to derive revenues from any of its functions. Revenue-producing activities invariably will distort NASA's priorities.

4. A separate body should be created at a high level within the Administration to replace the coordination and policy functions now conducted by SIG-Space.[36] This is necessary to eliminate the parochialism now present due to the fact that each SIG-Space member is concerned mainly about the effect of each policy action on his own agency and budget.

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[36]The Senior Interagency Group on space (SIG-Space) advises the President on space policy.

5. Obsolete or unnecessary government regulations that impose barriers to direct private-sector involvement in overseas marketing, sales, operations, and R&D need to be removed. Action also is needed on antitrust and other legislation to permit easier collaboration among U.S. space companies, as is done in Japan and Europe.

6. All government-industry interaction mechanisms, such as NASA's Joint Endeavor Program, need to be reexamined to eliminate unnecessary government involvement and constraints, and to seek maximum support of industrial initiatives.

7. A role should be created in the United Nations for representation of the growing interests of the private sector. The UN Committee on the Peaceful Uses of Outer Space (which enacted the 1967 outer space treaty and the controversial 1979 Moon Treaty) has no mechanism for private-sector participation. It did not even admit Intelsat,[37] the prime example of peaceful international space cooperation, to observer status until 1985.

## Communications

1. The U.S. government should continue to expand satellite communications research and technology advancements -- a critical area of basic research.

2. The U.S. should take vigorous action through international communications agencies to support U.S. industry in the face of strong pressure by developing nations and the Eastern bloc to limit U.S. private-sector activities and satellite deployment.

3. We should revive consideration of an international aeronautical communications system to counter foreign initiatives, using new U.S. capabilities that can offer combined communications and navigation services.

4. We should establish policies that will keep the government's Global Positioning System from competing with private-sector navigation and positioning services.

5. We should open up the frequency spectrum for mobile satellite systems to allow startup operations, and phase in limits gradually to allow the industry to accommodate them in pace with the phase-in of new equipment.

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[37] The International Telecommunications Satellite Consortium (Intelsat) was founded in 1964 as an international communications system. Countries can invest in the consortium and share the profits. Countries also can be represented by private companies, such as Comsat.

## Remote Sensing

1. The U.S. government should honor its agreement with Eosat and allow the company to proceed with operations.

2. The Land Remote Sensing Commercialization Act of 1984 should be amended to remove constraints that prevent U.S. commercial operators from competing on an equal basis with the French Spot Image and other competitors.

3. The U.S. should initiate discussions with the French, the Japanese, the Soviets, the Canadians, and other remote-sensing system operators, both meteorological and Earth-observing, to explore the prospects for a global all-inclusive remote-sensing organization, comparable to Intelsat or the World Meteorological Organization's weather satellite system.

4. The government should pursue a vigorous R&D program in remote-sensing technology to maintain U.S. preeminence.

## Space Transportation

1. The Administration should clarify and make specific the August 15, 1986, general policy of limiting the Shuttle's commercial and foreign payloads. Definitions are needed for the exceptions to this policy. For example, the Administration needs to articulate what constitutes "Shuttle-unique" payloads, what the need for manned presence is considered to be, what is meant by foreign-policy needs, and what kind of payloads involve national security.

2. The pricing policy for any commercial or foreign payloads that are considered to be exceptions to the general Shuttle exclusion policy should not be artificially low.

3. The government should promptly establish firm costs and operating policies for private use of federal launch facilities.

4. The government should assume a strong role in ensuring fair trade practices by foreign competitors for commercial launch services.

5. A unified policy needs to be established to define the specific role of commercial ELVs in government launches.

6. The government should encourage rejuvenation of the launch and spacecraft insurance industry and set limits on third-party liability for commercial ELV operators.

7. Development of next-generation launch systems should be initiated as soon as possible and pursued vigorously, not only to bring down the launch costs for commercial satellite operators and space-processing

R&D, but also to maintain U.S. competitiveness with advanced foreign launchers. These include Europe's Ariane 5, the Japanese H-2, the British Hotol, the German Sanger, and the strong moves the USSR is currently making toward entering the commercial launch market.

8. The government should establish a policy for transferring operational responsibility of service functions such as the Shuttle and eventually the space station to the private sector. Such transfers cannot take place, of course, until the systems in question have matured beyond their development stage to full operational status. But planning and policy-making should begin soon.

## Space Manufacturing

1. The government should create more opportunities for research experiments in the microgravity environment, accepting its role as the principal supporter of basic and applied research in this long-term, high-risk, but promising area.

2. Incentives such as Technical Exchange Agreement and Joint Endeavor Agreement should be actively promoted with additional attention to resolving industry concerns to present stipulations of these mechanisms.

3. Federal policy should promote research, not space manufacturing opportunities, which will come later. Overselling has been a problem in the past, and should be avoided in favor of articulating the true benefits of research and realistic projections of schedules and markets.

4. In planning the Space Station, which will offer the first real opportunities for extensive materials-processing research, care must be taken not to fall into the trap the Shuttle did. Operational costs for today's Shuttle users are higher because the government was unwilling to invest enough up-front money to construct a more efficient system.

5. NASA's internal organization should be modified to coordinate or even integrate microgravity research programs with those of the Office of Commercial Programs.

6. Substantial growth in the microgravity research budget is required, in keeping with the overall budget recommendation cited earlier.

**NOTE:** Nothing written here should be construed as necessarily reflecting the views of the National Center for Policy Analysis or as an attempt to aid or hinder the passage of any bill before Congress.

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## ABOUT THE AUTHOR

Jerry Grey is Publisher of Aerospace America, the monthly magazine of the American Institute of Aeronautics and Astronautics. He is the author of 20 books and more than 200 technical papers in the fields of solar energy, space technology, aerospace policy, fluid dynamics, heat transfer, rocket and aircraft propulsion and power, plasma diagnostics, instrumentation, and the applications of technology. He is a member of Discover magazine's Scientific Advisory Board.

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