APPENDIXES

Appendix A
INSTITUTIONAL EVOLUTION OF THE U.S. SPACE PROGRAM

Introduction

This section focuses on the relationship between space policy and the institutions of the space program. It traces the origin and evolution of the institutional structure of the U.S. Government for civilian space activities, and it asks whether that structure, as it exists today, is appropriate to the kind of civilian space program the United States has today and will have in the near future. Institutional effectiveness is a means to the success of certain policies, not an end in itself. On the **other hand, a mismatch between policy and structure is likely to be a major barrier to such success, and thus an issue deserving** of detailed attention.

Not infrequently in Government programs, particular policies reflect the requirements of a particular institutional structure. As the subsequent discussion will suggest, there is not much evidence of this being the case with respect to the civilian space effort. It seems, rather, that for space, the relationship is as most students of public administration would have it: that is, structure follows strategy. In the U.S. space programs, institutions to a large degree have been based on and designed to implement agreed-on policies and carry out particular programs, rather than the reverse relationship.

What follow attempts to demonstrate how the basic policy principles were translated into a particular institutional structure, and how that structure has evolved since its inception. It does not purport to be a definitive description of the institutional structure of the U.S. space program or of its evolution over the last two decades. Rather, it highlights those characteristics of and relationships among structures that appear relevant to any evaluation of the current and future organization of the national space effort.

Separate Programs, Separate Structures

The policy decision with the most direct impact on the structure of the U.S. space program was that calling for the institutional separation within the Government of the civilian and military space activities (see ch. 6). In the immediate post-Sputnik period, when it was evident that some accelerated response to the Soviet space accomplishments by the United States was required, there were a number of contenders for the job of managing the national space effort. they included:

- a single agency for all Government space programs managed by the military, either at the level of the Secretary of Defense or by one of the armed services, most likely the Air Force;
- a new Cabinet-level Department of Science and Technology which, among its other responsibilities, would have charge of the civilian space effort;
- adding space to the responsibilities of the Atomic Energy Commission;
- expanding the responsibility of the National Advisory Committee on Aeronautics (NACA) to include a substantial component of space activities; and
- creating a new civilian agency with a responsibility for Government space activities, except those primarily associated with defense applications (which would be managed by the Department of Defense (DOD)).

Once the decision to separate civil and military space activities was made, the claims by DOD and by the armed services that they were the appropriate managers of the national space program found limited political support either within Congress or in the public (outside of those constituencies with close connections to the military). The idea that the U.S. space program in its civilian aspects should be an open, unclassified effort was widely accepted among those concerned with shaping national space policy.

As the Government agency concerned with aeronautics research, NACA mounted a campaign to have space added to its activities. However, NACA was an introspective, research-oriented agency with little orientation toward major technological enterprises. Further, it was an agency managed by a committee, not by a single executive; this was an administrative arrangement strongly preferred by the scientific community as a means of insulating Government activities with strong scientific components from "politics. " A similar form of organization had been accepted for the **Atomic Energy Commission and had** been proposed, but vetoed by President Truman, for the National Science Foundation. What Eisenhower's admin**istrative, budgetary, and policy advisers** wanted was an agency responsive to the policy directions of the President, headed by a single individual responsible for implementing those policy directives, and with the capabilities for carrying out potentially major research

and development (R&D) activities. Those activities, it was thought, would be pursued within the aerospace industry under Government contract rather than "in-house" with Federal laboratories. They thus concluded that the creation of an essentially new Federal structure for space, but one built around the **NACA core of technical capability and research institutions, was the appropriate route to go.**

In the National Aeronautics and Space (NAS) Act of 1958, the primacy of civilian objectives in space was stated: "it is the policy of the United States that activities in space should be devoted to peaceful purposes for the benefit of all mankind;" and the responsibility for those activities was given to a civilian agency: "Such activities shall "be the responsibility of and shall be directed by a civilian agency exercising control over aeronautical and space activities sponsored by the United States."

One area of controversy in the development of the 1958 NAS Act was whether the new space agency should be responsible for all space R&D, including that ultimately to be used by the military for defense applications. The decision was to make explicit from the start the total separation of these two major categories of space activities, with the National Aeronautics and Space Administration (NASA) having no direct involvement in military work. Thus, the NAS Act also declared that DOD should have responsibility for "activities peculiar to or primarily associated with the development of weapons systems, military operations, or the defense of the United States (including the research and development necessary to make effective provisions for the defense of the United States)."

The formal separation of the civilian and military space activities into different institutional frameworks meant transferring to the new civilian space agency functions related to its mission but under military control and, particularly after NASA had been assigned the lunar landing mission, developing new capabilities required to carry out an active space R&D effort. Within DOD there was a desire to develop a space R&D and a space operations structure, and to determine the division of responsibility at the Secretary of Defense level between the various military services. Both the NASA buildup and the development of the initial military structure for space were accomplished by the early 1960's.

Within the first 2 years of its existence, NASA had transferred to it a number of facilities, programs, and personnel that had formerly been operating under military auspices. These included, from the Army, the Von Braun rocket development team at Huntsville, Ala. (which became the core of the Marshall Space Flight Center), and the Jet Propulsion Laboratory at the California Institute of Technology. NASA was authorized to develop several new field centers related to its mission, including the Goddard Space Flight Center for science and applications programs and the Manned Spacecraft Center (later the Johnson Space Center) for manned programs, and to develop a civilian launch facility at Cape Canaveral, Fla. (later the Kennedy Space Center).1 These were added to the three former NACA centers: Langley, Lewis, and Ames; in addition smaller NACA facilities at Wallops Island, Va., and Edwards Air Force Base, Calif., came under NASA control. By 1962, NASA had in place an impressive institutional capability, one fully mobilized for meeting a broad set of national objectives in space.

This Government institutional base for civilian space programs was reinforced by the development of an elaborate external network of organizations—industries, universities, and nonprofits—involved in carrying out the civilian space program under NASA contracts or grants. In addition, as space activities matured, other Government agencies, including the Departments of Agriculture; Commerce; Energy; Health, Education, and Welfare; and Interior also became involved in space-related activities. At the peak of the Apollo program in fiscal year 1965, fully 94 percent of NASA's budget obligations went to external grants and contracts, and NASA's prime contractors in turn created a wide base of more specialized subcontractors. Of direct NASA procurements in that year, 79 percent went to business firms, 8 percent to educational institutions, 12 percent to other Government agencies, and 1 percent to nonprofit organizations. This pattern has remained consistent over the years; in fiscal 1978, the same percentage (94 percent) of NASA's budget went to extramural procurement, and the distribution among performers was rather similiar—business (81 percent); educational institutions (12 percent); nonprofits (1 percent); and other Government agencies (6 percent).

As the development of Government space activities during the 1960's and 1970's continued, the separation between the civilian and military (including intelligence) communities became quite pronounced. The Government developed and maintained separate and distinct institutional structures for both functions, not only in terms of line agencies within the executive branch, but also in terms of policy review, budget development and review, and congressional oversight. The elements of the Government space program coordinated their work but in a limited way compared to the separate efforts developed by each element of the Government space effort.

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1 There was already a military launch facility at the Cape.

The **NASA structure created under the direction of its first two administrators, Keith Glennan and James Webb, has remained basically unchanged during the past two decades. NASA headquarters in Washington is responsible for policy development and overall management and technical direction of the various components of the civilian space research program. Technical management of those specific projects is assigned to one of the various** NASA field centers. NASA has adopted the "Air Force model" of agency-contractor relationships, in which most R&D work is performed outside the Government by the aerospace industry. The Government role is that of program and project initiator, technical monitor of contractor performance, and user of the results of the R&D efforts.

The set of field centers under NASA authority today is the same as it was during the early 1960's.[2] Because NASA is responsible for civilian space activities aimed at a number of different purposes, including science, applications, and development of technological capability, and because the responsibility for each of those missions is lodged in a different field center, one of NASA headquarters' major responsibilities is allocating priorities and resources across the NASA institutional complex. The vitality of various field centers is closely related to the priority assigned to particular types of space activities under that center's control, and thus there is strong institutional motivation to compete for particular emphases within the overall NASA program.

Congress dealt with the need to establish a firm policy foundation for space by creating two temporary select committees in early 1958. Later that year it established two new standing committees to deal with civilian space matters. In the Senate this responsibility was given to the Committee on Aeronautical and Space Sciences; in the House, to the Committee on Science and Astronautics. Both of these committees derived their visibility and status within Congress from the importance of program oversight and their authorization authority over those programs. As long as the civilian space program was a matter of high national priority with major budgetary support there was a corresponding degree of status in being involved with these two congressional committees. However, as the resources allocated to civilian space activity declined after Apollo, Congress viewed space activities as just one among various science and technology programs of Government, and during the 1970's committee jurisdictions and names were modified to reflect this reality. Now **the** programs **of** NASA **and the National Oceanographic and Atmospheric Administration are** reviewed in the Senate by the Subcommittee on Science, Technology, and Space of the Committee on Commerce, Science, and Transportation; there is no separate Senate Space Committee. In the House, the Committee on Science and Astronautics in 1974 was renamed the Committee on Science and Technology and its jurisdiction was broadened to cover most civilian science and technology activities, rather than being focused primarily on NASA efforts.

This institutional base offers the potential for rapid mobilization if the Nation decided to accelerate the pace of its civilian space effort; the consequences of allowing the NASA and contractor institutional bases to shrink are unclear. It may be a sound *national* investment to maintain a strong institutional capability within the Government for civilian space development, even though that capability is not always being fully utilized. On the other hand, as this report has argued throughout, it may also be appropriate, as U.S. activities in space mature, to shift more of the responsibility for program and project planning and development for space applications and transportation to the private sector, with a parallel diminution of Government's institutional involvement.

In 1977-78, a National Security Council Policy Review Committee reviewed the structure of the national space program. The report validated the fundamental principle of separating civilian and military space activities. It concluded that "our current direction set forth in the Space Act in 1958 is well-founded" and that "the United States will maintain current responsibility and management among the various space programs. "3

Policy and Program Coordination

The decision to separate civilian and military space activities led naturally to the requirement for policy and program coordination between the programs. The type of policy coordination needed and mechanisms for coordination have been, and continue to be, controversial issues (see ch. 6). The nature of coordination at the program level has been less problematic and working-level cooperation between civilian and military space efforts has been the rule. However, occasional disputes have arisen over, for example, proposed civilian uses of technology developed for national security purposes.

During the 1958 debate on space policy, a major congressional concern was the relationship between military and civilian objectives in space and some broader set of national interests. Senate Majority

[2]Except for the brief period during which NASA also had an Electronics Research Center in Cambridge, Mass.

[3]The only public announcement of the results of this review was in the form of a June 20, 1978, press release from the White House,

Leader Lyndon Johnson, in particular, was convinced that space policy ought to be the subject of Presidential attention; the Eisenhower administration was far less convinced that space policy deserved such high priority. Johnson wanted to coordinate policy at a high level by creating an Executive Office group modeled on the National Security Council but dedicated specifically to aeronautical and space activities. The Eisenhower adminstration reluctantly accepted Johnson's notion as a price of getting the space legislation through Congress, and a National Aeronautics and Space Council was established by the NAS Act. The Space Council was to be a high-level advisory body, chaired by the President and consiting of the heads of other agencies concerned with space activities and several nongovernmental members.[4] It was to assist and advise the President in developing a comprehensive program of aeronautical and space activities, in assigning specific space missions to various agencies, and i n resolving differences among agencies over space policy and program.

Although the Eisenhower adminstration agreed to the inclusion of the Space Council in the legislation setting up the national space effort, it never used the Council. Rather, space policy under Eisenhower was developed through the channels of the National Security Council and Bureau of the Budget. Eisenhower believed that civilian and military functions in space development were "separate responsibilities requiring no coordinating body. " Thus, in 1960 he asked Congress to abolish the Space Council.

This proposal was sidetracked by Lyndon Johnson. When Kennedy won the 1960 election, with Johnson as his Vice President, the new President was convinced to keep the Space Council but to change the legislation so it would be chaired by the Vice President. During the Kennedy administration, the Space Council hired its first staff members and played an active role in developing the national policies that led to the Apollo project and to the administration's position on communications satellites. In the rest of the 1960's, under the Johnson and Nixon administration, the Space Council continued to exist, but stood at the margins of most space policy debates. it developed a relatively large (for the Executive Office) staff under the leadership of Vice Presidents Hubert Humphrey and Spiro Agnew. **However, as the priority assigned to the civilian space program continued to decrease** in the President's agenda and as the separate space activities of the Government became governed increasingly from within the separate agencies, the Space Council became rather a moribund institution, and in 1973 President Nixon proposed its dissolution. Congress raised no objection and the Space Council went out of existence.

Without a central policy coordinating structure during the 1970's, stresses among various Government space activities developed. Several of these were the results of disagreements between **NASA and** DOD over the appropriate national security constraints to be applied to civilian space efforts, particularly for Earth observations. NASA-DOD relationships with respect to the space shuttle program have been another area of controversy. It was these stresses that were the primary cause of the Carter administration review of national space policy that began in 1977.

A major result of that review was the reestablishment of a Presidential-level policy review process for space. The process existed in the form of a Policy Review Committee (Space), operating under National Security Council auspices but chaired by the Director of the Office of Science and Technology Policy. This committee provided a forum for all involved Federal agencies (including Departments such as Interior and Agriculture) to air their views on space policy, to advise the President on proposed changes in national space policy, to resolve disputes among agencies, and to provide for rapid referral of space policy issues to the President for decision when required. Unlike the Space Council, the Policy Review Committee (Space) did not have a standing professional staff structure. Rather, it served as recognition of the need to formalize the channels of interaction among the various components of Government space activity rather than have policy and program disputes settled through the budgetary review process or other means of interagency coordination.

The structures for coordination among military and civilian space efforts at the program level have had a rather different history than those for policy-level coordination. The 1958 NAS Act created an institution for coordination at this level, the Civilian Military Liaison Committee (CMLC), but that statutory committee, like the Space Council, was a congressionally imposed structure and was seldom used. Rather, NASA and DOD set up a number of working-level groups on issues of interest to both agencies as the early years of the space program passed. CMLC was eventually abolished and replaced by a nonstatutory Aeronautics and Astronautics Coordinating Board (AACB), which formalized the contacts between NASA and DOD at the working level. AACB was established by NASA-DOD agreement in 1960 and was given responsibility for coordinating NASA and DOD activities so as to "avoid undesirable duplication . . . achieve efficient utilization of available resources" and undertake" the coordination of activities in areas of

[4]These nongovernmental members were never appointed and the positions were eliminated when the Space council was reorganized in 1961.

common interest. The early years of AACB were quite productive in terms of data exchanges and creating an awareness of what the other agency's plans were; **AACB continues to exist today as the primary mechanism for addressing major program** issues of interest to DOD and NASA in space. However, as the separate NASA and defense programs became more institutionalized in the 1960's and 1970's there has been a tendency for coordination between the programs to be defensive in character, i.e., aimed at protecting each agency's own programs and "turf."

From Research to Operation

In the 1958 debate over space activities the notion of operating civilian space systems did not receive much attention. The NAS Act gave **NASA the responsibility for most aeronautical and space activities but defined those activities as: 1) research into problems of flight within and outside the Earth's atmosphere; 2) the development, the construction, testing and operation for research purposes of aeronautical and space vehicles; and 3) such other activities as may be required for the exploration of space. This language seemed to limit** NASA to R&D activities, and that was the general understanding of the agency's mission at the time.

By providing launch services to a variety of customers, including other Government agencies, the Communications Satellite Corporation (COMSAT) and other private sector firms, and other countries, NASA has gone beyond R&D to a clearly operational role in one area. Restriction to R&D has had little impact on NASA's efforts in space science and exploration or technology development, but it has had a definite impact for space applications.

Limiting NASA to the R&D part of the job of bringing space applications into being means that other users of space technology are necessarily involved in the total applications effort. **NASA has developed an orientation toward "technology push" efforts rather than a tradition of close coupling with potential** users of space technology who would exercise "demand pull" on the development of space applications. While NASA has almost from its start included "technology transfer" functions in its organization, many observers think that NASA has so far done an inadequate job of marketing its technological capabilities to potential users of space application systems.

While an emphasis on developing and demonstrating new technical capabilities is often necessary to convince potential users of their value, especially in situations where no preexisting user community exists, most observers believe that **NASA, particularly in its early years, put** more stress on pushing the technological frontier in space applications than on developing technology either in response to user demand or in anticipation of the kinds of demands likely to arise as new capabilities became known. In addition, NASA has developed a history of emphasizing the development of constantly more sophisticated technology in its application programs rather than concentrating on bringing an adequate application system into early operation. This is at least in some measure a reflection of the institutional reality that, once NASA completes R&D for an applications program, it must transfer that program to some user outside of the agency. There is an organizational tendency to attempt to hold onto programs, even if that means prolonging the R&D phase beyond the socially optimum points Since the early 1970's, **NASA has placed a high priority on developing closer relationships with potential users of space technology, particularly** in remote sensing and advanced satellite communications.

The first test of NASA's bias toward continuing R&D in applications was in weather satellites. in the early 1960's NASA's initial meteorological satellite program, which had been transferred from DOD, was called TIROS. As the agency in charge of space R&D, **NASA regarded TIROS as only the first** step in weather satellite development and wanted to go immediately to the creation of an advanced meteorological satellite called NIMBUS. The Weather Bureau within the Department of Commerce, a potential user agency, had another point of view. TIROS would markedly improve its services, and the Weather Bureau wanted NASA to focus on it rather than initiate a new weather satellite program. However, it took several years and substantial bureaucratic conflict before NASA was willing to shift its emphasis away from the advanced NIMBUS development program back to completing TIROS and bringing it to an operational state.[6] Eventually, NASA worked out an effective agreement with the Weather Bureau both to support on-going meteorological satellite activities and to continue R&D on advanced sensors relevant to meteorological applications.

The complex history of the use of satellites for remote sensing of land and ocean areas demonstrates the institutional problems stemming from, among other sources, NASA's focus on R&D and its lack of close links with potential users of operational space systems. The debate over the appropriate develop-

[5] **There may be technical and managerial as well as institutional reasons why the development of a space application may take longer than originally hoped for. Some also suggest that there have been instances of premature shifts from R&D to operational status in space applications.**

[6] **For a detailed account of the NASA/Weather Bureau dispute, see Richard Chapman,** *TIROS-NIMBUS: Administrative, Political, and Technological Problems of Developing Weather Satellites* **(Syracuse, N. Y,: Interuniversity Case Program, Inc., 1972).**

ment pace and management structure for the Landsat system has extended over a decade.

A major issue as arrangements for operational land remote sensing have been debated is whether **NASA's charter ought to be revised to extend its authority to the operation of space applications sytems. The Presidential directive of November 1979 ended this debate with the decision to keep NASA as an** R&D agency in remote sensing and to assign civilian Earth observation operations within the Government to NOAA, even though there were other claimants to a share of the operational remote-sensing role such as the Department of the Interior and the Department of Agriculture. Throughout the Landsat program, NASA has emphasized the experimental nature of the early remote-sensing satelites. While it has worked with potential users to make them aware of possible applications of Landsat data to their programs, it has also proposed more advanced sensors for orbital evaluation in later Landsat satellites, but it has not given priority attention to developing the ground segment, including associated data management and information processing and dissemination systems, required for early deployment of a first generation operational remote-sensing system.

Public-Private Sector Relations

NASA's relationships as an R&D agency for space with other potential users of space applications are relatively underdeveloped; this is particularly the case when those users are not other Government agencies, but rather private sector, profit-oriented firms. The appropriate division of responsibility between public and private organizations for research and development oriented toward commercial applications for space technology has been problematic since the start of the space age.[7]

This issue initially surfaced in communications satellite research. The Eisenhower adminsitration recognized that communication via satellite was an area of potential major economic payoff and decided, in keeping with its general pro-business orientation, that communication satellite research should be left to those interested in making a profit in it. Others, however, feared that allowing only private entitites to develop the technology of space communications meant in effect giving a virtual monopoly in that area to the corporation with the most resources available to invest in communications satellite research, American Telephone & Telegraph (AT&T). From the perspective of those interested in preventing monopoly power in new areas of human activity, such a development was not desirable. The situation was further clouded by the recognition that, even if AT&T or another private entity developed a communications satellite using its own funds, it would have to depend on launchers developed with public money to place that satellite into orbit. Thus the Kennedy administration reversed the Eisenhower policy of leaving communications satellite research to the private sector; Kennedy authorized NASA to conduct a vigorous program of research in the communications satellite area.

There were some in 1961 and 1962, as space communications approached reality, who thought that the Government should not only be involved in communications satellite R&D and make the results of that research available to a variety of potential private sector firms for commercialization, but also that the Government itself should take advantage of that research and undertake the operational satellite communications role, returning the eventual profits to the Treasury. The advocates of this position were not able to gather majority support in the 1962 debate over communications satellite policy. With the creation of a new institution, COMSAT, which had some aspects of public control but was fundamentally a new private enterprise, the notion that the Government should go into the communications satellite business itself disappeared.s

The precedent established during the communications satellite debate was that developing new applications of space technology with commercial potential and nurturing them to operational status is a mixed private sector-public sector responsibility, with the appropriate division of roles to be determined on an ad hoc basis for each area of applications; the goal, however, is eventual private sector operation of civilian space application systems. In each area in which a space application has reached or approached maturity, such as point-to-point communications and some applications of satellite remote sensing, business structures have emerged that operate as commercial enterprises related to that application. The Government has continued to fund research in other areas of space applications with potential commercial utility, including space transportation, materials processing, and other aspects of remote sensing, with the hope of discovering whether there are indeed profitable opportunities for private sector involvement in those areas, and demonstrating to potential operators what those opportunities are. It maybe that continued Government

[7]This problem is not limited to the space sector. The issue of Federal policies affecting private sector innovation, including direct support of civilian R&D, has been a subject of much recent discussion within both the executive branch and Congress.

[8]For a full discussion, see Jonathan F. Galloway, *The Politics and Technology of Satellite Communications* (Lexington, Mass.: D.C. Heath & Co., 1972).

willingness to push the applications of space technology and to bear the costs and risks of the research, development, and demonstration phases of commercializing those applications is the only way for some of them to become reality, at least in the short to midterm.

Advanced communications was one area of policy and institutional controversy during the Nixon and Ford administrations. NASA was ordered in 1973 to end its communications R&D efforts, on the grounds that the space communications business was far enough advanced so that it should be totally a private sector responsibility. The consequence of this decision was that the U.S. private sector concentrated on only those aspects of space communications which had the promise of early commercial payoff; other governments, most notably France and Japan, have provided R&D support for advanced space communications development, leading to increasing international competition with U.S. firms for sales of advanced communications satellites. This situation led the Carter administration in 1978 to decide that the potential economic and social benefits of communications satellites were not being adequately tended to by private sector R&D. The Carter administration reestablished a NASA research effort in advanced space communications and Information Administration of the Department of Commerce with assisting in market aggregation and possible development of domestic and international public satellite communication services.

From "Preeminence" to "Leadership"

President Kennedy in 1961 committed the United States to a policy of "preeminence" in all areas of space activity. The notion that the United States should maintain a position of "leadership" in space activity has been repeated by each Chief Executive since Kennedy,

As other countries in Europe, Asia, and South America develop independent space capabilities and as the Soviet Union continues an extremely active space effort, how the United States will continue policies of "leadership" and "preeminence" is unclear (see chs. 3, 9, and 10). One possibility is for the United States to compete across the board with other nations in all areas of space activity, from the development of large, permanent manned structures in orbit, through various types of space applications, to exploration of the cosmos. Another option is to focus U.S. space priorities in areas of high national payoff (which would include international leadership in those areas). Another option is to view application activities in space as competitors with Earth-bound enterprises, and to undertake them only when they are the most efficient means of meeting broader national objectives.

The initial result of the commitment to across-the-board preeminence was to create in NASA an agency with the structure, institutional relationships, and organizational culture needed to carry out a high-priority, nationally mobilized effort to developing a large-scale technology. NASA, at least in formal terms, remains today an organization designed for such purposes, but the terms of a national commitment to Leadership in space activities are much less clear than they were during the peak of the Apollo program in the mid-l **960's. As space activities have matured, and as they promise to grow and** become even more routine over the coming decade, a major institutional issue is whether a single central space agency with the desire and structure for carrying out an integrated, high-priority national space effort in the civilian sector is an anomaly.

The International Context: Cooperation and Competition

During the 1960's, NASA developed international cooperative programs that were clearly secondary in priority to using space technology as a demonstration of national technical resources. Almost all of NASA's international activities were scientific in character and were carried out under policy guidelines that kept them limited in scope, including the restrictions that cooperation had to be based on mutual scientific benefit and that there would be no exchange of funds between the United States and its partners in international space activities. This limited concept of international cooperation was broadened during the 1970's to the applications area, as a number of nations become interested in the Landsat program, building their own ground stations or otherwise receiving Landsat data, and for the first time paying NASA a fee for access to the remote-sensing satellites. Other application efforts also had international dimensions; for example, the Application Technology Satellite and Communications Technology Satellite programs demonstrated some of the uses of communications satellites for education and health care in both developing and industrialized countries (see ch. 7).

Also during the 1970's, there was limited use of international cooperation in space technology to serve what were explicitly foreign policy goals. The leading

[9]A major exception was the set of international agreements required to establish a global tracking network,

[10]For the foundations of U.S. policy toward international cooperation, see Arnold Frutkin, *International Space Cooperation* (Englewood Cliffs, N. J.: Prentice Hall, 1965); for criticism, see Don Kash, *The Politics of Space Cooperation* (West Lafayette, Ind.: Purdue University Studies, 1967),

example was U.S.-U.S.S.R. cooperation in the Apollo-Soyuz test project. Increasingly, the potential of space as a tool of our foreign assistance program and as a means of demonstrating our concern for the developing countries has led to assistance programs in a variety of third- and fourth-world countries that use Landsat data.

Cooperation with our major industrial partners and potential competitors in space technology development began during the same time period. The European Space Agency assumed the responsibility for developing the Spacelab, which is to be flown on the shuttle as a base for orbital scientific experiments requiring the presence of human experimenters. The U.S. stance toward cooperative programs that would develop commercially useful space technology is however, somewhat ambivalent, because of possible economic returns from these activities and because of the desire of the United States either to maintain or establish a competitive advantage.

'As other major nations develop advanced space technology, the mixture between international competition and international collaboration in space should be a dynamic one. Competition between U.S. and European launch vehicles for payloads in the 1980's is just one example. A number of issues being debated in international forums could affect U.S. civilian space activities in the coming decades. Examples are the actions of the World Adminsitrative Radio Conferences in allocating frequencies (and potentially slots in geosynchronous orbit) and the debate in the United Nations **on a Moon treaty.** The United Nations has also scheduled a Conference on Space Applications for 1982.

The Soviet Union, West Germany, France, Japan, Brazil—and indeed a number of other countries—are allocating significant resources to space R&D. In coming years, the U.S. civilian space program will function in an international context quite different than has been the case. The institutional implications of this changed context—for example, how to relate space activities to foreign policy objectives and how to carry out the diplomacy required to support our space objectives— require examination.