Chapter 10

POLICY ALTERNATIVES

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INTRODUCTION

The policy by which the U.S. civilian space program has developed was first articulated in the 1958 National Aeronautics and Space Act (NAS Act), which provided broad guiding principles for U.S. space activities. The Act authorized the formation of the National Aeronautics and Space Administration (NASA) and declared that "activities in space should be devoted to peaceful purposes for the benefit of all mankind" (sec. 101 (b)). It specifies, among other things, that NASA should conduct its space activities so as to contribute to:

- the preservation of the role of the United States as a leader in aeronautical and space science and technology and in the application thereof to the conduct of peaceful activities within and outside the atmosphere; and
- cooperation by the United States with other nations and groups of nations i n work done pursuant to this Act and in the peaceful application of the results thereof.[1]

Where necessary, Congress has enacted other specific legislation, such as the Communications Satellite Act of 1962,2 which created the Communications Satellite Corp. (COMSAT) and aided in establishing INTELSAT,[3] or took other legislative measures to advance the civilian uses of space.[4] All of these measures have built on the provisions of the NAS Act.

The broad policy principles of the NAS Act have allowed each successive Administration considerable latitude in deciding how to implement its basic provisions. Over the past 27 years, the Act has been amended from time to time, but its basic guiding principles, including the above references to competition and cooperation, have remained intact. According to most observers, because of its generality, the NAS Act remains an appropriate overall guide for the Nation's civilian space activities. s Nevertheless, the terms on which the United States and other nations operate in space have altered dramatically over the years. As the analysis of previous chapters has emphasized, the emergence of commercial and governmental competition from other industrialized nations in space, the increasing interest of the U.S. private sector in space investments, concern over access of U.S. firms to foreign space-related markets, and changes in the climate of cooperation with both developed and developing countries, raise several important policy questions:

1. What new national goals and objectives, if any, are needed to sustain the general principles of the NAS Act in the 1990s?
2. What alternative approaches or strategies should be considered by Congress in implementing these goals and objectives?
3. What are the appropriate roles of individual Government agencies, including NASA, in carrying out future space policy and conducting governmental space activities?
4. What is the appropriate role of Government in supporting and" regulating private sector activities in space?

Space Policy and National Objectives

The use of space technology is undergoing a period of rapid and significant change. Because decisions concerning many domestic space-re-

[1] National Aeronautics and Space Act of 1958, as amended, sec. 102 (c), Public Law 85-568, 85th Cong., H.R. 12575, July 29, 1958.

[2] Communications Satellite Act of 1962, Public Law 87-624, 87th Cong., H.R. 11040, Aug. 30, 1962.

[3] Communications Satellite Act of 1962, Amendment: International Maritime Satellite Communications Act, Title V, Public Law 95-564, Nov. 1, 1978.

[4] For a more detailed discussion see: U.S. Congress, Office of Technology Assessment, *Civilian Space Policy and Applications,* OTA-STI-177 (Washington, DC: U.S. Government Printing Off Ice, June 1982), ch. 10. Congress also enacted the National Science and Technology Policy, Organization and Priorities Act of 1976 (Public Law 94-282), which, among other things, authorized the formation of the Office of Science and Technology Policy,

[5] See, for example, Finding 2, Sec. 202 of Public Law 98-361, which states, "The National Aeronautics and Space Act of 1958 has provided the policy framework for achieving this success (of the U.S. space program), and continues to be a sound statutory basis for national efforts in space. "

lated issues necessarily affect decisions over international issues related to foreign competition and cooperation, domestic and international concerns must be considered simultaneously. Examples of such domestic issues include the deregulation of the communications industry, the efforts to transfer space-based land remote sensing to private ownership, the development of a commercial space transportation industry, and the development of commercial products from research on materials processing in space. The necessary interaction of domestic and international issues has produced a complex, and sometimes conflicting, matrix of policies. For example:

- our desire to benefit from the technology developed in the space programs of other developed countries and our commitment to assisting developing countries suggest increased cooperation. Yet, our desire to limit the transfer of technology to economic as well as political competitors, maintain U.S. technological leadership, and ensure that the economic benefits of U.S.-developed technology flow directly to the U.S. economy, suggest a more restrictive international stance.
- U.S. commitment to free trade and open markets supports policies of reducing Government subsidies of space industries and eliminating "buy-national" practices. Yet most countries, including the United States, use "buy-national" policies to support fledgling space industries and develop valuable experience with space technology.
- The United States encourages the participation of the private sector in all aspects of space technology development and application. Yet, in such important areas as space transportation and remote sensing, the Government's own programs have created barriers to the successful commercialization of these technologies.
- The NAS Act gives NASA responsibility not only for developing untried technologies but also for supporting critical U.S. competitive and cooperative goals, including commercialization of space tech nology.[6] Yet the political and economic dimension of space technology already exceeds the purview of any one Government agency [7]—let alone one dedicated to the demanding task of research and development of intricate and advanced space technology.
- The United States espouses the virtues of commercial competition in satellite communication services, yet foreign policy interests may cause it to restrict U.S. satellite firms wishing to compete in international facilities markets,

There is no single resolution of these sometimes conflicting policies. This report has explored the application of these and other policies as they relate to specific space technologies, Because the path from initial conception to a mature technology capable of governmental, commercial, or scientific application is a complicated one, involving many decisions of the Government and the private sector, it is clear that no single set of policies can ever be sufficient to govern all space technologies. The development of space goals and the policy strategies chosen to pursue them must follow an evolutionary process, responding to specific technical as well as social, economic, and political problems.

One end of the spectrum of policies related to space technology applies directly to questions of technology R&D and Government programs; the other applies to the development of domestic commercial space industries and to their success in international markets. In the latter, space policy may serve as a component of more general industrial policies. As the debates over transfer of remote sensing to the private sector, or over the appropriate U.S. response to private competition with INTELSAT, have shown, proposed commercial space ventures may raise important issues

[6] Public Law 98-361 amends the NAS Act to give NASA responsibility for commercializing space technology.

[7] In addition to NASA, the Departments of Agriculture, Commerce, Interior, and State as well as the Agency for International Development, the Federal Communications Commission, and the National Science Foundation, all have some responsibility for portions of our overall civilian space program.

of foreign policy. In some instances, it will be necessary to choose between the claims of private commercial interests and the demands of diplomacy and international relations.

These considerations underscore the need for a new national debate and consensus on the Nation's important goals and objectives in space. Given the current confusion which exists regarding the future of space technology and the role of space policy as it relates to other national policies, including industrial policies, well-articulated goals would do much to focus the space debate and increase the likelihood of resolving specific problems. Once specific goals are articulated, it will be easier to identify specific objectives to carry us from where we are today to where we would like to be a decade or two from now. In time, as relevant technical, economic, social, and political changes occur, these goals will have to be reexamined and, where appropriate, revised in the light of such changes.

Setting Goals and Objectives

In framing the NAS Act, Congress in 1958 recognized the need for ongoing high-level policy review by establishing the National Aeronautics and Space Council (NASC), which was chaired first by the President, and later by the Vice-President and included the Secretaries of State and Defense, the Administrator of NASA, and the Chairman of the Atomic Energy Commission. Its responsibilities included surveying all U.S. space activities, both civilian and military, developing a comprehensive program for Government agencies, and coordinating all Government space programs. The Council oversaw the U.S. space program during the critical years of the Apollo project.

The Nixon Administration abolished the NASC in 1973, in part because of a shift in emphasis after completion of the Apollo project that placed the Office of Management and Budget (OMB) closer to the center of space policy decisions. President Carter assigned formal responsibility for space policy coordination to a National Security Council Policy Review Committee for space (PRC-space), chaired by the director of the Office of Science and Technology Policy (OSTP). President Reagan established a Senior Interagency Group for space (SIG-space) under the chairmanship of the Assistant to the President for National Security Affairs.

The way in which space policy has developed in the last decade reflects a generally reduced congressional role. As the organization and conduct of space policy became centered in the White House, the twin goals of providing for national security and limiting increases in the Federal budget tended to be the most important determinants of national space policy. A strong indication of these trends is the central role played by OMB in White House policy reviews, and the membership of SIG-space: NASA, the Departments of Defense, State and Commerce, the Office of the Special Assistant to the President for National Security Affairs, the Central Intelligence Agency, the Joint Chiefs of Staff, and the Arms Control and Disarmament Agency. Of these, all but NASA and Commerce are primarily concerned with national security and foreign policy.

Much of the success of the NAS Act can be ascribed to the fact that the Act was a bipartisan, broadly representative response to the perceived threat of early Soviet successes in space. It represented a national consensus on outer space. Although the international use of space has changed radically over the years, since the NASC was disbanded there has been no broadly constituted national review of this Nation's long-term goals and objectives in space. Recent reviews conducted within the executive branch have been useful for focusing attention on the near-term needs of the space program, but they have been dominated by individuals within NASA and the aerospace community and have often been influenced by immediate political and budgetary issues. According to many observers, it is now appropriate to institute a national debate that includes a wider range of U.S. industry and society and focuses on the long-term goals and objectives for outer space.[8]

Recent interest in commercial opportunities in space and concern over U.S. leadership has led

[8] U.S. Congress, Office of Technology Assessment, *Civilian Space Stations and the U.S. Future in Space,* OTA-STI-241 (Washington, DC: U.S. Government Printing Office, November 1984).

to increased congressional involvement in space policy. The 98th Congress formulated and passed three major bills:

- Public Law 98-361, provisions of which: 1) amend the NAS Act to require NASA to "seek and encourage, to the maximum extent possible, the fullest commercial use of space, " and 2) establish a National Commission on Space;[9]
- Public Law 98-365, * an act which provides for transfer of space-based land remote sensing to the private sector (see ch. 7); and,
- Public Law **98-575,**** an act to encourage the commercialization of expendable launch vehicles (ELVS) and related services. In addition, bills dealing with satellite communications have also been introduced by several Members.

Many observers, including OTA,1° have suggested that, given the increasing number of governmental and private users of space technology, and the emergence of foreign commercial competition, any body established to recommend policy should be as diverse and broadly based as possible. The National Commission on Space is expected to, among other things, help the United States:

1. define the long-range needs of the Nation that may be fulfilled through the peaceful uses of outer space;
2. maintain the Nation's preeminence in space science, technology, and applications;
3. promote the peaceful exploration and utilization of the space environment; and
4. articulate goals and develop options for the future direction of the Nation' s-civilian space program.[11]

The Commission's term is just 1 year. This will probably be sufficient to determine important new goals and objectives for the U.S. space program and to lay the groundwork for further policy discussion. However, it may be appropriate to extend the Commission's term beyond 1 year in order to assure continued broad-based discussion of these goals and objectives.

In addition to developing recommendations for goals and objectives, it may be appropriate for the Commission to suggest strategies by which those goals and objectives might be carried out.[12] The previous chapters illustrate the potential (beyond satellite communications) for commercial application and the opportunities for international cooperation in the various space technologies. In all cases, effective policy decisions can be made only after careful analysis of the individual characteristics of the individual technologies. Moreover, a range of broad "strategies" articulated by the Commission would aid the development of policy for individual technologies. The following sections summarize elements of competitive and cooperative approaches.

[9] Public Law 98-361 directed the President to establish a National Commission on Space within 90 days of its enactment. The bill was signed by the President on July 16, 1984. On Mar. 29, 1985, the President announced the Commission appointees.

[10] See, for example, *Civilian Space Policy and Applications*, op. cit., ch. 10; J. H. Gibbons, testimony before the Subcommittee on Space Science and Applications of the House Committee on Science and Technology, Aug. 4, 1982 and Oct. 18, 1983; T. F. Rogers, testimony before the Subcommittee on Science, Technology and Space of the Committee on Commerce, Science, and Transportation, Mar. 1, 1984.

*Text in app. C.

* *Text in app. D.

[11] Title II, Public Law 361, the National Aeronautics and Space Administration Act of 1984.

[12] The OTA assessment, *Civilian Space Stations and the U.S. Future in Space*, op. cit., suggests a list of goals and objectives that such a commission, if appointed, might wish to consider.

APPROACHES TO COMPETITION

Like other U.S. industries, space-related industries contribute to the overall economy by producing goods and services, by providing employment and tax revenue, and by making export sales. Like other industries, they are affected by Government policies of many kinds, but they also have certain unique characteristics related to the Nation's overall goals for space. As a result, the

development of the U.S. space program has led to the formulation of distinct "space policies" that set these industries apart from other U.S. industries. This section identifies the principal elements of U.S. policies for competition in space-related endeavors and then assembles them into four more or less coherent approaches to international competition.

Principal Elements of Competition Policy in Space-Related Activities

As discussed in chapter 4 and in the individual technology chapters, U.S. policy toward international competition involves policies directed toward international trade, noncommercial programs, and R&D.

International Trade Policy in Space-Related Industries

U.S. post-war international trade policy has generally been to work for fair and open trade. To further this goal, the United States has been a leading proponent of international trading rules embodied in multilateral or bilateral agreements. Although most international agreements regulating market access, subsidies, and government procurement apply only to a limited extent to trade in space-related equipment and even less to services, the fair trade principles involved are reasonably clear and relevant. One day they may be applied more thoroughly to trade in space-related goods and services.

If free trade principles come to dominate space-related trade, the pricing of Ariane and Shuttle, as well as market access to telecommunications equipment procurement, is likely to be affected. Even at present, while the general trade principles have only a small direct effect on these and similar issues, they are the measuring device by which unfair practices are identified. When agreements or understandings are reached among governments in the space arena, they tend to draw on these principles.

According to fair trade principles, market forces should determine market events in most cases. Governments should not "load the dice" against particular sellers but rather should construct "level playing fields" for all market participants. The specific principles basically deal with various kinds of subsidy and favoritism. "Most favored nation" treatment (no discrimination among foreigners) and "national" treatment (no discrimination between foreigners and residents once in the local market) mean that sellers from all countries should be able to compete for nongovernment, domestic sales on equal terms, once the relevant tariffs have been paid and other entry terms complied with. Export subsidies, below-market credit terms, or subsidized costs are now generally regarded as unfair. Further, favoritism in government procurement toward national firms is considered, in principle, to be an illegitimate practice in an open trading regime. As earlier chapters have shown, these concepts are unevenly applicable or applied, even when they have been incorporated into agreements, especially to high-technology sectors such as space. Nevertheless, they are widely recognized to incorporate the basic concepts of fairness in international trade.

Open trade is not always the objective of governments. In exporting big-ticket items in advanced-technology sectors, such as space transportation contracts or telecommunication satellites, making the sale may be considered more important than defending the open trading regime. When this is the case, as it often is, governments resort to subsidies, encourage discriminatory treatment at home and in third countries, and compete vigorously through political horse-trading.

A complicating factor is that trade policy is not the only or even the principal reason why governments intervene or act in advanced technology sectors. They underwrite or carry out R&D of both commercial and noncommercial relevance when they believe that reliance on market forces does not make good public policy. For instance, it has been plausibly argued that private firms tend to underinvest in R&D because, among other reasons, they may be unable to profit sufficiently from their investment when their competitors can easily copy the technology once developed. It has also been argued that firms are unwilling to take large risks with long time horizons (see ch. 4). To correct for these deficien-

cies in the private economy, governments may have good reason to engage in product-oriented R&D, even when it is of direct benefit only to particular industries.

Certain governments, and certain opinion sectors in all countries, espouse industrial policies designed to stimulate particular industries–in this case, space-related industries—for the conscious purpose of making them more competitive internationally. They argue that government interventions, such as targeted R&D programs, subsidies, import protection, antitrust relaxation, and discriminatory government procurement stimulate "sunrise" high-technology sectors striving to become industries, by shielding them from international competition until they become competitive.

Even if the focus of industrial policies is primarily domestic, they affect international trade as well. Subsidies in the name of domestic industrial policy are subsidies nonetheless. When they are implemented in pursuit of legitimate domestic economic objectives, however, it becomes more difficult to identify them as unfair trading practices. They are therefore less likely to be contained by general agreements or be the subject of bilateral ones. Nevertheless, the more commercially developed the technology, and the greater the impact of government support on international sales, the more likely it is that this support will come to be identified as an unfair trade practice that can be placed on the table when trade negotiations occur, or one that should be matched in kind in the interest of fair international competition.

R&D support is undoubtedly one of the most difficult policies to subject to an international trade regime. Little agreement exists on whether it is a threat to the open trading system, even when it is designed to improve the international competitiveness of national industries. We have noted international trade effects of subsidized R&D in each of the four technologies discussed in this report. In satellite communications, international trade considerations are among the principal arguments in favor of the Advanced Communications Technology Satellite (ACTS) research program (ch. 6).

Noncommercial Competition for Leadership

U.S. policy toward international competition in space also involves significant noncommercial competitive aspects summarized as "leadership" (or "preeminence" when this leadership is striking). The United States has derived substantial foreign-policy benefits from its space activities. Beyond the foreign policy benefits that the United States has obtained from noncommercial leadership, the public has derived the direct intangible benefit of national pride and the scientific benefits of space research. Any strategy toward international competition must deal with the noncommercial dimension of competition as well as the commercial one.

As the history of INTELSAT indicates (chs. 3 and 6), there is a clear relationship between cooperation and leadership. The United States is a valuable partner for future cooperation because it has achieved high technological status and capability.

Research and Development

U.S. policy toward space R&D draws on several different motivations. At the simplest level, aside from motives of international competition, the Government spends funds on basic and applied space research because of the direct satisfaction citizens derive from accomplishing major engineering feats in space or gaining knowledge of the universe. As space research is directed toward application, the competitive motivations become more prominent.

The Government is also motivated to stimulate space research by the fact that, without a Government program, certain speculative research in potentially commercializable technologies might not be done by private firms. If firms cannot effectively gain ownership over the research results, they are understandably reluctant to finance research.

The problem of ownership arises when research results financed by a private firm flow into the public domain and are used free by competitors.

For example, research personnel move freely among U.S. firms and bring the fruits of their research with them. They may also set up their own firms in competition with their previous employers. The firm in question is then at a financial disadvantage. If no firm (or industry joint venture) is willing to do particular kinds of research for the whole industry, it may be appropriate for the Government to do it for the good of society. As an extension of this line of reasoning, NASA has long maintained that the direct and indirect "spinoffs" of NASA R&D have produced returns to society well in excess of the Government investment. An individual firm might not be able to capture similar returns, even if it could protect its research, because the expected profit from an innovation may be small compared to the investment. The Government may be able to justify the program because of the spinoffs.

Another rationale for Government support of space research is the trade-related industrial policy motivation referred to above. According to this line of reasoning, if the U.S. Government fails to take an active role in some research areas, foreign research programs will give foreign producers of space-related goods and services an unfair advantage. Countervailing U.S. Government R&D subsidies are one answer to such research abroad, but foreign governments, in turn, often justify their research programs as a means of countering ongoing U.S. civilian and military space research. In their eyes, research funding of military space programs constitutes an implicit subsidy of some U.S. civilian projects. ' [3]

One key motivation for the Government to carry out and finance space R&D is to support various Government activities. For example, much of the motivation for the Shuttle or for land remote sensing research was to meet Government needs, both military and civilian, for space transportation and remotely sensed data.

Although the different motivations for doing R&D are conceptually separate, most of them, in fact, come into play at some stage in most space research programs and shape the direction of the program in direct or subtle ways. It is therefore often not possible to determine precisely which motivation led to a particular project. The inability to classify projects neatly is also reinforced by the fact that ongoing projects often attempt to gain support from more than one constituency as they progress.

[13] See however, *Civilian Space Policy and Applications*, op.cit., ch.5. **The process of transfer of innovative ideas from the military context to civilian products is often fraught with delay and other difficulties. There is no one-to-one correspondence between military funding for research and technological benefits to the civilian population.**

Approaches to International Competition

Previous chapters have identified additional specific measures that may be appropriate for a given technology. With these measures and the previous discussion of this chapter as background, this section discusses four broad alternative approaches:

- Stimulate substantial exploitation of space.
- Continue to seek U.S. preeminence in space.
- Let market forces predominate where possible.
- Keep Government financial outlay low.

Stimulate Substantial Exploitation of Space

This approach employs the three principal elements of policy discussed above for the overall purpose of stimulating the development of space for its own sake. Those who favor substantial development view exploration and scientific, R&D, and commercial uses of space all as valid reasons to move to the last "frontier." But more than that, they tend to see space development as a national imperative that should be supported by as broad a coalition as possible. To realize this goal, they favor an eclectic policy approach: do whatever "works" best (as long as it happens in space)—and be ready to change when necessary. As they see it, the more actors on the space stage, and the more influential and permanent they are, the better. Under such conditions, international competition among countries is seen as the stimulus to achieve a greater presence in space,

In this approach, commercial space endeavors are welcome, its proponents would usually support the trade policy preferences of such firms

with respect to organizing competition in space-related industries. They view serious conflict within the "space community" over Government policies as undesirable, and seek industry consensus, particularly among U.S. actors. In their view, conflict even in international commercial competition should ideally be kept at a low level, and each international competitor should have a role. In other words, public squabbles among commercial competitors should not be allowed to undercut public confidence in the overall space effort.

To stimulate the exploitation of space the Government, in addition to conducting its own R&D, could support space industries by means of loans, subsidized loans, or loan guarantees to companies attempting to produce and market new products. One proposal suggests that Government loans be provided for high-risk projects from which private capital shies away.[14]A These loans would be paid back if the enterprise succeeded and forgiven if it failed. Such a policy might even extend Government-subsidized or Government-guaranteed loans to foreign purchasers of U.S. space products and services. The Government might also offer short-term trade protection on the grounds that infant industries need to mature in the domestic market before they can compete successfully in international markets.

Competition for leadership with other countries in both commercial and noncommercial programs is viewed by those whose aim is to stimulate space development as a benign activity in the service of all mankind. As a dramatic element, competition for leadership can increase support for the space program in the public and boost morale in the participants. Cooperation on large projects is especially welcome because it could release significant amounts of resources for use on still other important activities.

Because exploration, space science, and R&D directly stimulate the use of space, Government R&D programs would usually be preferred over the subsidizing of space-related exports as a means of promoting private sector competitiveness, and thus involvements. In addition, transferring costly Government-supported development projects to commercial sponsorship would be doubly welcome. In the first place, Government funds would be freed up to address concerns that the private sector cannot be expected to meet. Second, and perhaps more important, the private sector would thereby become more involved, thus making the structure of the space sector more closely resemble that of other, already successful economic sectors. Unless it undermined unity in the coalition of space interest groups, those supporting the space-development approach would be likely to favor some form of subsidized space transportation as a general way for the government to support space development.

The major problem with this approach is that the links of space policy to other areas of public policy are tenuous; "more is better" is not a fully adequate prescription for public policy.

Continue to Seek U.S. Preeminence in Space

Although multiple motivations are involved here, as in the previous approach, seeking preeminence emphasizes the political and commercial benefits that proponents believe will flow both from a successful U.S. national civilian space program and from growing U.S. commercial space activities. In defining this approach, one must first define preeminence–is it dominance across the board in space activities? or could "leadership" in *most* important activities satisfy the criterion? When the space programs of other nations (except for the Soviet Union) were small or nonexistent, the United States was the preeminent space power, however defined. Now, however, with the emergence of large national space programs abroad, each of which seeks to make its own mark, what U.S. "preeminence" is to mean, for actual policy determination, needs to be clearly defined, in order to formulate and evaluate an achievable approach. For the purposes of this discussion, "preeminence" will mean the achievable goal of leadership in most important civilian space activities.

Although competition in military space activities has recently assumed greater importance, ci-

[14]See the Space Industrialization Act of 1979 (H. R. 2337), hearings before the Subcommittee on Space Science and Applications of the House Committee on Science and Technology, 96th Cong., 1st sess., 1979.

viiian space competition with the Soviet Union continues to be important. Preeminence over the Soviet civilian space program, in this approach, is an important political goal and can be achieved through a continuing large commitment of resources.

Preeminence in noncommercial competition with the national space programs of non-Communist countries is also a goal. One major objective of this competition is to ensure that the United States will lead in commercially important space technologies and therefore also in experimental technologies that are expected to lead to commercial products. But the goal is broader than this. Proponents of this approach believe that the United States should use its resources to retain leadership in most space activities, commercial or not. The use of Government agencies to produce subsidized commercial services (e.g., NASA as the principal world provider of space transportation services) is consistent with such a stance because a U.S. subsidy makes it more costly for other countries to offer effective competition.

If the entry of U.S. firms in an industry that had been dominated by Government led to phasing out subsidized production (e.g., in ELVS), foreign governmental or commercial competition that had been deterred by the subsidy might then emerge and threaten U.S. preeminence. For instance, proponents of this approach argue that full cost pricing of the Shuttle, which accounted for all the risks and operating costs that a private firm would have to factor in, could enable Arianespace to capture an even larger share of the market than they now have and thereby damage U.S. preeminence. They therefore tend to oppose full cost pricing for the Shuttle, even if it largely prevents the U.S. private space transportation industry from developing.

In general, proponents of U.S. preeminence in space are less concerned with the commercial viability of a project than some others; they are prepared to recommend subsidies to cover revenue shortfalls, and see commercial ventures as vehicles to express U.S. leadership.

In terms of trade policy, these considerations tend toward a mercantilist position. Those who favor the approach of preeminence tend to favor clear U.S. dominance in the commercial uses of space. They would want to assure this by, first, reserving the large U.S. market for domestic space producers by the usual means this is accomplished—price/quality dominance where possible, as in communication satellite production, and subsidy and Government procurement restrictions where it is not, as in remote sensing and materials processing. They might also want to restrict access by other nations to the Shuttle.

Second, in export markets, these proponents would urge open trade, in which space industries are brought under the general coverage of relevant international trading rules when U.S. producers have price/quality dominance, but work for government-to-govern ment market sharing agreements and/or export credit and other forms of subsidy when they do not. R&D subsidies targeted to achieve a goal of enhancing the competitiveness of U.S. producers of space goods and services would have a major role in this approach, both because of the sunrise-industry characteristics of many space technologies and because it allows an easy coalition with those favoring substantial space development for its own sake.

Like the space-development approach, this is an approach in which “more is better, ” and the links to broader political and economic policies are not always explicitly considered. When Congress favors financing a large and growing program, strategies built around substantial development and preeminence fit together well. When resources are scarce, however, the implicit conflict between groups espousing the two positions leads to much more stressful bargaining. Neither group can then achieve all its important objectives.

For instance, the influence of the space-development strategists may result in advanced technology that gains little significance in the actual market. Conversely, politically attractive projects to construct manned demonstration systems favored by those seeking preeminence may crowd out the more developmentally significant ones favored by the space-development point of view. The crowding out of other NASA programs by the Apollo program in the 1960s and the Shuttle program in the 1970s are examples of this latter conflict.

Let Market Forces Predominate Where Possible

Letting market forces predominate is a well-defined approach for potentially commercializable activities, including their R&D phase. It can be combined with the noncommercial elements of other approaches to form rather diverse overall strategies. The hallmark of this approach is the idea that, as a rule, Government should not invest heavily in activities that the private sector is in a position to pursue. This stance is supported by the belief that markets for products and services in the U.S. economy can usually be relied on to signal which activities are socially useful, According to this reasoning, if the private sector is not willing to fund a development project as conceived by NASA, the project probably should not be carried out, at least in that form. Outside of R&D, Government's role is envisaged as simply to do its best to assure a fair, workably competitive marketplace, domestically and internationally, for those firms that wish to compete in selling space-related goods and services.

Consumers of space products and services, in the rationale of this approach, would be expected to pay prices that recover the full cost of providing them. With certain exceptions, such as meteorological data products, products and services that private firms would not provide at the unsubsidized prices are judged to be less valued by society than those that private markets do produce. They have not passed the market test. Contrary judgments about social value, which would allow government to overrule the dictates of the market, would have to show that, in the instance involved, the market was not reflecting the preferences of potential buyers, that there was some other market failure involved, or that government involvement would produce a clear-cut political benefit that was worth the outlay.

As discussed earlier in this section, Government R&D activities have a clear rationale when private firms cannot expect to establish full property rights in the fruits of research. When this is the case, private firms are likely to underinvest. The more basic the research, the riskier it is, or the larger the time until commercial payoff, the less adequate the performance of private firms, Government outlays intended to promote technological progress may include: funds to improve scientific and engineering education, direct conduct of basic and applied research with potential industrial applications, sponsorship of such research in universities or industries, transfer of research findings from Government programs (e.g., military) to the private sector, joint Government-industry research ventures, or special tax treatment for private research.

Consistent with this approach, then, is the idea that as prospective R&D results come to look more commercializable, Government-supported research can move from Government-performed research (e.g., NASA research laboratories) to Government-funded research (e.g., ACTS program) to Government-subsidized research (e.g., NASA's Joint Endeavor Agreements) to no significant Government involvement at all. Thus, this approach is consistent with a large government R&D role in the early stages of technological development that diminishes as markets develop.

One benefit of an approach that depends on market signals is that it sets space policy in the context of overall economic policy. Attention to space technology becomes just one component of the U.S. approach to high-technology R&D. As high-technology industries, space-related industries would expect to benefit from a general policy of fostering R&D. But under a policy of broad support, they would not be singled out for more favorable treatment than that received by other high-technology industries. They would still be expected to sink or swim in the marketplace.

Large demonstration projects, in particular, are less likely to be undertaken under this approach. Its proponents do not regard failure to invest heavily in a particular Government development prototype as evidence of the unwillingness of the private sector to invest in the technology per se. They argue that scientists and Government officials might incorrectly substitute their ideas of potential demand for those of entrepreneurs, financial analysts, and insurance executives, thereby distorting technological processes.

Previous chapters have also made the point, in the case of certain public goods like meteorological remote sensing, that private markets

would be unlikely to produce the socially desirable kinds and amounts of weather data. Therefore, Government production or subsidy is justified as an exception.

An approach where market forces are allowed to predominate requires clear signals from the Government to allow markets to work well for society. In a sector where Government involvement has been high, firms and investors that might be willing to invest on a commercial basis r-night hold off in the hope of receiving a subsidy. In part, their reluctance to start might also reflect their fear that competitors would subsequently receive a subsidy or that the Government itself might undertake the project in competition with them. The cost of waiting in these circumstances would generally be low. Because no firm would make a move until the Government acted, waiting would not disadvantage them.

Many proponents of an approach depending on market forces would undoubtedly prefer open, fair international trade in space goods and services, but others, despairing in obtaining it, might favor countervailing subsidies or restrictions on U.S. market access to match foreign restrictions. This approach can only lead to a partial strategy for achieving national goals. It does not apply, for instance, to noncommercial competition.

As long as make, buy, or contract decisions for Government use, including those designed to increase U.S. prestige, are made with prudent contracting controls this approach has little inherent conflict with an approach of preeminence in space. in practice, however, the two approaches are typically in conflict. Those who favor a market strategy tend to want to leave the development of most commercializable space systems, particularly their form, to the market, whereas those favoring an approach of preeminence would typically be loathe to entrust the fate of valued projects to the uncertain decisions and timing of private companies.

In contrast, the approach of depending on market forces would seem to be compatible with one favoring substantial space development, as long as dependence on markets produces a vigorous private sector. In practice, however, proponents of substantial space development tend to be impatient with letting market forces lead the way. Their concept of commercialization tends to be one in which Government takes the lead in developing prototypes. They are usually in natural alliance with those favoring an approach of preeminence.

Keep Government Financial Outlay Low

The low-outlay approach is the final competitive approach. It is competitive in the sense that as total outlay on civilian space-related Government activity is reduced, certain aspects of the other options become infeasible. Sharply limiting the available funds more or less defines a set of possible policy options. in particular, an effective policy to match the R&D, production or export-credit subsidies of other countries would become impossible without substantial funding, as would subsidized Government production of space-related goods and services for U.S. consumption, such as Shuttle transportation. Consequently, a low-outlay approach tends toward one that depends on market forces.

Proponents of this approach would argue that most needed research would be funded by the private sector. If the market would not support the research, it was probably not needed and therefore should not be done. Only a limited amount of R&D would be funded, and, in particular, few large, expensive projects would be undertaken by the Government. The allocation among various types of projects—those that would develop space, those that would bring political benefits, and those that would bring industrial policy benefits–would depend on the alliances their proponents could make. One possible alliance might be among the proponents of space development, market forces, and low-outlay. In this case, NASA would tend to concentrate on more basic R&D and avoid building prototypes and use less expensive methods of technology transfer. One potential drawback of this approach is that it might put U.S. industry directly in competition with government-supported foreign industry.

Even though the low-outlay approach is incompatible with expensive “sunrise” industry indus-

trial policy, it is not necessarily incompatible with the low-cost protectionist elements of this policy. Several retaliatory weapons to punish unfair trading practices by other space-capable countries exist that are not costly in budget terms: tariffs, quotas, boycotts, standards harassment, and government procurement restrictions. These could effectively restrict foreign access to the U.S. market, although they would usually increase prices for U.S. users. They might be utilized, in retaliation for foreign subsidies in both U.S. and third-country markets, under Section 301 of the Trade Act of 1974 or other existing trade laws,

Somewhat ironically, protectionist restrictions even have a role in securing free international trade in space-related goods and services. They could be used as bargaining chips in bilateral and multilateral negotiations to create a more liberal international regime.

In the low outlay approach, cooperating with other countries in space applications (e.g., remote sensing), space science, and exploration of outer space assumes even greater importance than in the other competitive approaches. A highly active program of cooperation would be necessary to maintain a level of technological leadership otherwise unavailable in this approach.

ELEMENTS OF COOPERATIVE POLICIES

International cooperation in civilian space activities may serve a variety of goals:

1. sharing the costs of expensive projects;
2. increasing exchange of scientific knowledge and U.S. access to foreign technology;
3. promoting international understanding;
4. coordinating potentially conflicting international activities (e.g., the use of the electromagnetic spectrum for telecommunications);
5. providing services on a multinational basis (e.g., through INTELSAT or INMARSAT);
6. regulating international trade in space-related goods and services;
7. providing assistance to developing countries;
8. improving political relations; and, indirectly,
9. promoting U.S. exports.

At different points in the history of its space program, the United States, acting through NASA, the National Oceanic and Atmospheric Administration (NOAA), the Department of State, National Telecommunications and Information Administration (NTIA), Federal Communications Commission (FCC), and U.S. Agency for international Development (AID), has pursued some or all of these goals. Yet, as noted in the introduction to this chapter and in chapter 3, increased international competition and changes in the outlook of the developing countries have altered the international environment for cooperation. In light of these changes, and the fact that the private sector has demonstrated increased interest in commercial space activities, a reassessment of U.S. policies for space cooperation is in order. The key question in such a reassessment must be, under what circumstances and in which technologies does cooperation serve the long-term political and economic interests of the United States?

This section identifies a range of cooperative approaches that the United States has taken in the past, and discusses their use in today's climate. The options presented here are not mutually exclusive; indeed, an effective overall policy would include aspects of each. Some potential cooperative approaches would be inconsistent with certain of the competitive approaches described in the previous section. The opportunities for cooperation also vary considerably across the range of technologies studied in this report. The suitability of various approaches for cooperation varies accordingly.

Emphasize Cooperation That Contributes to the Technological Goals of the United States

Given the enormous cost of space research and exploration, and the recent space accomplishments of other countries, the United States cannot hope to remain a leader in every aspect of this technology, unless it actively seeks cooperative ventures. International cooperation is one means by which the United States can participate in numerous expensive projects. NASA's largest cooperative project, Spacelab, cost the European Space Agency (ESA) in excess of $1 billion and is perhaps the best example, to date, of the monetary value of international cooperation, For budgetary reasons, the alternative to an ESA Spacelab was not a less capable U.S. spacelab, but rather no Spacelab at all. Additionally, Canadian expenditures (over $100 million) for the Shuttle's highly successful remote manipulator arm freed the United States from this Shuttle expense. Not counting Spacelab, NASA has estimated that other countries have contributed over $2 billion to U.S. objectives in space over the last 25 years through cooperative programs.[15]

Joint technology development programs raise a unique set of difficulties. A cooperative policy that stressed common technological goals would focus almost entirely on projects with nations having reasonably advanced space programs. Such cooperative projects with developed countries, however, increase the likelihood of inadvertently transferring commercially useful technology to them and increase the possibility that foreign firms will be able to compete more effectively with U.S. firms in commercial space markets. In addition, when dealing with new technologies it is often desirable to reduce the administrative complexity of research; cooperative projects tend to increase the difficulty of technology development. For these reasons NASA has traditionally avoided joint production arrangements with other countries for essential hardware. As discussed elsewhere in this report, however, the industrialized countries are increasingly capable in space technology and are concerned about transferring the fruits of their research to the United States.

In the near future, the largest single area in which the United States will cooperate with the industrialized countries is in building and using permanently inhabited space infrastructure, including a so-called space station. The United States has already signed cooperative agreements with Canada, ESA, and Japan for the design phase of NASA's space station program. As planning for the development *and* operation of the space station(s) proceeds, the various modes of cooperation should be carefully studied. Possible cooperative options are detailed in the OTA report, *Civilian Space Stations and the U.S. Future in Space.*[16]

Emphasizing joint technology development programs makes it difficult to define a meaningful role for many developing countries. Yet including them in cooperative activities could give them an opportunity to engage in the pursuit of space technology and thereby ease current difficulties in the United Nations and make international consensus on issues such as frequency and spectrum allocation easier to obtain.

It is important to assess whether an international cooperative venture is truly in the long-term interest of the United States. Short-term budgetary or political pressures should not be allowed to affect adversely the long-term viability of important national programs. Yet, any policy on cooperation should be designed to allow access to foreign technology and expertise where they would materially benefit U.S. programs. In the near future the major space powers will have to make critical decisions concerning the level of international cooperation they wish to pursue. The United States may wish to limit cooperation to the investigation of basic scientific phenomena or the development of discrete components (e.g., the shuttle remote manipulator) so as not to conflict with the potential commercial activities of the U.S. private sector. To add to the subtlety of

[15] U.S. Congress, Office of Technology Assessment, U.S. Government Printing Office, *UN/SPACE '82: A Context for Cooperation and Competition,* OTA-TM-ISC-26 (Washington, DC: March 1983), app. B.

[16] See for example, *Civilian Space Stations and the U.S. Future in Space,* op. cit., app. C.

the decision process, it should be noted that U.S. corporations sometimes find that international joint ventures (e.g., AT&T and Olivetti) enhance their overall international competitive ability.

Emphasize Political Benefits of Space Technology

How can the United States reap the maximum advantage from current and future cooperative activities? The possession of highly visible, technologically advanced industrial capacities, such as the ability to produce and use space technology, carry with them certain foreign policy benefits. The precise nature of these benefits, although difficult to define, is usually measured in terms of increased "prestige and influence." Cooperating with the United States on space projects (or, for that matter, on any high-technology project) can create the perception that, by working with the United States, nations are "on the winning team, " and can create an incentive for such nations to compromise with the United States on both space and nonspace issues if they believe that such cooperation earns them the advantage of long-term access to advanced technology or other bilateral support.

Using space technology for peaceful purposes to accomplish diplomatic goals is a complex task that is pat-t of a larger diplomatic picture. international space policy in the United States has evolved slowly over the years, changing in response to technological developments and the global political environment. For example, the Apollo-Soyuz Test Project, a U.S.-Soviet cooperative project, was a reflection of the era of detente.17 The Carter Administration's emphasis on the use of science and technology as tools for development led to increased assistance in space technology to developing countries.

If the use of international cooperative efforts in space to accomplish diplomatic ends is desirable, then it is appropriate to consider what Government organization is appropriate. The present arrangement divides the policy responsibility for international space activities among the Department of State (foreign affairs and international organizations); the Department of Commerce (operational remote sensing [NOAA], international satellite communications INTIA], and trade-related activities); NASA (space R&D, science, and transportation); the FCC (regulation of U.S. international satellite communications); and the National Security Council (national defense). Considerable confusion now exists over who has jurisdiction in any given issue involving more than one of these elements, as do most international space activities. As a result, the task of using science and technology for diplomacy has often been considered of secondary importance.

Most of the day-to-day work of putting international space policy into practice has fallen to NASA and NOAA. The FCC and the Department of State have overseen commercial satellite communications. NASA's role as an R&D organization compels it to seek partners with which it can accomplish technological goals, and is, therefore, less inclined to focus on the broad foreign policy implications of decisions. NOAA's interest in maximizing the collection and distribution of critical atmospheric and land remote sensing data has led it to seek broad *operationa/* agreements with its counterparts in other countries. It therefore focuses on operational goals rather than on diplomatic issues. The FCC and the Department of State have jointly formulated U.S. positions in bilateral and multilateral negotiations related to satellite communications.

The State Department, as the foreign policy organ of the Government, pursues relationships that accomplish diplomatic tasks and is responsible for overseeing U.S. treaty obligations (see ch. 3). Lacking NASA's, NOAA's, and the FCC's expertise in space technology, it has traditionally deferred to their judgment on most international space activities. Although the Department of State consults regularly with NASA and NOAA on the one hand, and the FCC on the other, the success of this coordination depends heavily on the personalities of the individuals involved.

Using civilian space activities more aggressively to pursue broad U.S. foreign policy interests, including the reduction of international tensions,

17 See *Issues in U.S./U.S.S.R. Cooperation in Space (Office* **of Technology Assessment, technical memorandum, in press) for a discussion of the Apollo-Soyuz cooperation and the political and technical issues surrounding cooperation with the Soviet Union.**

would require the Department of State to increase substantially its technical expertise and the continuity—both policy and human—of its responsibilities in space.[18] This would require, at a minimum, adding staff with substantial experience in space technology.

Participation in International Organizations

As the analysis of chapter 3 indicates, in the face of a changing international environment in which the influence of the United State~ is shrinking, the United States seems to have three broad options to consider in its participation in the international organizations dealing with space such as the International Telecommunication Union (ITU), the Committee on the Peaceful Uses of Outer Space (COPUOS), and, more generally, the United Nations General Assembly:

1. Adopt a more flexible approach, emphasizing diplomacy and a willingness to compromise in areas where critical U.S. interests are not at issue. Attempt to build broadly based coalitions within the organizations. Establish immediately a permanent technical presence at the U.S. Mission to the U.N.
2. Take an increasingly confrontational posture, using the threat of withdrawal in an attempt to prevent decisions contrary to U.S. interests. Emphasize building coalitions of like-minded nations, or establishing alternative organizations. Where possible, tie decisions on space issues to other U.S. policies on financial and technical assistance thereby acquiring leverage in negotiations.
3. Drastically reduce or end U.S. participation in international organizations if they stray too far from U.S.-supported policies, and establish U.S.-led, permanent ad hoc multinational or bilateral arrangements where necessary.

The United States has tended toward following option 2 in recent years on the premise that other countries have politicized these international bodies. However, tying decisions on space issues to other policies carries with it the very risk of politicizing these organizations that the United States seeks to avoid. In developing policies toward international organizations dealing with space issues, it is also important to understand that each of these organizations have markedly different operational agendas and should be treated separately.

Option 3 may not be advisable in those instances where for technical reasons, cooperation is a virtual necessity. For example, current U.S. participation in ITU helps to guarantee interference-free access to the radio spectrum for satellite communications. The assignment of a particular frequency is of little value if others feel free to use it for purposes that cause critical interference. There are no sanctions to force compliance with ITU decisions. Consequently, the United States, as well as other ITU members, rely on the voluntary agreement and cooperation of other nations to refrain from interfering with its assigned use of the spectrum.

Provide Assistance to Developing Countries

The United States could take the position that its competitive interests limit the number of desirable cooperative opportunities with the other space-capable nations. Cooperative activities with the developing countries, on the other hand, might be pursued with renewed vigor in order to spread U.S. influence abroad. As a first principle, the United States has always recognized its responsibility to contribute to the welfare and development of the Third World. However, such programs may also provide indirect economic, political, and strategic benefits to the United States. Strengthening the scientific and technical capabilities of the developing world may *promote* the growth and expansion of important markets, provide new outlets for U.S. goods and services, and orient the indigenous scientific and engineering community toward the United States.

[18] The State Department has recently made some moves to strengthen its expertise in space and other technology fields, and to place greater importance on science and technology in diplomacy. See John Walsh, "Shultz Signals Backing for Science Attach&," Science, vol. 226, 1984, pp. 518-51 9; Also, Otho Eskin, hearings before the House Subcommittee on Space Science and Applications of the Committee on Science and Technology, July 25, 1984.

The United States has considerable experience in providing technological assistance. Its meteorological satellites have been used for global weather coverage since the early 1960s, and the Landsat Earth remote sensing system has been in operation since 1972 under a policy whereby the United States has sold imagery to any country for little more than the price of reproduction. NASA and AID have cooperated in giving developing counties valuable training in the use of Landsat data. In another example, NASA and AID used the ATS [advanced technology satellite] series of experimental direct broadcasting satellites in the mid-1970s to carry out several important studies in India, South America, and the Pacific, which demonstrated the usefulness of satellite communications to deliver programs to rural areas. *

The principal cooperative space activities with the developing world are in remote sensing and telecommunications. * * These could be coordinated with other assistance programs and be made more responsive to the abilities and expressed needs of recipient nations. Such programs would likely include a large educational component, and would present only minimal technology transfer problems. It would be unlikely to interfere with other AID, NASA, and NOAA goals and programs.

Although the United States has the technical and institutional means to carry out an expanded program of assistance using space technology, serious questions remain concerning the desirability of such a course of action. The current official attitude of the United States (primarily within the Administration) toward many Third World countries is one of profound mistrust. In the view of many, Third World demands for access to technology and space resources, and its support for larger political agendas, such as the New World Information order or the New International Economic Order, threaten such important American ideals as free speech and free enterprise. Such Third World demands have diminished the desire of some U.S. policy makers to support multinational technology transfer programs.

The United States has several methods available for pursuing cooperative programs. The first, already used extensively, is an emphasis on bilateral, as opposed to multilateral, assistance programs. This allows projects more closely related to individual country needs and assures some degree of accountability for both participants. Another method, introduced at the **ITU** Plenipotentiary Conference in Nairobi in 1982, is the use of private U.S. firms to pursue development goals. The U.S. Telecommunications Training Institute was established to promote the planning and operation of telecommunication and information systems in developing countries. Because private U.S. firms provide the training, equipment, and funding for the Institute, its operation is unlikely to be subverted solely for political or ideological motivations.

Establish International Organizations to Provide Space Services

Once a technology has been developed and its value proven, the question then arises of how best to apply the benefits of this technology. This has generally led to debate over whether the private sector or the government is best suited to manage the applications phase of the technology. Particularly important for this discussion is the role that international cooperation in the form of intergovernmental consortia can play in this process.

When INTELSAT was established, its advocates considered the system to be the most effective way of quickly bringing the benefits of satellite communications to much of the world. Now, with the rise of potential private sector competitors, the cons as well as the pros of an internationally governed monopoly in satellite communications are being discussed (see ch. 6). A similar analysis might be used in relation to remote sensing. Although land remote sensing is now seen as an area of international competition, it may turn out that the raw satellite data is less marketable than communications services, at prices that

***The countries that participated in these projects contributed to them as well.**

****The U.S. Government can provide certain technology to developing countries, but it does not own or control all space-related technology these countries might wish to acquire. Much of it is privately owned and would need to be licensed from private owners by individual countries.**

provide an adequate return on investment, and will remain more of a public, than a private, good. If so, then it might be appropriate to attempt to organize an international body to collect and distribute the data free or at low prices (see ch. 7). Such an organization might pool international resources to maintain a single system of satellites, which no single nation would invest in alone, but from which all participants would benefit. Alternatively, the national members might agree to specialize in particular types of satellite facilities and data collection they would provide to all users at low prices. All would benefit from an international division of labor.[19]

There may be instances (e.g., to save system costs) where the United States would benefit by actively pursuing the formation of international consortia. Presumably, such a course would be followed only in the absence of financial interest by the private sector in a new technology, or where the foreign policy benefits of such an organization clearly outweighed its negative effects on the formation of a free market.

[19] Indeed, such an organization was suggested as one of the Policy options of *Civilian Space Policy and Applications,* op. cit., ch. 10, pp. 298-300. NOAA is now attempting to organize a variation of such a cooperative venture in ocean remote sensing among Canada (Radarsat), ESA (ERS-1), Japan (MOS-1), and the United States (NROSS), in which NOAA would take the lead in gathering, processing, and distributing data sets globally.

THE RELATIONSHIP BETWEEN COOPERATION AND COMPETITION

Few elements of either governmental or private sector space activities are either purely cooperative or purely competitive. Indeed, the motivations for cooperation or competition are driven primarily by economic and political factors and are often closely intertwined. As this report has emphasized throughout, cooperative projects are often undertaken, in part, for competitive purposes. For example, part of the U.S. political motivation in cooperating with developing countries is to demonstrate the willingness of the United States to share its knowhow with these countries in competition with the Soviet Union. On the other side of the coin, the enhanced ability of Europe and Japan to compete economically with the United States in offering space goods and services makes them more attractive cooperative partners for major projects such as an international polar-orbiting remote sensing platform or a permanently inhabited space station.

In developing policies for the U.S. space program it is important to recognize not only the roles played by cooperation and competition, but also how each may enhance the effectiveness of the other. The four approaches to international competition discussed in the section on competition—stimulate the substantial exploitation of space, continue to seek U.S. preeminence in space, let market forces dominate, and keep Government financial outlay low—would be improved by one or more of the cooperative elements explored in the section on cooperation. For example, although the French will soon be offering remotely sensed data from their SPOT system, in competition with data from the U.S. Landsat system, it is nevertheless in the best interests of both countries to cooperate on setting data standards, format, and other aspects of the two systems. In doing so, both countries may gain in political prestige and even in access to markets.

However, cooperation and competition do not necessarily enhance one another. For example, governmental cooperation with other countries, particularly technologically advanced ones, may make competition more difficult for U.S. firms. As mentioned in several places in this report, cooperation with Europe and Japan raises the specter of outward technology transfer that could strengthen their ability to offer space goods and services in direct competition with the United States. This argues for structuring cooperative projects in such a way as to reduce the negative effects of unwanted technology transfer. However, as other countries reach parity with the

United States in certain technologies, or even surpass it, the United States will have something to gain from them. This is the case now in some narrow areas (e.g., in building manned space habitats). Therefore, in structuring cooperative agreements, it will also be important for the United States to consider what technology it might gain from other countries.

As the United States structures its cooperative activities in space between now and the end of the century, and faces greater competition from other space-capable nations, it will be important for policy makers to consider the interactions of cooperation and competition in each international project on which the United States embarks. **In order to compete effectively with other nations in space science and space applications, it is necessary to cooperate. On the other hand, in order to cooperate most effectively, it is necessary to be able to compete as well.**

ORGANIZING FOR THE FUTURE

The NAS Act, in addition to establishing the basic guidelines for the Nation's space activities, authorized the formation of NASA and assigned it the responsibility for the "aeronautical and space activities sponsored by the United States. " As a result, except for satellite communications, during the past quarter century most civilian programs and policies dealing with space have tended to focus primarily on NASA. Operating under a broad mandate to pursue excellence in space technology, NASA had a major hand in developing the technology for three industries—satellite communications, remote sensing, and space transportation; it is currently working on a fourth-materials processing in space. Yet, despite NASA's successes, it is unlikely that the agency can continue to be the primary focus of civilian space activities as commercial interests in space become stronger. NASA by itself is ill--equipped to deal with such complex issues as international commercial competition, trade policy, domestic health, safety, and economic regulation, and tax policy, all of which will have essential roles in the development of vital U.S. space industries.

An important aspect of future national policy for space will be the manner in which the responsibility for various space activities is divided among the various Federal agencies. This responsibility is essentially of two types, first, the broad responsibility for the maintenance of U.S. "leadership" in space; this is inherently a shared responsibility which requires the effective coordination of Government agencies and the private sector and, second, the responsibility for the use and successful commercial application of individual space technologies. This latter responsibility can probably be most effectively carried out when a designated agency has the responsibility for a specific technology.

MAINTENANCE OF U.S. LEADERSHIP

The NAS Act specifically calls for the United States to preserve its role "as a leader in aeronautical and space science and technology and in the application thereof. . ." This has often been interpreted to imply that the United States should be preeminent in all space activities, a point of view appropriate to the early days of the U.S. civilian space program. However, as the scope of space activities has increased, other countries have developed expertise in space, and costs have risen dramatically. It may now be more appropriate for the United States to attempt to maintain its leadership in many, rather than all, areas of space technology, and to choose areas on which it will focus its efforts. Whichever ones are chosen, successful coordination among Gov-

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structing permanent space infrastructure,[23] or remote sensing,[24] or materials processing,[25] as well as the role of space technology in development assistance programs.

If successful, such an interdepartmental assessment might result in a 5- or 10-year program of action, a more formal division of responsibilities, and a clearer understanding of the long-term problems likely to be faced individually and collectively by various Government organizations.

Responsibility for Individual Technologies

The commercial success of specific space technologies will depend to some degree on how the Government organizes to support, and, where necessary, to regulate these activities. Although coordination of Government agencies remains an important task, the success of specific space industries may depend, at least initially, on the active participation of a lead agency. The role played by the Civil Aeronautics Board (CAB) and the continued role of the Federal Aviation Administration (FAA) in commercial aviation, the activities of the FCC in telecommunications, are all examples of Federal agencies assisting in the development of new industries.

Much has been written about the potential negative effects of regulation on industry. However, the potential danger to the public posed by some space technologies, and their ability to affect international relations suggest that some form of Government intervention will be necessary.[26]

Decisions regarding which agencies should be responsible for which space technologies should be a function of the maturity of the technology and the industry and their relationship to like terrestrial activities. Because these conditions differ with each technology discussed in this report it is useful to examine them separately.

- **Satellite communications is a mature technology; it was incorporated into the overall communications industry almost from the start.** The relationship of satellite communications to the private sector has been close from the beginning. In the pre-commercial period, Bell Laboratories and other telecommunications entities carried out significant R&D on communication satellites that predated NASA's activities, and the technology transfer that took place has been a two-way phenomenon, fruitful to the R&D programs of both NASA and the private sector. Because a large market for intercontinental telecommunications services was already a certainty and because a well-developed regulatory structure already existed for the industry, a clear natural division of responsibilities existed among the FCC, NASA, and the Department of State. Only recently have problems come to be perceived.

  The Satellite Communications Act of 1962 (building on the Communications Act of 1934) ratified the natural division of labor among these agencies: the FCC would regulate communications carriers, interstate and internationally; the Department of State would lead or instruct U.S. representation in international institutions concerned with satellite communications (e.g., COPUOS, ITU, and INTELSAT); and NASA would do satellite communications R&D. NASA phased out most of this latter activity in the early 1970s, based on the expectation that the satellite equipment industry would do its own R&D (see ch. 6).

  Recently, as technological change and deregulation allowed a vigorous domestic industry to develop and look for access to international service markets and as foreign satellite equipment manufacturers started to make inroads into U.S. and world markets, the neat division of labor has become less adequate. In the early 1980s, new Government actors came to play a larger part in international telecommunications policy: NTIA in the Department of Commerce, the Office of Telecommunications Policy in the Department of State, the U.S. Trade Representative's Office, not to mention the Nation-

[23] See, for example, the discussion in *Civilian Space Stations and the U.S. Future in Space,* op. cit., app. C.

[24] See *Civilian Space Policy and Applications, op.* cit., ch. 10.

[25] See R. Dalbello and S. Finer, "Prospects for International Cooperation in Materials Processing Technologies," 33rd International Astronautical Congress, Paris, September 1982.

[26] The 1967 Space Treaty makes states responsible for their own actions or the actions of their citizens.

al Security Council, the Department of Defense, the Council of Economic Advisors, the Department of Justice, and the Federal Courts. NASA has also increased its involvement in communication satellite research for reasons relating to international trade and the international resource of the geostationary orbit. With all the executive branch agencies involved, a Senior Interagency Group and the White House came to play coordinating roles. Even so, Congress has complained of executive branch disarray.

The size and maturity of the telecommunications industry both in the United States and foreign countries, and the increasing interdependence of the world economy, make it almost certain that the tasks for which the U.S. Government must organize will continue to be complex and, even more than in other large mature economic sectors, will defy easy organizational solutions.

- **Remote sensing is a mature technology directed toward a yet infant industry.** After operational authority for Landsat was transferred from NASA to NOAA, NASA's involvement in this technology was sharply reduced. NASA now primarily conducts limited advanced R&D in high-resolution sensors (see ch. 7). The Government's primary concern now is to encourage the development of an economically viable private industry. Unlike satellite communications, the market for remote sensing services is small and the private sector has been reluctant to invest in this technology without some form of Government assistance.

  The Land Remote Sensing Commercialization Act of 1984 (Public Law 98-365) designates the Department of Commerce as the lead agency for future remote sensing activities. Among other things, this Act instructs Commerce to encourage private sector participation, establish a licensing system for prospective entrants, ensure compliance with domestic and international law (with guidance from the Department of State), establish appropriate regulation, and protect national security interests (with guidance from DOD). The legislation also directs NASA and NOAA to continue R&D activities in remote sensing and encourages the Secretaries of Interior and Agriculture to continue research into the application of remote sensing data.

  Advocates of this legislation argued that designating the Department of Commerce as the lead agency improved the probability that a remote sensing industry could develop. By providing a single point of contact within the Government, interested parties know where to make their application for systems development, and where to express their ideas and grievances. The goal, as is also demonstrated in space transportation, is to establish a focal point for the still diffuse private sector interest in commercial space activities. The experience that the Department of Commerce has gained (through NOAA) makes it the logical agency to oversee the private development of a remote sensing industry.[27]
- **Space transportation is, in some respects, both a mature technology and industry.** Mature space transportation systems (ELVS) and a mature market (communication satellites to geostationary orbit) both exist; the issue now is how to encourage private sector entry while NASA fulfills other important Government needs. Two competing positions are maintained; one encourages NASA to compete for commercial launch services and the other instructs the Department of Transportation (DOT) to promote the development of a private industry (see ch. 5). As a result of this policy competition and its own long-term needs for space transportation services, NASA remains effectively the only actor in space transportation services.

  An Office of Commercial Space Transportation has been formed within the Department of Transportation.[28] The Expendable Launch Vehicle Commercialization Act established DOT as the lead agency for commercial space transportation. This legislation is designed to promote and accomplish goals similar to Public Law 98-365 discussed above for remote sensing. DOT would license private operators, draft regulation for launch activities and, after consultation with other

[27] Still to be worked out is the thorny problem of who is to regulate use of the Shuttle for private sector or foreign remote sensing systems. See, for example, "SPARX Fly Over U.S.-German Space Venture," *Science, vol.* 227, pp. 617-619, 1985.

[28] Public Law 98.575 was signed into law Oct. 30, 1984.

relevant agencies (e.g., NASA, DOD, and the Department of State), determine whether such activities are in the public interest, are safe, and are in the national security and foreign policy interests of the United States. DOT, in consultation with the Department of State, is also responsible for determining whether private launch companies conform to U.S. treaty obligations.

- **Materials processing in space (MPS) is a set of embryonic technologies directed towards known markets.** NASA remains the most significant actor in the development of these technologies and in the attempt to encourage private sector participation in their creation. Without NASA support it is unlikely that MPS research would go forward in this country. No lead agency has been designated to encourage the development of a materials processing industry nor does one seem necessary.

  Should commercially viable MPS products be discovered, MPS would probably follow the commercialization pattern of satellite communications rather than remote sensing and space transportation, because MPS products currently under investigation, such as pharmaceuticals and crystals for electronic applications, are—like satellite communications services—directed toward large and growing commercial markets.

  In most instances it will be obvious which Government agencies should take the lead on regulating MPS products. For example, regulation of pharmaceuticals made in space would be the responsibility of the Food and Drug Administration (FDA).

CONCLUSION

There is no single set of space policies capable of adequately responding to the challenges the Nation will face as a result of its scientific and commercial activities in space. This chapter suggests that the United States should, at a minimum, develop the institutional means to achieve consensus on future space goals and to revise these goals **when circumstances so dictate. In order to survive over time,** such goals must be, to the greatest extent possible, independent of short-term budgetary and political influences.[29] The National Space Commission may offer a means by which to accomplish this objective.

Because goals must alter as milestones are reached or circumstances change, it may also be appropriate to adopt “strategies” for approaching competitive and cooperative goals in space. Correctly articulated, such strategies could provide continuity and an important middle ground between the basic principles of the NAS Act and future space goals,

[29] See *Civilian Space Stations and the U.S. Future in Space,* op. cit.