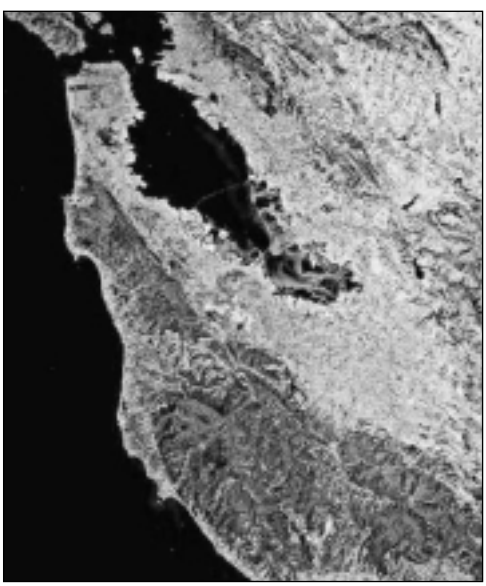

CHAPTER FIVE

# COMMERCIAL PROGRAMS

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# COMMERCIAL PROGRAMS

## Introduction

Although NASA historically collaborated with the private sector through its aeronautics programs, academic grants, commercial satellite launch support, and dissemination of remote-sensing and other data, cooperation between NASA and the private sector grew in the late 1970s and through the 1980s. More than once, President Ronald Reagan stated his belief that NASA should encourage private-sector involvement in space and that the agency should remove obstacles to that involvement.

In 1984, in response to the Reagan administration's 1984 National Policy on the Commercial Use of Space, NASA established the Office of Commercial Programs (OCP). This office encouraged the private sector to become more involved in using space for commercial purposes and increased NASA's efforts to find private-sector uses for NASA-developed technology. This chapter describes the establishment and activities of OCP through 1988.

## Management of the Office of Commercial Programs

NASA Administrator James Beggs established OCP in September 1984. He appointed Isaac (Ike) Gillam IV, who had been director of the Dryden Flight Research Facility, as its first associate administrator. Gillam served until his retirement in September 1987. James T. Rose was appointed to the position in October 1987.

OCP consisted of the Program Support Office, Technology Utilization Division, Commercial Development Division, and Plans, Policy and Evaluation Division. The Technology Utilization Division was charged with enhancing the transfer of NASA-developed technologies to U.S. industry through cooperative agreements, joint ventures, and information dissemination. Henry J. Clarks was the division director until 1987, when Raymond Whitten followed as acting division director. Clarks returned as division director in August 1988.

The Commercial Development Division negotiated and coordinated the bilateral/multilateral agreements with aerospace and nonaerospace companies that sought access to NASA-developed technologies and facil-

ities. Gary E. Krier was named division director in 1985 until he left in 1987. Henry Clarks then served as acting division director and was appointed division director in 1988. He remained there until August 1988 when he returned to the Technology Utilization Division. Richard H. Ott became director of the Commercial Development Division in 1988.

The Plans, Policy and Evaluation Division conducted long-term strategic planning, supporting the development of agency policies to expand private-sector investment in civil space and space-related activities. Peter T. Eaton was acting division director, followed by Barbara A. Luxenberg in 1986. Barbara A. Stone succeeded Luxenberg in 1987.

In 1985, the Small Business Innovation Research Division was moved to OCP from the Office of Aeronautics and Space Technology. Harry W. Johnson was named division director.

## Money for Commercial Programs

Before the establishment of OCP in 1984, funding for commercialization activities was located in the Office of Space and Terrestrial Applications or the Office of External Relations. Until the end of FY 1985, the only major program category was Technology Utilization. In FY 1985, OCP established the Commercial Use of Space program, and total OCP funding became considerably greater. Initially, programmed funding for the Commercial Use of Space program was drawn from the Space Station, Physics and Astronomy, and Space Research and Technology programs within the Research and Development (R&D) appropriation, while Space Transportation Operations, Space and Ground Network, and Communications and Data Systems programs fell within the Space Flight Control and Data Communications (SFC&DC) appropriation. Appropriated funding for the Commercial Use of Space program began with FY 1986. See Table 5–1 through 5–13.

## NASA's Commercial Programs (1979–1988)

In 1979, NASA Administrator Robert A. Frosch released guidelines aimed at increasing private-sector use of NASA's resources. These guidelines provided early direction to NASA's efforts to support private-sector development of space technologies and were based on provisions of the Space Act of 1958, which called for the preservation of U.S. leadership in space science and technology. Administrator Frosch stated, "Since substantial portions of the U.S. technological base and motivation reside in the U.S. private sector, NASA will enter into transactions and take necessary and proper actions to achieve the objective of national technological superiority through joint action with United States domestic concerns."[1]

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[1] Robert A. Frosch, "NASA Guidelines Regarding Early Usage of Space for Industrial Purposes," June 25, 1979, NASA Historical Reference Collection, NASA History Office, NASA Headquarters, Washington, DC.

The Frosch guidelines named three incentives to interest the private sector in joining NASA in research activities:

- Providing flight time on the Space Shuttle
- Providing technical advice, consultation, data, equipment, and facilities
- Entering into joint research and demonstration programs with NASA and the private sector partner funding their own efforts

The Reagan administration set the overall direction for U.S. space policy, including the encouragement of commercial space activities, in its 1982 National Space Policy. The administration declared that a goal of the U.S. space policy was to "expand United States private sector investment and involvement in civil space and space related activities." It went on to say that the United States encouraged "domestic commercial exploitation of space capabilities, technology, and systems for national economic benefit" and that the government would "provide a climate conducive to expanded private sector investment and involvement in space activities. . . ."

Congress stated its support of commercial space activities during its deliberations in the spring of 1983. A House Committee on Science and Technology report stated that "we should establish a policy which would encourage commercialization of space technology to the maximum extent feasible." The Senate Committee on Commerce, Science and Transportation also stated its support of "efforts by the private sector to invest and seek commercial opportunities in space."[2]

In mid-1983, NASA formed the NASA Space Commercialization Task Force, chaired by L.J. Evans, Jr., who reported to NASA Associate Administrator Philip E. Culbertson. NASA charged the task force with examining the opportunities or impediments to expanded commercial activities in space and developing a policy for NASA's commercialization efforts and an implementation plan for putting the policy to work. The task force consisted of representatives from NASA Headquarters and field centers, advisory groups from industry and academia, private contractors, and a NASA senior management steering committee.

In early 1984, the task force completed its efforts to develop a NASA-wide policy and plan to enhance the agency's ability to encourage and stimulate free enterprise in space. The task force concluded that private enterprise should help the nation retain its lead in science and technology, as well as modify or eliminate natural and bureaucratic barriers to the commercial use of space. A partnership among government, industry, and academia could result in great benefits to the United States. The task force recommended the implementation of a NASA Commercial Space

[2] Committee on Science and Technology, U.S. House of Representatives, report, April 15, 1983. Committee on Commerce, Science and Transportation, U.S. Senate, report, May 15, 1983.

Policy "to expedite the expansion of self-sustaining, profit-earning, tax-paying, jobs-providing commercial space activities."

Congress expressed its endorsement of this policy by amending the NASA Space Act of 1958, on July 16, 1984, to include the following provision: "The general welfare of the United States of America requires that the National Aeronautics and Space Administration seek and encourage, to the maximum extent possible, the fullest commercial use of space."[3] Within days of passage and signing of the amendment, the Reagan administration announced a National Policy on the Commercial Use of Space to encourage private enterprise in space. The national policy was designed to actively support commercial space ventures in the areas of new commercial high-technology ventures, new commercial application of existing space technology, and unsubsidized initiatives aimed at transferring existing space programs to the private sector. The policy stated that "private sector investment and involvement is essential if the enormous commercial potential of space is to be developed." It defined steps in four areas to be taken to benefit commercial involvement in space: (1) economic and tax-related issues, (2) legal and regulatory issues, (3) research and development initiatives, and (4) initiatives to implement the policy. It also spelled out specific ways in which NASA and other agencies could "facilitate the commercial use of space" and called for the establishment of a Cabinet Council on Commerce and Trade Working Group on the Commercial Use of Space, with a NASA representative serving as vice chairman.[4]

NASA established the Office of Commercial Programs (OCP) to support the National Space Policy and to translate the conclusions of the 1983 NASA task force into working policies and programs. NASA Administrator James Beggs stated that OCP "will provide a focus for and facilitate efforts within NASA to expand U.S. private sector investment and involvement in civil space related activities."[5] Beggs was also looking toward the proposed space station and the opportunity for private-sector investment and involvement.

NASA released its Commercial Space Policy in October 1984. The plan, drawn up by representatives from NASA Headquarters and field centers, was a detailed policy and implementation plan aimed to foster commercial involvement in space. It stated that NASA encouraged "free enterprise to participate in space by inviting industries and other private entities to finance and conduct business in space." It stated NASA's support for commercial space activities by reducing the technical, financial, and institutional risks to levels competitive with conventional investments and by establishing new links with the private sector to stimulate the

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[3] Subsection added by the National Aeronautics and Space Administration Authorization Act, 1985, Public Law 98–361, July 16, 1984.

[4] The White House, Office of the Press Secretary, "National Policy on the Commercial Use of Space," Fact Sheet, July 20, 1984.

[5] "Special Announcement," NASA, September 11, 1984.

development of private businesses in space. The policy specified initiatives for involving the private sector in research and development, the use of NASA facilities, patent rights and procedural issues, organizations designed for commercial involvement in space, and NASA's outreach program.[6]

This new OCP absorbed two existing programs: the Small Business Innovation Research (SBIR) program from the Office of Aeronautics and Space Technology and the Technology Utilization program from the Office of External Relations. OCP focused its activities on two major areas: technology utilization and commercial use of space.

**Technology Utilization**

The Technology Utilization program concentrated on technology transfer activities. The program involved cooperation and collaboration with industry, primarily through its nationwide network of Industrial Applications Centers (IACs), the dissemination of publications and computer software, conferences and seminars on the subject of technology transfer, and technology applications projects. OCP funds were used for the NASA field centers to conduct research and develop technology in response to needs that the private sector identified.

The university-based IACs disseminated NASA-developed technology to a broad range of industrial clients by providing them access to nearly 100 million scientific and technical documents in the NASA data bank. They also provided access to more than 600 other computerized data banks. In 1988, NASA had ten IACs.

A 1987 agreement between NASA and the Federal Laboratory Consortium, established by the Federal Technology Transfer Act of 1986, connected IACs and their affiliates to the consortium's network of 500 research and development laboratories and its clearinghouse. This agreement enabled U.S. industries and entrepreneurs, using access points within their home states, to learn about relevant federal technology available in federal laboratories throughout the country.

The Federal Technology Transfer Act of 1986 amended the Stevenson-Wydler Technology Act of 1980. It permitted each federal agency to allow its laboratories to "enter into cooperative research and development agreements with other federal agencies," state and local governments, industry, and nonprofit organizations and to negotiate licensing agreements.[7] It also established the Federal Laboratory

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[6] "Preamble" to NASA Commercial Space Policy, October 1984, as printed as part of Document III-27 in John M. Logsdon, gen. ed., with Dwayne A. Day and Roger D. Launius, *Exploring the Unknown: Selected Documents in the History of the U.S. Civil Space Program, Volume II: External Relations* (Washington, DC: NASA SP-4407, 1996), pp. 573–74.

[7] Federal Technology Transfer Act of 1986, Public Law 99–502.

Consortium for Technology Transfer, which was charged with developing and administering "techniques, training courses, and materials concerning technology transfer" for federal employees and using "the expertise and services of . . . the National Aeronautics and Space Administration" and other agencies.

## Commercial Use of Space

The Commercial Use of Space program, managed by the Commercial Development Division, focused on increasing private-sector awareness of space opportunities and encouraging increased industry investment and participation in high-technology space-based research and development. The program also promoted the development of new markets for the Space Transportation System and other NASA space services. It worked to facilitate private-sector space activities through improved access to available NASA resources and encouraged increased private-sector investment in the commercial use of space independent of NASA funding.

### *Centers for the Commercial Development of Space*

In 1985, NASA initiated the Centers for the Commercial Development of Space. This program was designed to increase private-sector interest and investment in using space for commercial activities. Through 1988, OCP selected and funded sixteen Centers for the Commercial Development of Space at a level of up to $1 million per center. These centers received additional financial and in-kind contributions from industrial affiliates. NASA also provided the centers with scientific and technical expertise, opportunities for cooperative activities, and other forms of continuing assistance. The centers performed basic space research activities and received funding for up to five years. Table 5–14 lists the centers and their research areas.

### *Joint Agreements*

When NASA Administrator Frosch issued his 1979 guidelines calling for more involvement with the private sector, NASA also defined and developed three types of cooperative agreements into which the agency could enter with the private sector: the Joint Endeavor Agreements (JEA), the Technical Exchange Agreement (TEA), and Industrial Guest Investigator (IGI) Agreement. These agreements all involved research efforts in the Materials Processing in Space (MPS) program area and called for using the microgravity environment of space for a variety of experimental purposes in the MPS area that hopefully would lead to commercial activities in the space environment.

In each of these joint legal arrangements, the government would not fund any of the work done by the private-sector partner but would pro-

vide other incentives, such as space on the Space Shuttle at no cost. The JEA had the objective of encouraging early space ventures and demonstrating the usefulness of space technology to meet marketplace needs. The TEA was an agreement to exchange technical information and cooperate in ground-based research programs. In an IGI Agreement, a company arranged for an industry scientist to collaborate with a NASA investigator on a spaceflight MPS experiment and to become a member of the investigative team. NASA also used the already established memorandum of understanding and memorandum of agreement arrangements to structure additional agreements. In 1985, NASA added the Space Systems Development Agreement (SSDA) to the cooperative agreements available to the private sector. The SSDA enabled a company to acquire Shuttle launch and launch-related services under special terms, such as a deferred payment schedule, tailored to the particular venture.

NASA signed the first JEA in December 1979 with McDonnell Douglas and began implementing the agreement in January 1980. The agency was fairly successful in inducing industry to become partners in space research on the Space Shuttle until the *Challenger* accident in 1986. That event forced NASA to delay implementing the agreements, and the agency found it difficult to regain momentum when the Shuttle flew again. Table 5–15 lists the various cooperative agreements entered into by NASA and the private sector from 1979 to 1988.

**Small Business Innovation Research**

NASA established the Small Business Innovation Research (SBIR) program in 1983 in response to the Small Business Innovation Development Act of 1982. Congress passed reauthorization legislation in 1986 that extended the program until October 1, 1993.[8] The objectives were to stimulate technological innovation, use small business to meet federal research and development needs, foster and encourage participation by minority and disadvantaged persons in technological innovation, and increase private-sector commercialization innovations derived from federal research and development. The program enabled the government to use the innovation and efficiency of small, high-technology firms and research institutions to accomplish agency mission objectives.

The legislation initially placed SBIR funding for agencies of NASA's size at 1.25 percent of its extramural research and development budget. Funding came from an assessment of each NASA organization's research and development budget. In July 1985, NASA transferred its SBIR office administratively to OCP from the Office of Aeronautics and Space Technology.

[8] Small Business Innovation Development Act of 1982, Public Law 97–219, July 22, 1982, and Reauthorization Amendment extending program until October 1, 1993, Public Law 99–443, enacted October 6, 1986.

Small businesses could participate in the program in two phases. Phase I SBIR activities were to determine the scientific and technical merit and feasibility of ideas submitted in response to SBIR program solicitations. The commercial potential of the ideas were considered when NASA selected the winning proposals. Phase II projects were selected from the Phase I participants. To be selected, the commercial potential of a project must be apparent in addition to meeting the requirements of Phase I projects.

Table 5–16 shows funding that NASA made available to the SBIR program by fiscal year. Table 5–17 provides the number of proposals and contract awards resulting from each annual solicitation. Table 5–18 shows the SBIR projects chosen in each topic area through 1988, and Table 5–19 shows the cumulative SBIR awards in each topic area and the percentage selected in each area.[9]

[9] These four tables are derived from a Small Business Innovation Research (SBIR) program/Small Business Technology Transfer (STTR) program presentation, NASA, SBIR data base, 1996.

*Table 5–1. Total Commercial Programs Funding (in thousands of dollars) a*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1979 | 9,100 | 12,000 | *b* | 9,100 |
| 1980 | 12,100 | 12,100 | *c* | 11,980 |
| 1981 | 11,800 *d* | 12,600 | 8,800 | 8,800 |
| 1982 | 8,000 *e* | 12,680 | *f* | 8,000 |
| 1983 | 4,000 *g* | 9,000 | 4,000 | 9,000 |
| 1984 | 4,000 | 10,000 *h* | 9,000 | 9,000 *i* |
| 1985 | 9,500 | 9,500 | 9,500 *j* | 17,100 |
| 1986 | 41,100 *k* | 28,100 | 28,100 | 26,800 |
| 1987 | 41,300 *l* | 40,300 | 41,300 | 40,900 |
| 1988 | 54,000 | 49,000 | 50,000 | 48,700 |

*a* The Office of Commercial Programs (OCP) was established in September 1984. Prior to that, the Technology Utilization program was located in the Office of Space and Terrestrial Applications (1979–1983) and the Office of External Relations (1984).

*b* Undistributed. Total 1979 R&D appropriation = $3,477,200,000.

*c* Undistributed. Total 1980 R&D appropriation = $4,091,086,000.

*d* Amended budget estimate. Original estimate = $13,100,000.

*e* Amended budget estimate. Original estimate = $14,600,000.

*f* Undistributed. Total 1982 appropriation = $4,740,900,000.

*g* The Technology Utilization program was part of the Office of Space and Terrestrial Applications.

*h* The Technology Utilization program was part of the Office of External Relations.

*i* This was the last time the programmed amount was for Technology Utilization only. See Table 5–6.

*j* This was the final time the appropriation for commercial activities was for Technology Utilization only. See Table 5–6 for the Technology Utilization line item after OCP was established.

*k* Commercial activities added the Commercial Use of Space program.

*l* Revised budget request. Original request = $45,300,000.

*Table 5–2. Major Budget Category Programmed Funding History (in thousands of dollars)*

| Budget Category/Fiscal Year | 1979 | 1980 | 1981 | 1982 | 1983 |
|---|---|---|---|---|---|
| Technology Utilization *a* | 9,100 | 11,980 | 8,800 | 8,000 | 9,000 |
| Technology Dissemination | 3,200 | 3,700 | 2,594 | 5,700 | 5,800 |
| Technology Applications | 4,500 | 4,400 | 3,858 | 2,300 | 3,200 |
| Program Control and Evaluation *b* | 1,400 | 1,480 | 1,148 | *c* | |

| Budget Category/Fiscal Year | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|
| Technology Utilization *d* | 9,000 | 9,500 | 10,580 | 15,700 | 19,000 |
| Technology Dissemination | *e* | | | | |
| Technology Applications | *f* | | | | |
| Commercial Applications R&D | | (6,350) | | | |
| Commercial Development Support | | (1,250) | | | |
| Commercial Use of Space | | | 16,220 | 25,200 | 29,700 |

*a* The Technology Utilization program was located in the Office of Space and Terrestrial Applications in fiscal years 1979 to 1983.

*b* The budget category was changed to Program Evaluation and Support.

*c* The budget category was eliminated.

*d* The Technology Utilization program was located in the Office of External Relations prior to the establishment of the Office of Commercial Programs in September 1984.

*e* The budget category was eliminated.

*f* The budget category was eliminated.

*Table 5–3. Technology Dissemination Funding (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1979 | 3,600 *a* | — *b* | — | 3,200 |
| 1980 | 3,800 | 3,800 | *c* | 3,700 |
| 1981 | 4,000 *d* | 4,100 | 2,400 | 2,594 |
| 1982 | 5,700 *e* | *f* | *g* | 5,700 |
| 1983 | 5,700 *h* | 3,200 | 3,200 | 5,800 |
| 1984 | 5,500 *i* | 2,200 | 2,200 | 5,500 |
| 1985 | 5,800 | 5,800 | 5,800 | 5,800 |
| 1986 | 6,300 | 6,300 | 6,300 | *j* |
| 1987 | 7,600 | 7,600 | 7,600 | *k* |

*a* Revised budget estimate. Original estimate = $3,715,000.
*b* No authorization or appropriation for budget category.
*c* Undistributed. Total 1980 R&D appropriation = $4,091,086,000.
*d* Revised budget estimate. Original estimate = $4,100,000.
*e* Amended budget request. Original request = $4,600,000.
*f* Undistributed. Total Technology Utilization authorization = $12,600,000.
*g* Undistributed. Total 1982 R&D appropriation = $4,740,900,000.
*h* Revised budget estimate. Original estimate = $3,200,000.
*i* Amended budget request. Original request = $2,200,000. The increase reflects congressional action to provide for dissemination activities at approximately fiscal year 1983 level and to allow the continuation of ongoing as well as some new efforts in technology applications. The funding increase also reflects increased dissemination activities in support of small business activities.
*j* No programmed amount for budget category.
*k* No programmed amount for budget category.

*Table 5–4. Program Control and Evaluation Funding (in thousands of dollars) a*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1979 | 1,400 *b* | 1,27 | *c* | 1,400 |
| 1980 | 1,500 *d* | 1,500 | *e* | 1,480 |
| 1981 | 1,600 | 1,600 | 400 | 1,148 *f* |

*a* This was called Program Evaluation and Support beginning with the fiscal year 1980 request.
*b* Amended budget estimate. Original estimate = $1,275,000,000.
*c* Undistributed. Total 1979 R&D appropriation = $3,477,200,000.
*d* Amended budget estimate. Original estimate = $1,600,000.
*e* Undistributed. Total 1980 R&D appropriation = $4,091,086,000.
*f* The program concluded. The activity formerly funded under this budget category was incorporated into the Technology Dissemination budget category.

*Table 5–5. Technology Applications Funding*
*(in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1979 | 4,100 *a* | *b* | *c* | 4,500 |
| 1980 | 4,400 | 4,400 | *d* | 4,400 |
| 1981 | 3,800 *e* | 4,300 | 2,800 | 3,858 |
| 1982 | 2,300 *f* | *g* | *h* | 2,300 |
| 1983 | 3,300 *i* | 5,800 | 800 | 3,200 |
| 1984 | 3,500 *j* | 1,800 | 1,800 | 3,500 |
| 1985 | 3,700 | 3,700 | 3,700 | 3,700 |
| 1986 | 4,800 | 4,800 | 4,800 | 4,580 |
| 1987 | 5,700 | 5,700 | 5,700 | 6,000 |
| 1988 | 7,000 *k* | 6,620 | 6,620 | 7,000 |

*a* Revised budget request. Original request = $4,110,000.
*b* Undistributed. Total 1979 R&D Technology Utilization Authorization = $12,100,000.
*c* Undistributed. Total 1979 R&D appropriation = $3,477,200,000.
*d* Undistributed. Total 1980 R&D appropriation = $4,091,086,000.
*e* Revised budget request. Original request = $4,800,000.
*f* Amended budget request. Original request = $2,100,000.
*g* Undistributed. Total Technology Utilization authorization = $12,600,000.
*h* Undistributed. Total 1982 R&D appropriation = $4,740,900,000.
*i* Amended budget estimate. Original estimate = $800,000.
*j* Amended budget estimate. Original estimate = $1,800,000.
*k* Amended budget estimate. Original estimate = $6,600,000.

*Table 5–6. Technology Utilization Funding*
*(in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1985 | *a* | — | — | 9,500 *b* |
| 1986 | 11,100 | 11,100 | 11,100 | 10,580 |
| 1987 | 15,700 *c* | 13,300 | 15,700 | 15,700 |
| 1988 | 18,300 | 18,300 | 18,300 | 19,000 |

*a* Prior to fiscal year 1986, all commercialization activity was funded from the Technology Utilization budget. See Table 5–1.
*b* This budget category became a line item under the Office of Commercial Programs.
*c* Amended budget request. Original request = $13,300,000.

*Table 5–7. Product Development Funding History (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1986 | | | | 1,140 |
| 1987 | 1,500 *a* | — *b* | — | 1,500 |
| 1988 | 1,400 *c* | 1,920 | 1,920 | 1,400 |

*a* Amended budget estimate. Original estimate = $1,470,000.
*b* No authorization or appropriation.
*c* Amended budget estimate. Original estimate = $2,000,000.

*Table 5–8. Acquisition, Dissemination, and Network Operations Funding History (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1986 | | | | 3,270 |
| 1987 | 4,100 | — *a* | — | 4,100 |
| 1988 | 4,665 *b* | 4,730 | 4,730 | 4,700 |

*a* No authorization or appropriation.
*b* Amended budget estimate. Original estimate = $4,700,000.

*Table 5–9. Program Development, Evaluation, and Coordination Funding History (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1986 | | | | 1,590 |
| 1987 | 1,780 | — *a* | — | 1,700 |
| 1988 | 2,600 *b* | 2,380 | 2,380 | 2,600 |

*a* No authorization or appropriation.
*b* Amended budget estimate. Original estimate = $1,800,000.

*Table 5–10. Industrial Outreach Funding History (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1987 | 2,370 | — *a* | — | 2,400 |
| 1988 | 2,035 *b* | 2,650 | 2,650 | 2,000 |

*a* No authorization or appropriation.
*b* Amended budget estimate. Original estimate = $2,600,000.

*Table 5–11. Commercial Use of Space Funding (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1985 | | | | 7,600 *a* |
| 1986 | 30,000 | 17,000 | 17,000 | 16,220 |
| 1987 | 25,600 *b* | 27,000 | 26,500 *c* | 25,200 |
| 1988 | 35,700 | 30,700 | 31,700 | 29,700 |

*a* New budget category. The amount was drawn from the Space Station, Physics and Astronomy, and Space Research and Technology programs in the Research and Development (R&D) appropriation and the Space and Ground Network and Communications and Data Systems programs in the Space Flight Control and Data Communications (SFC&DC) appropriation.

*b* Amended budget estimate. Original estimate = $32,000,000.

*c* This reflects a general reduction of $6,400,000.

*Table 5–12. Commercial Applications R&D Funding (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1985 | | | | (6,350) |
| 1986 | 15,500 *a* | — *b* | — | 12,940 |
| 1987 | 22,600 *c* | 30,100 | 30,100 | 22,200 |
| 1988 | 22,200 *d* | 26,000 | 31,000 | 25,200 |

*a* Amended budget estimate. Original estimate = $28,500,000.

*b* No authorization or appropriation.

*c* Amended budget request. Original request = $31,100,000.

*d* Amended budget estimate. Original estimate = $31,000,000.

*Table 5–13. Commercial Development Support Funding (in thousands of dollars)*

| Year | Request | Authorization | Appropriation | Programmed (Actual) |
|---|---|---|---|---|
| 1985 | | | | (1,250) |
| 1986 | 1,500 | — *a* | — | 3,280 |
| 1987 | 3,000 *b* | 1,900 | 1,900 | 3,000 |
| 1988 | 2,400 *c* | 4,700 | 4,700 | 4,599 |

*a* No authorization or appropriation.

*b* Amended budget request. Original request = $1,900,000.

*c* Amended budget estimate. Original estimate = $1,400,000.

*Table 5–14. Centers for the Commercial Development of Space*

| Center | Technical Discipline |
|---|---|
| Center for Advanced Materials, Battelle Columbus Laboratories | Materials Processing |
| Center for Macromolecular Crystallography, University of Alabama at Birmingham | Life Sciences |
| Consortium for Materials Development in Space, University of Alabama at Huntsville | Materials Processing |
| ITD Space Remote Sensing Center, Institute for Technology Development | Remote Sensing |
| Center for Space Processing of Engineering Materials, Vanderbilt University | Materials Processing |
| Center for Mapping, Ohio State University | Remote Sensing |
| Wisconsin Center for Automation and Robotics, University of Wisconsin | Automation and Robotics |
| Center for Development of Commercial Crystal Growth in Space, Clarkson University | Materials Processing |
| Space Vacuum Epitaxy Center, University of Houston | Materials Processing |
| Center for Advanced Space Propulsion, University of Tennessee Space Institute | Space Propulsion |
| Center for the Commercial Development of Space Power and Advanced Electronics, Auburn University | Space Power |
| Center for Autonomous and Man-Controlled Robotic and Sensing Systems, Environmental Research Institute of Michigan | Automation and Robotics |
| Center for Cell Research, Pennsylvania State University | Life Sciences |
| Center for Bioserve Research, University of Colorado at Boulder | Life Sciences |
| Center for Materials for Space Structures, Case Western Reserve University | Space Structures and Materials |
| Center for Space Power, Texas A&M University | Space Power |

*Table 5–15. Cooperative Agreements Between NASA and the Private Sector*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| January 1980 | McDonnell Douglas | Production of pharmaceuticals in space | JEA | NASA provided Shuttle flights to McDonnell Douglas Astronautics Company (MDAC). Although greater purity was achieved by processing in space, MDAC abandoned the project because alternative ground-based processes were more cost-effective. |
| June 1981/ June 1984 | John Deere & Co. | Ground-based research on graphite formation in cast iron and improved metallic alloys | TEA | No space-based research was undertaken. |
| June 1981 | DuPont | Ground-based research on catalytic materials | TEA | Research was completed but never led to research in space. |
| August 1981 | INCO | Ground-based research on electroplating devices | TEA | Research was completed but never led to research in space. |
| April 1982 | Defense Systems, Inc. | Shuttle deployment of experiments leading to a network of small communications satellites being deployed in low-Earth orbit | JEA | The company abandoned the project prior to any activity on the Shuttle. |
| July 1982 | GTI Corporation | Development of Shuttle-based furnace for processing materials | JEA | The company abandoned the project prior to building any hardware |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| February 1983 | A.D. Little | Ground-based research on long-term blood storage | MOU | The project never materialized because the company was unable to form the necessary consortium of firms. |
| February 1983 | Honeywell | Research on mercury-cadmium-telluride materials (semiconductor materials) | TEA | There was no real activity by the company under this agreement. |
| April 1983 | Orbital Sciences Corp. | Shuttle launch of a Transfer Orbit Stage (TOS) for boosting payloads from the Shuttle cargo bay to geosynchronous orbit | JEA | The company never built the TOS because of an insufficient market. However, based on other successful projects, Orbital Sciences went from a start-up company to become a viable NASA and Defense Department contractor. |
| April 1983 | Micro-Gravity Research Associates | Production of gallium arsenide crystals (semiconductor material) in space | JEA | The company did not provide any experiments for flight on the Shuttle. |
| August 1983 | Fairchild Industries, Inc. | Shuttle deployment of an unpressurized space laboratory platform to house experiments and manufacturing equipment in space | JEA | The company built no hardware because it could not justify the project based on its subsequent market analysis. |
| December 1983 | Spaceco, Ltd. | Shuttle flight of equipment for monitoring the space environment | JEA | The company provided no hardware for flight. |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| January 1984 | $C^2$ Spacelines | Shuttle cargo booking service | MOU | The company never initiated business operations. |
| January 1984/ July 1986/ December 1986 | 3M Corporation | MOU: Research on thin film materials and organic crystal materials<br>TEA: Ground-based experiments on polymers<br>JEA: Shuttle flights of organic and polymer chemistry experiments | MOU, TEA, JEA | The MOU led to two JEAs. NASA provided Shuttle flights. 3M abandoned the project. As for the TEA, 3M subsequently abandoned interest in commercial utilization of the space environment. |
| February 1984 | Space Industries, Inc. | Shuttle deployment of an Industrial Space Facility for housing experiments and manufacturing facilities | MOU | The MOU led to the first Space Systems Development Agreement (SSDA). |
| October 1984 | Martin Marietta Corporation | Shuttle flights of propellant fluids management equipment | JEA | NASA provided Shuttle flights of the equipment, but no commercial business resulted based on the device. |
| November 1984/April 1986/March 1987 | Rockwell International | TEA: Ground-based materials science<br>MOU/JEA: Shuttle flights of fluids experiment equipment regarding float zone crystal growth technology | MOU, TEA, JEA | The MOU and TEA led to the follow-on JEA. NASA provided Shuttle flights, but the results did not lead to a commercial business venture for Rockwell. |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| November 1984/May 1986 | Boeing Aerospace Corporation | Shuttle flights of materials processing experiments leading to commercial materials manufacturing in space | MOU, JEA | The MOU led to a follow-on JEA. Boeing completed its Shuttle-based research under the JEA. The work did not lead to a commercial venture. |
| February 1985/October 1986 | Grumman Space Systems | Gallium arsenide crystal growth in space | MOU, JEA | The MOU lead to a follow-on JEA. The company abandoned the project before any Shuttle flights were provided. |
| June 1985 | Instrumentation Technology Associates | Standardized carrier for housing materials processing experiments | JEA | The apparatus was built and flown; the equipment proved to be only marginally successful, and no commercial venture resulted from the work. |
| August 1985 | Sperry Corporation | Magnetic Isolation System to buffer materials processing equipment from vibrations | MOU | The company abandoned the project. |
| August 1985 | Space Services, Inc. | See Space Industries, Inc., MOU above | SSDA | The company was to pay for the Shuttle flights and associated NASA services on a deferred payment basis. The company never developed the Industrial Space Facility. |
| September 1985 | GTE | Organic and polymer crystal growth in space | MOU | The company never developed hardware. |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| October 1985 | Scott Science and Technology, Inc. | NASA technical assistance in the design and development of a transfer vehicle to deliver satellites to a geosynchronous transfer orbit from the Shuttle cargo bay | MOA | The company never built any hardware. The *Challenger* accident diminished investor interest. |
| November 1985 | Geostar Corporation | Shuttle deployment of satellites regarding a commercial position determination/ nonvoice communications system | SSDA | Geostar was to reimburse NASA for Shuttle flights and associated services on a deferred payment basis. The company went out of business because the technology became obsolete, and no Shuttle flights were provided. |
| December 1985 | Rantek | Shuttle-based research equipment to study rheumatoid arthritis | MOU | The company never built any hardware. |
| January 1986/ August 1988 | SPACEHAB, Inc. | Shuttle middeck augmentation module for housing and servicing materials processing research and manufacturing facilities | MOU, SSDA | The MOU led to the SSDA with NASA. The commercial module was built and flown on the Shuttle. The economic viability of the venture was tied directly to a subsequent NASA lease of the module for government-sponsored research. SPACEHAB was unsuccessful in developing a commercial customer base; accordingly, it was not a real commercial venture. |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| February 1986 | David A. Mouat | Satellite and aircraft remote sensing equipment for mineral and hydrocarbon exploration | TEA | No activity under this agreement was undertaken by the firm. |
| March 1986 | Earth Data Corporation | Development of a commercial remote sensing system | TEA | No commercial activity resulted. |
| March 1986 | Institute for Technology Development | Commercial remote sensing technology | MOA | No commercial activity resulted. |
| May 1986 | Abex Corporation | Microgravity experiments aboard the KC 135 aircraft on the subsequent development of a materials processing furnace | TEA | There was no follow-on commercial venture. |
| May 1986 | Union Oil Company | Research to develop remote sensing equipment | MOU | There were no follow-on commercial activities. |
| October 1986 | General Sciences Corporation | Development of a commercial orbiting power source to service the Shuttle, free-flying platforms, and the space station | MOU | No commercial activity resulted. |
| November 1986 | Hercules Corporation | Materials processing research | TEA | There was no follow-on commercial activity by the company. |

*Table 5–15 continued*

| Date | Company | Description | Type of Agreement | Remarks |
|---|---|---|---|---|
| October 1988 | United Technologies Corporation | Ground-based materials experiments | TEA | There was no follow-on joint activity with NASA by the company. |

*Legend:* JEA—Joint Endeavor Agreement, MOA—Memorandum of Agreement, MOU—Memorandum of Understanding, SSDA—Space Systems Development Agreement, and TEA—Technical Exchange Agreement.

*Table 5–16. SBIR Funding by Fiscal Year (in millions of dollars)*

| Fiscal Year | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| Funding | 4.9 | 13.2 | 24.2 | 32.6 | 38.9 | 40.7 |

*Table 5–17. Proposals and Contract Awards From Each Annual Solicitation*

| Program Year | 1983 | 1984 | 1985 | 1986 | 1987 | 1988 |
|---|---|---|---|---|---|---|
| ***Phase I*** | | | | | | |
| Proposals | 1,000 | 920 | 1,164 | 1,631 | 1,827 | 2,379 |
| Awards | 102 | 127 | 150 | 172 | 204 | 228 |
| ***Phase II*** | | | | | | |
| Proposals | 92 | 113 | 129 | 154 | 179 | 203 |
| Awards | 58 | 71 | 84 | 86 | 98 | 112 |

*Table 5–18. NASA SBIR Awards by Phase and Topic Area (1983–1988)*

| | 1983 | | 1984 | | 1985 | | 1986 | | 1987 | | 1988 | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Topic** | **I** | **II** | **I** | **II** | **I** | **II** | **I** | **II** | **I** | **II** | **I** | **II** |
| Aero Propulsion and Power | 7 | 4 | 9 | 5 | 9 | 3 | 10 | 6 | 9 | 3 | 9 | 6 |
| Aerodynamics and Acoustics | 12 | 8 | 12 | 3 | 10 | 4 | 11 | 8 | 21 | 10 | 19 | 10 |
| Aircraft Systems | 8 | 5 | 6 | 3 | 10 | 5 | 11 | 5 | 13 | 7 | 16 | 8 |
| Materials and Structures | 12 | 6 | 11 | 5 | 16 | 13 | 15 | 6 | 21 | 8 | 23 | 7 |
| Teleoperators and Robotics | 4 | 1 | 5 | 1 | 8 | 5 | 10 | 3 | 20 | 11 | 21 | 9 |
| Computer Sciences | 6 | 2 | 7 | 3 | 11 | 4 | 11 | 7 | 11 | 6 | 11 | 5 |
| Information Systems | 3 | 2 | 7 | 3 | 8 | 4 | 14 | 8 | 11 | 7 | 12 | 5 |
| Instrumentation and Sensors | 18 | 11 | 16 | 15 | 19 | 15 | 31 | 20 | 35 | 17 | 37 | 21 |
| Spacecraft Systems | 6 | 5 | 15 | 10 | 17 | 8 | 16 | 5 | 12 | 8 | 18 | 9 |
| Space Power | 6 | 2 | 7 | 5 | 5 | 3 | 4 | 2 | 6 | 4 | 13 | 5 |
| Space Propulsion | 4 | 3 | 3 | 2 | 2 | 2 | 5 | 3 | 5 | 2 | 6 | 3 |
| Space Habitability and Biology | 4 | 3 | 10 | 6 | 13 | 6 | 8 | 3 | 16 | 6 | 16 | 8 |
| QA, Safety and Checkout | 4 | 3 | 7 | 2 | 8 | 6 | 10 | 5 | 10 | 4 | 9 | 4 |
| Space Communications | 6 | 3 | 7 | 4 | 9 | 3 | 8 | 3 | 7 | 2 | 11 | 7 |
| Commercial Space Applications | 2 | 0 | 5 | 4 | 5 | 3 | 8 | 2 | 7 | 3 | 7 | 5 |
| **Total** | **102** | **58** | **127** | **71** | **150** | **84** | **172** | **86** | **204** | **98** | **228** | **112** |

*Table 5–19. Cumulative NASA SBIR Funding Awards by Topic Area (1983–1988)*

| Topic | Total Award | |
|---|---|---|
| | Number | Percent |
| Aero Propulsion and Power | 80 | 5.4 |
| Aerodynamics and Acoustics | 128 | 8.6 |
| Aircraft Systems | 97 | 6.5 |
| Materials and Structures | 143 | 9.6 |
| Teleoperators and Robotics | 98 | 6.6 |
| Computer Sciences | 84 | 5.6 |
| Information Systems | 84 | 5.6 |
| Instrumentation and Sensors | 255 | 17.1 |
| Spacecraft Systems | 129 | 8.6 |
| Space Power | 62 | 4.2 |
| Space Propulsion | 40 | 2.7 |
| Space Habitability and Biology | 99 | 6.6 |
| QA, Safety and Checkout | 72 | 4.8 |
| Space Communications | 70 | 4.7 |
| Commercial Space Applications | 51 | 3.4 |
| **Total** | **1,492** | **100.0** |