United States General Accounting Office

GAO

Report to the Chair, Subcommittee on VA, HUD, and Independent Agencies, Committee on Appropriations, U.S. Senate

May 1991

COMMERCIAL USE OF SPACE

Many Grantees Making Progress, but NASA Oversight Could Be Improved

GAO/NSIAD-91-142

GAO

United States
General Accounting Office
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National Security and
International Affairs Division

B-242600

May 30, 1991

The Honorable Barbara Mikulski
Chair, Subcommittee on VA, HUD,
and Independent Agencies
Committee on Appropriations
United States Senate

Dear Madam Chair:

This report responds to your request that we review the extent of private sector involvement in the National Aeronautics and Space Administration's grant program supporting the Centers for the Commercial Development of Space, the centers' progress toward and prospects for self-sufficiency, and the management of the program.

As agreed with your office, unless you publicly announce its contents earlier, we plan no further distribution of this report until 30 days from the date of this letter. At that time, we will send copies to the Administrator, National Aeronautics and Space Administration; the Director, Office of Management and Budget; and other interested parties.

Please contact me at (202) 275-5140 if you or your staff have any questions concerning the report. Other major contributors are listed in appendix III.

Sincerely yours,

Mark E. Gebicke

Mark E. Gebicke
Director, NASA Issues

Executive Summary

Purpose

The National Aeronautics and Space Administration (NASA) has long recognized that to help the United States maintain a technological edge throughout the world, it must find ways to encourage and support the development of a domestic commercial space industry. In 1985, NASA began to provide grants and other types of support to the Centers for the Commercial Development of Space to encourage the melding of the resources and talents of government, industry, and academic institutions for researching and developing space-related technologies that have potential commercial applications. After a limited period of grant support of 5 to 7 years, NASA expected the centers to become self-sufficient.

The Chair, Subcommittee on VA, HUD, and Independent Agencies, Senate Committee on Appropriations, asked GAO to review the extent of private sector involvement in the centers' programs, the centers' progress toward and prospects for self-sufficiency, and NASA's management of the program.

Background

Through 1990, NASA has provided about $81 million in grants to 16 centers, most of which are located at state and private universities. The centers work in one of seven areas of specialization: materials processing, life sciences, remote sensing, automation and robotics, space structures and materials, space propulsion, and space power. The centers, which have operated from 3 to 5 years, reported that by the beginning of 1990 they had established about 300 affiliations with other organizations and companies, and they had completed over 750 flight tests and other experiments, including 18 conducted in space. At that time, they were also planning over 300 more flight tests.

Results in Brief

Since the inception of the program, NASA has had some success in establishing centers capable of attracting and sustaining industry interest and support. It is too soon to gauge the extent to which the program may ultimately achieve its goals, although it is clear that the centers will not become self-sufficient in 5 to 7 years. However, such a fixed period of support applicable to all centers fails to recognize differences among the centers. Recognizing such differences would require NASA to establish grant support goals for the individual centers based primarily on the 3 to 5 years' operating experience each center has had.

NASA also has opportunities to make improvements elsewhere in the program. With the expectation for significant growth in the number of

future experiments requiring access to space, the process for evaluating the centers' payload requests should be examined to ensure that it efficiently provides the desired mix of expertise to adequately review requests. Also, NASA needs to examine the adequacy of the internal controls it employs to ensure that its accounting system contains timely, complete, and accurate information reported by grantees on their uses of federal funds.

Principal Findings

Growth of Industry Involvement and Support

Since the inception of the program, the centers have been increasing the number of organizations and companies with which they have become affiliated. More importantly, the number of such affiliates that represent industry has also been increasing, from 63 reported by 6 centers for 1986 to an estimated 199 reported by 16 centers for 1990.

The level of cash support the centers have received from their industry affiliates has also been increasing. In 1986, industry affiliates provided less than $1 million. By 1990, the amount of cash support from industry was estimated at $4.1 million for the 13 centers that received such support. The industry affiliates that were working with a center in 1989 had been doing so for an average of 2.3 years, and almost all of them had provided cash or other types of support to their center.

Centers Will Not Be Self-Sufficient Soon

The proportion of centers' support provided by NASA grants has been increasing, not decreasing. For example, NASA provided 28 percent of the centers' total support in 1986, but by 1990 NASA's share was estimated at 47 percent. The centers' heavy reliance on NASA grants will continue for the foreseeable future. The main reason for this pattern of increasing support is that NASA's overall grant support to help the centers fund the cost of access to space and the cost of unique hardware and facilities has increased.

None of the center directors believe that their centers will be able to continue at their present levels of activity if grant support is withdrawn before 1995. The most optimistic directors believe their centers can achieve self-sufficiency somewhere between 1995 and 2000. At the opposite end of the scale, five directors do not ever foresee a time when their centers will be able to do without NASA grant assistance.

Structure of the Payload Review Process Should Be Reviewed

For about 2 years NASA has used a Payload Selection Board to assist in reviewing the centers' requests for flying their payloads on the Space Shuttle. However, little specific guidance has been provided to Board members about the review process and what they were expected to contribute to it. Some Board members expressed uncertainty and concern about the process and their role in it. In addition, the Board's membership, which was initially planned to include three members representing industry, has not had more than one.

Availability of Good Fiscal Information Should Be Ensured

Timely, complete, and accurate fiscal information on grantees is not routinely available from NASA's accounting system because reporting requirements on the use of federal funds are not effectively enforced. Even after the reports are received, the information is not routinely entered into the agencywide accounting records in a timely fashion.

NASA accounting personnel have been able to get the centers to voluntarily correct various reporting problems, including a number of instances of erroneous and incomplete reporting. However, late reporting has proven to be much more difficult to deal with. NASA accounting personnel estimate that a majority of the required quarterly reports are late.

Information from grantees' financial reports is used to update the agencywide accounting records. However, sometimes such updates are not done until two or more quarterly reports are on file. NASA accounting personnel frequently receive complaints about the lack of current financial information on grantees in the agencywide data base.

Recommendations

GAO recommends that the Administrator, NASA,

- establish, in consultation with each center, a grant support goal with interim targets for tracking progress toward self-sufficiency and for determining the need for, and to help measure the results of, corrective actions;
- review the flight request and approval process to ensure that the expertise needed for such reviews is available in the most efficient manner possible and that those who are asked to assess flight requests fully understand the intended scope of their participation; and

- assess and, as necessary, strengthen the internal controls for ensuring that timely, complete, and accurate fiscal information on grantees is available in NASA's accounting system.

Agency Comments and GAO's Evaluation

In commenting on a draft of GAO's report, NASA said that it provides a useful commentary on one of NASA's newest and fastest growing commercial space programs. NASA noted that GAO's recommendations were reasonable and could be implemented. However, while recognizing the slower-than-anticipated pace of the program, NASA said that determining how and when to establish grant support time limits would be considered in the future. GAO believes that a grant program that is essentially intended to be self-liquidating must include a constantly visible grant support goal to focus and encourage each grantee's efforts to develop alternative revenue sources. GAO recognizes that support goals may change as circumstances warrant, but each such change should be a highly visible management action subject to review and to a determination that the change in the goal, rather than grant termination, is justified.

NASA also offered other specific suggestions, which GAO incorporated into the report where appropriate.

Contents

Figures

Abbreviations

CCDS	Centers for the Commercial Development of Space
GAO	General Accounting Office
NASA	National Aeronautics and Space Administration
OCP	Office of Commercial Programs

Introduction

In 1984, the Congress mandated the National Aeronautics and Space Administration (NASA) to seek and encourage the fullest commercial use of space. Since then, NASA has been faced with an important challenge: to find ways to encourage and support the development of a domestic commercial space industry to help the United States maintain a technological edge throughout the world.

The Office of Commercial Programs (OCP) is the focal point of NASA's national efforts to help develop a commercial space industry. One of OCP's major initiatives is a grant program begun in 1985 to support Centers for the Commercial Development of Space. OCP's goal was for the centers to use the resources and talents of government, industry, and academic institutions to research and develop space-related technologies with potential commercial applications. The centers were to develop relationships with industry and respond to industry's needs for information on the commercial advantages of operating in the space environment. Over time, the centers were expected to develop alternative sources of support so that after 5 years they would no longer require OCP grants.

NASA's Support of Centers' Activities

From the mid-1980s through the 1990 operating year,[1] OCP has given about $81 million to 16 centers that specialize in seven areas of space-related research. Table 1.1 lists the centers and describes their areas of specialization.

[1]The operating year for 13 of the 16 centers coincides with the federal government's fiscal year (October 1 through September 30). The operating year starts on November 1 for two centers and on January 1 for one center.

Table 1.1: Centers for the Commercial Development of Space

Specialization area	Center	Year NASA first funded
Materials processing in space Development and growth of crystals; thin film growth and materials purification; microgravity effects on metals, alloys, ceramics, and glasses.	Advanced Materials Center Battelle Memorial Institute, Columbus, OH	1986
	Center for Space Processing Vanderbilt University, Nashville, TN	1986
	Center for Commercial Crystal Growth in Space Clarkson University, Potsdam, NY	1987
	Consortium for Materials Development in Space University of Alabama, Huntsville, AL	1986
	Space Vacuum Epitaxy Center University of Houston, Houston, TX	1987
Life sciences Space-based biomedical and agricultural research; understanding cell functions for disease treatment; crystal growth.	Bioserve Space Technologies University of Colorado, Boulder, CO	1988
	Center for Cell Research Penn State University, University Park, PA	1988
	Center for Macromolecular Crystallography University of Alabama, Birmingham, AL	1986
Remote sensing Faster and more reliable ways to produce and update maps from satellite imagery; improving productivity and efficiency of land use planning using remote sensing, image processing, and information systems.	Center for Mapping Ohio State University, Columbus, OH	1987
	Space Remote Sensing Center Institute for Technology Development, Inc., Stennis Space Center, MS	1986
Automation and robotics Robotic technologies to enhance living, traveling, and exploring in space; developing machine vision and sensing systems and biological technology for life-support systems.	Wisconsin Center for Space Automation and Robotics University of Wisconsin, Madison, WI	1987
	Space Automation and Robotics Center Environmental Research Institute of Michigan, Ann Arbor, MI	1988
Space structure and materials Materials for space structures capable of being made and/or assembled in space.	Center for Materials for Space Structures Case Western Reserve University, Cleveland, OH	1988
Space propulsion Advanced propulsion research, including computational fluid dynamics analysis of rocket engine performance and fault diagnosis.	Center for Advanced Space Propulsion University of Tennessee Space Institute, Tullahoma, TN	1988
Space power research Developing power systems for space-based platforms; identifying critical technological impediments to economic use of power systems in space.	Center for Commercial Development of Space Power Auburn University, Auburn, AL	1988
	Center for Commercial Development of Space Power and Advanced Electronics, Texas A&M University, College Station, TX	1988

The areas of specialization generally differ in their current levels of commercial maturity. For example, using satellite remote sensing to collect data and ground-based systems to receive, analyze, and integrate it into useful descriptive and predictive products has known applications in such areas as minerals exploration, environmental monitoring and land-use planning, and in the agriculture and forestry industries. In comparison, relatively little is known about the ultimate commercial value

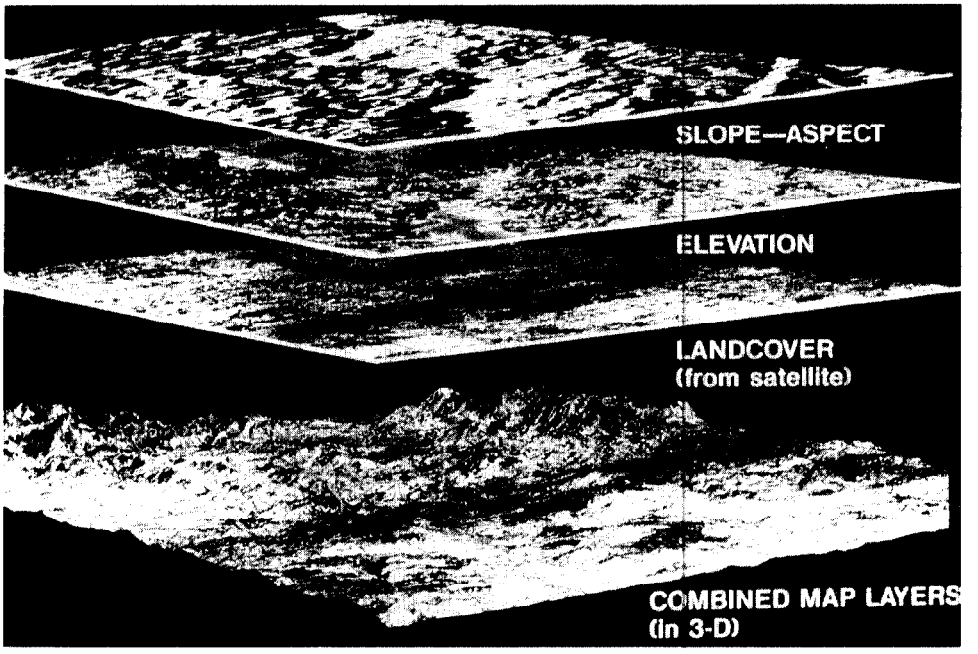
of space-based life sciences and materials processing in space. However, NASA believes each area of specialization contains potential commercial value leading to the development and implementation of more efficient industrial processes and procedures, new technologies to improve the management of natural resources, and more effective approaches to medical diagnoses and treatments. Specifically, these processes and technologies include:

- forming high quality protein crystals in microgravity to improve the understanding of biologically active compounds used in a variety of industries, including pharmaceuticals, chemicals, and agriculture;
- mapping soil by remote sensing to improve the efficiency of fertilizer used in agriculture; and
- developing automated systems for use in hazardous environments.

The centers' activities are shown in figures 1.1 through 1.3.

Figure 1.1 shows geographic information system image display developed by the Institute for Technology Development Center that combines data into a three-dimensional view.

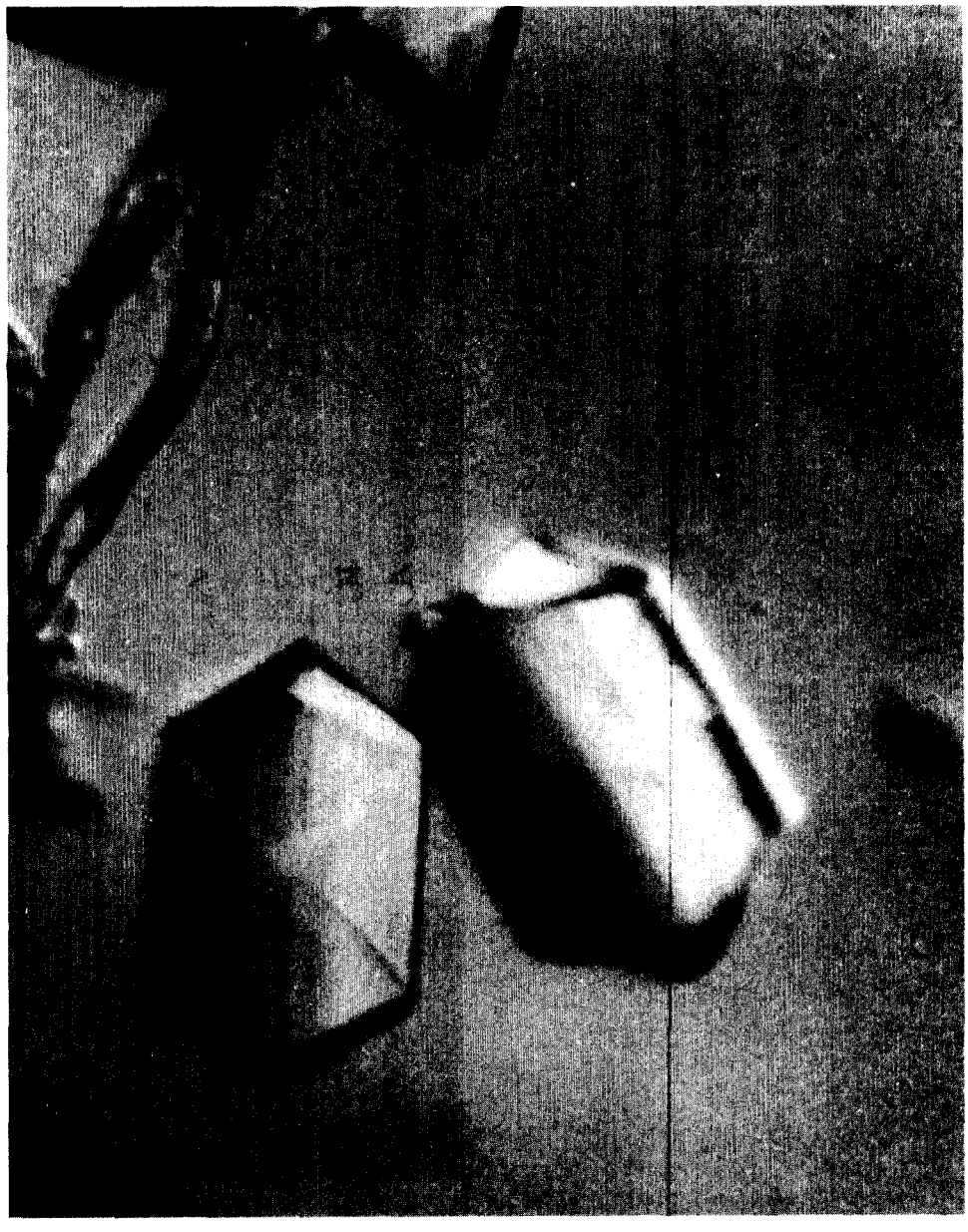
Figure 1.1: A Geographic Information System Image Display



Source: NASA

Figure 1.2 shows large and uniform crystals that were grown on a Space Shuttle mission for the Birmingham Center and that illustrates the quality of the internal structure of crystal obtainable in the microgravity environment.

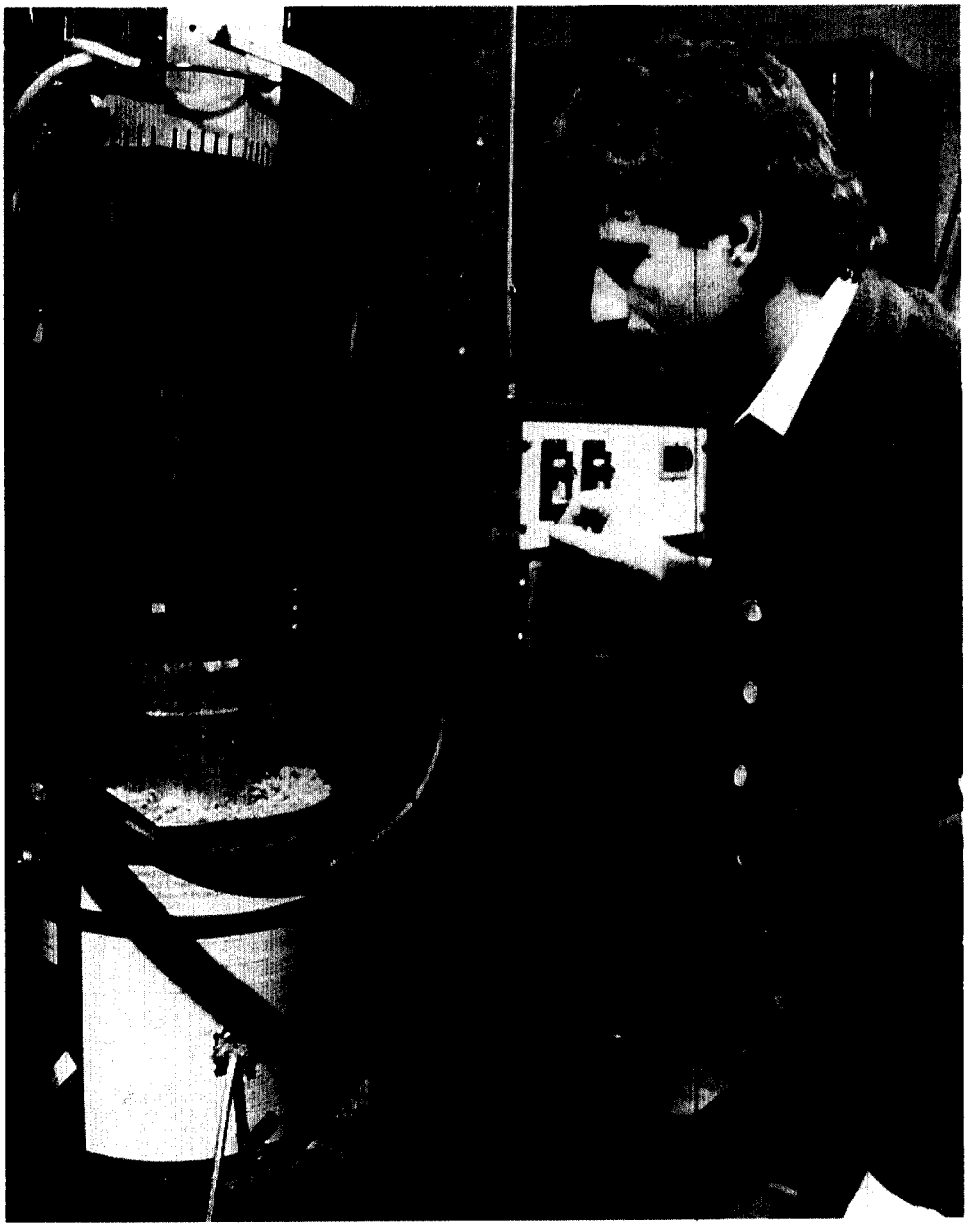
Figure 1.2: Large and Uniform Crystal Grown on a Space Shuttle Mission



Source: NASA

Figure 1.3 shows the low voltage scanning electron microscope developed by the Case Western Center for examining metals, ceramics, polymers, and composite materials.

Figure 1.3: Low Voltage Scanning Electron Microscope



Source: NASA

OCP funds each center with a basic annual grant of about $1 million to cover part of its operating budget. Through operating year 1990, the centers received about $65 million in basic grants. Also, many of the centers have received additional OCP funding—called augmentations—totaling about $16 million. According to OCP officials, augmentation funds are being used primarily to provide access to a high quality microgravity environment for the centers' experiments and to develop spaceflight hardware and facilities.

In addition to direct financial support, the centers are provided with access, such as the following, to scientific and technical advice, opportunities to work cooperatively, and other forms of assistance:

- A NASA commercial space representative at each field center acts as a liaison to help the centers identify and obtain access to technical assistance.
- NASA field center personnel assist the centers in developing hardware and meeting safety requirements when they are going to fly their experiments on the Space Shuttle.
- OCP provides the centers with access to nontechnical services, such as consultant assistance in developing marketing plans, and in performing assessments, surveys, and other business-related studies.

For their part, the centers, together with their industry partners, are to research and develop space-related technologies with commercial potential. The centers are expected to obtain financial and other forms of support from industry and other affiliates. OCP officials initially envisioned that these efforts would enable the centers to become less dependent on OCP grants and become self-sufficient after 5 years of grant support. To help the centers progress toward self-sufficiency, OCP officials said that, starting in 1988, they began to focus on the need to develop a commercial space technology data base, a commercial space infrastructure, and a cost-effective space transportation system for the centers.

Centers' Accomplishments and NASA's Future Plans

Since the inception of the program, the centers have claimed a variety of accomplishments, primarily in developing affiliations with industry, initiating projects involving flight tests in a space environment and other microgravity experiments, producing and disseminating research results, and developing patentable processes and products.

For example, for the 1990 operating year, the centers estimated they had 199 industrial affiliates, up from 158 in 1988, the first year in which all 16 centers were operating. The centers worked on 176

research projects in 1989 and, by the end of that year, had completed 759 flight tests and other microgravity experiments, including 18 in space. In addition, they reported that they had completed or were working on 897 publications and were planning 327 flight tests. More recently, 13 centers reported a total of 61 patents pending and 8 patents approved by the fall of 1990.

OCP is helping the centers prepare for future flight tests. For example, it has signed flight agreements with each center for conducting experiments on the Space Shuttle and is funding the leasing of additional space on the Shuttle for center experiments. Also, OCP is funding both suborbital rockets for the centers and the Commercial Experiments Transporter Program for launching and recovering small commercial space experiments starting in 1992.

In 1988, the Commercial Programs Advisory Committee was established to advise NASA on the proper roles and responsibilities of government and industry in commercial development of space. In a July 1989 report on "U.S. Space Enterprise and Space Industrial Competitiveness," the Committee recommended, among other things, that the centers

> ". . . be expanded and extended wherever [they] are producing results of value to industry. Measures of effectiveness should be reviewed and enhanced, and objective critical reviews should be conducted as a basis for decisions for extending or discontinuing Government funds for specific centers.

> "Continued funding should be tied to industry orientation and productive output, including patented products and processes. Consideration should be given to establishing additional centers to explore, jointly with industry, potential new opportunities and the need for new technology. . . . Consideration should also be given to establishing a business-oriented center (or adapting an existing center) to encourage new space product market sectors by drawing on product concepts emerging from other centers."

NASA is considering establishing up to two more centers in 1991 to specialize in making advanced satellite communications technology commercially available. It is also considering allowing the centers to establish affiliations with foreign companies and universities, if the centers can demonstrate that doing so would be advantageous to U.S. industry.

Objectives, Scope, and Methodology

At the request of the Chair, Subcommittee on VA, HUD, and Independent Agencies, Senate Committee on Appropriations, we reviewed (1) the extent of private sector involvement with the centers, (2) the centers' progress toward and prospects for self-sufficiency, and (3) NASA's management of the grant program.

To help address the extent of private sector involvement and the likelihood that the centers would become self-sufficient, we mailed a questionnaire to each center and conducted a follow-up standardized telephone interview with the center director or a designee. The questionnaire primarily focused on updating or obtaining additional information on matters reported to OCP by the centers on (1) sources, types, and values of contributions from affiliates, (2) projects underway in 1989 and industry support of and interest in them, and (3) augmentation funding. The telephone interview was principally focused on obtaining the views of center directors on (1) their center's ability to continue its present level of effort without OCP grants, (2) their planning for self-sufficiency and the likelihood of achieving it, (3) performance feedback from OCP, and (4) nonfinancial support their center had received from OCP. Some of the key standardized questions posed to center officials are listed in appendix I.

We did not independently verify the information provided by the centers. However, we did review the data collected for inconsistencies, which were resolved in discussions with center personnel. Both the questionnaire and the standardized interview were developed after discussions with NASA and center officials and were pretested with personnel at two centers.

We also interviewed OCP officials to determine the requirements placed on the centers for obtaining private sector interest and involvement and for attaining self-sufficiency. We reviewed NASA's and the centers' statistical reports that addressed, among other things, the number of private sector affiliates for each center and the amount of financial support each center generated. Part of our questionnaire was used to confirm or revise data previously reported to OCP by the centers on the type, source, timing, and amount of support they had received from sources other than NASA.

To examine NASA's management of the center grants, we discussed the development and implementation of various program oversight mechanisms with OCP officials. We reviewed internal NASA program documents, annual reports, advisory reports, briefing documents, grant and budget

documents, and fiscal information pertaining to the center. We also discussed fiscal oversight of the grants with NASA program and financial management officials.

We conducted our review from September 1989 to December 1990 in accordance with generally accepted government auditing standards.

Industry Involvement and Support Have Grown

Industry involvement with the centers is growing, as shown by the increasing number of industry affiliates and the rising value of their contributions. The number of industry affiliates rose from 63 in 1986 to an estimated 199 in 1990. On average, the number of industry affiliates grew from about 10 for each of the 6 centers reporting such affiliates for the 1986 operating year to about 12 expected for each of the 16 centers operating in 1990. The centers report that their support from industry has been increasing each year, including financial support, which has risen from less than $1 million in 1986 to over $4 million in 1990. However, some centers have received little or no financial support from industry.

Overall Industry Support and the Number of Industry Affiliates Are Increasing

The centers have established various types of affiliations with industry, universities, non-NASA federal agencies, NASA field centers, and state governments. Almost all of these affiliates provide the centers either cash or nonfinancial (in-kind) support by assigning personnel to work or consult on projects, giving or loaning hardware and equipment, providing software and data, and providing samples or other services. Table 2.1 shows the sources and types of support by operating year.

Table 2.1: Centers Support by Operating Year

Dollars in millions

	Operating year					
Type/source of support	**1986[a]**	**1987**	**1988**	**1989**	**1990[b]**	**Total**
Cash						
NASA	$4.5	$8.5	$17.2	$23.4	$27.1	$80.7
Industry	0.8	2.5	3.1	3.9	4.1	14.4
Others[c]	4.3	6.1	11.2	11.3	13.5	46.4
Industry in-kind support[d]	6.5	8.5	10.3	12.3	12.8	50.4
Total	**$16.1**	**$25.6**	**$41.9**	**$50.9**	**$57.5**	**$192.0**

Note: Some columns do not add due to rounding.

[a]Includes non-NASA contributions from a previous year for four centers.

[b]Includes estimates that were reviewed at about mid-year, except for industry and NASA cash support, which were estimated at or near the end of the year.

[c]Includes state agencies, academic institutions, and federal agencies other than NASA.

[d]Includes the centers' estimates of the value of industry personnel, equipment, and services supporting their work.

Since 1988, the first year in which all 16 centers received OCP grants, the total number of affiliates grew from 246 to an estimated 313 in 1990. Of these, 158 and 199, respectively, were industry affiliates. Overall, the

average number of industry affiliates increased from about 10 for each of the 6 centers reporting such affiliates for 1986 to about 12 for each of the 16 centers operating in 1990. Table 2.2 shows each type of center affiliate for each operating year.

Table 2.2: Center Affiliates for Operating Years 1986 to 1990

Type of affiliate	1986	1987	1988	1989	1990[a]
Industry	63	107	158	188	199
University[b]	25	36	53	61	69
NASA field centers	6	9	13	15	16
Other federal agencies	2	4	12	17	17
State agencies	4	5	10	11	12
Total	**100**	**161**	**246**	**292**	**313**

[a]Includes estimates that were reviewed at about mid-year, except for the number of industry affiliates, which was estimated at or near the end of the year.

[b]The centers' home universities are not counted as affiliates.

Industry affiliates represent, by far, the largest group of affiliates. Since the program began, industry affiliates have comprised about 60 percent or more of all affiliates, and the value of their cash and in-kind support has increased, from $7.3 million in 1986 to about $17 million estimated for 1990. The financial portion of their total support has also increased, from about 11 percent in 1986 to about 25 percent estimated for 1990.

Industry affiliates are private companies and include some of the nation's largest aerospace corporations, such as Boeing Aerospace and Electronic Corporation, Grumman Aerospace Corporation, and McDonnell Douglas Space Systems Company. Other industry affiliates are large, nonaerospace companies such as AMOCO Chemicals Corporation, E.I. Dupont de Nemours and Company, and John Deere Company. The others include many smaller companies; some are relatively new enterprises.

For 1989—the most recent complete operating year at the time of our fieldwork—the 16 centers had 188 industry affiliates.[1] On average, they had been affiliated with their center for 2.3 years, and almost all of them (97 percent) provided cash or in-kind support in 1989. Also, 83 of them had provided cash support since becoming affiliated with their centers. Cash support from 19 of these industry affiliates totaled at least $100,000 each.

[1]The number of companies is somewhat less because a few companies are affiliated with more than one center.

The centers worked on 176 projects during 1989. According to the centers, industry representatives were interested in receiving information about the results of 163 (93 percent) of them. Overall, industry affiliates directly supported 135 (77 percent) of the projects through targeted cash contributions or by assigning personnel to spend at least a week working on or reviewing them.

Some Centers Are Attracting Little Financial Support From Industry

The overall number of industry affiliates and the total value of industry support have grown, even though some centers expected to have fewer industry affiliates in 1990 than they had when they began operating and some had received little or no financial support from industry.

As indicated in table 2.3, most centers show either a relatively stable or an increasing number of industry affiliates since they first received an OCP grant. However, a few centers report a significant decrease in their number of industry affiliates over time.

Table 2.3: Number of Industry Affiliates for Each Center

	Operating year				
Center	**1986**	**1987**	**1988**	**1989**	**1990[a]**
Auburn			4	4	4
Battelle	7	10	10	11	12
Birmingham	10	12	12	13	11
Case Western		6	7	7	6
Clarkson	14	15	15	13	11
Colorado		16	24	31	42
Houston		6	5	7	10
Huntsville	9	8	10	11	15
Institute for Technology Development	11	7	8	10	7
Michigan			7	5	3
Ohio State		2	5	9	7
Penn State			7	17	30
Tennessee			6	9	9
Texas A&M			16	20	18
Vanderbilt	12	13	11	7	3
Wisconsin		12	11	14	11
Total	**63**	**107**	**158**	**188**	**199**

Note: A blank space indicates that the center did not report for that year.
[a]Estimates made at or near the end of the year.

The centers' varied abilities to consistently identify, design, and implement research projects of interest to their industry affiliates can be

viewed in light of the financial support being derived from these affiliates over time, as shown in table 2.4.

Table 2.4: Center Cash Support From Industry Affiliates

Dollars in thousands

	Operating year					
Center	**1986**	**1987**	**1988**	**1989**	**1990[a]**	**Total**
Auburn			$50	$155	$240	$445
Battelle	$97	$113	130	130	220	690
Birmingham	307[b]	221	280	577	633	2,018
Case Western		150	125	175	165	615
Clarkson	62	88	150	150	150	600
Colorado		210	230	230	80	750
Houston		500	51	124	137	812
Huntsville	239	333	633	246	138	1,589
Institute for Technology Development	70	120	231	127	266	814
Michigan			20	25	0	45
Ohio State		0	60	23	0	83
Penn State			69	377	385	831
Tennessee			140	120	196	456
Texas A&M			306	714	1,100	2,120
Vanderbilt	0	0	0	0	0	0
Wisconsin		776	674	720	411	2,581
Total	**$775**	**$2,511**	**$3,148**	**$3,892**	**$4,121**	**$14,449**

Note: Some columns and the total row do not add due to rounding; a blank space indicates that the center did not report for that year.

[a]Estimates made at or near the end of the year.

[b]Includes $30,000 received before operating year 1986.

Some centers show substantial increases in actual or estimated cash support from their industry affiliates over the years. Others display inconsistent and, in some cases, decreasing support levels, or modest patterns of relatively stable or increasing financial support. Clearly, the Vanderbilt, Michigan, and Ohio State centers have not obtained and sustained financial support from industry. OCP's assessment of this situation is summarized in chapter 4.

Self-Sufficiency Is Not Achievable in the Near Future

The centers will not achieve self-sufficiency anytime soon. None will be self-sufficient after the first 5 or 7 years of funding. Their progress toward self-sufficiency is slow, and most will continue to rely heavily on OCP grants for the foreseeable future.

Despite the slow pace, most directors believe OCP is satisfied with their center's progress toward self-sufficiency. Overall, the directors do not believe their centers can be independent of OCP grants anytime soon and still maintain current levels of activity. However, although some believe their centers will never be totally independent of OCP grants, 11 believe their centers can become self-sufficient sometime between 1995 and the turn of the century.

Progress Toward Self-Sufficiency Is Slow

The initial goal for the centers to become self-sufficient after 5 years of NASA support was set in 1985. It was established without the benefit of prior experience with this type of grant program. According to OCP officials, in initially setting the goal, the program managers considered the extent to which center experiments would have access to space using the Space Shuttle. They concluded that 5 years was adequate time for the centers to develop technical data and use it to develop sufficient industry support to enable them to continue their programs without OCP grants.

The goal was based on the assumption that the centers would operate at least at the same level without OCP grants as they did with them. In effect, they would develop other sources of revenue to supplant the grants and enable them to fully meet their operating requirements, including the cost of getting their experiments into space.

OCP officials told us that because of the Space Shuttle flight delays following the Challenger accident in January 1986, there has been some discussion of extending the goal to 7 years. Even though the goal has not been officially extended, the centers that were first funded in 1986 recently started their sixth grant year.

Officials at one center told us that its survival without OCP grants depends on its ability to complete projects with the potential for ultimately generating patentable processes and products with commercial applications. The patents would then be used to create a revenue stream from licensing and royalty arrangements or other financial agreements. In the nearer term, the center could progress toward self-sufficiency by designing projects with enough commercial potential to attract financing

from its affiliates to at least partially support its program. Essentially this same scenario can be applied to every center. It carries an expectation of a decline over time in the portion of the centers' budgets supported by OCP grants. However, instead of decreasing, the portion of the centers' budgets financed by OCP grants has increased, from 28 percent in the first year the centers were funded to an estimated 47 percent by 1990, as shown in table 3.1.

Table 3.1: Percentage of Centers' Support From Each Source by Operating Year

	Operating year				
Type/source of support	**1986**	**1987**	**1988**	**1989**	**1990[a]**
Cash					
NASA	28	33	41	46	47
Industry	5	10	8	8	7
Other[b]	27	24	27	22	23
Industry in-kind support[c]	40	33	25	24	22
Total	**100**	**100**	**100**	**100**	**100**

Note: Some columns do not add due to rounding.

[a]Percentages are based on dollar estimates that were made about mid-year for "other cash" and "industry in-kind support" and at or near the end of the year for NASA and industry cash support.

[b]Includes state agencies, academic institutions, and federal agencies other than NASA.

[c]Includes the centers' estimates of the value of industry personnel, equipment, and services supporting their work.

The centers' overall dependence on OCP grants is growing because some centers have yet to obtain financial support of any consequence from their industry affiliates, as indicated in chapter 2. These centers help perpetuate the high proportion of OCP grant support because they have received little or no cash from their industry affiliates to help offset it. Overall, however, growing dependence on OCP grants is mainly due to increases in OCP's funding augmentations in recent years.

OCP officials noted that, as the commercial focus of the program matured, it began to include the need for unique flight hardware and facilities and transportation to space. Such needs helped increase requirements for funding augmentations. Since their modest beginning in 1986 with one augmentation of $25,000 (a fraction of 1 percent of the total OCP grant funding for the centers that year), the use of funding augmentations has increased dramatically to 23 percent of OCP's total 1989 funding and an estimated 37 percent of the total 1990 funding.

Since the inception of the program, most of the centers have received funding augmentations. These augmentations have totaled about $16

million and generally have been used to fund a variety of activities not covered by the centers' budgets. Most augmentation funding so far has been for just two large projects. One project involves obtaining access to microgravity for the centers' experiments by purchasing suborbital sounding rocket services. The other involves developing a Space Shuttle deployable device for improving the quality of the microgravity environment for the centers' experiments.

Augmentations will likely continue to be a significant part of OCP's total grant funding as long as they are needed to finance flight opportunities for the centers' experiments. As previously noted, although relatively few center experiments have been carried out in space so far, many are being planned. As flight requirements grow, so will the need to pay for those that cannot be flown without charge on the Space Shuttle. However, the centers are not yet able to routinely fund the cost of access to space, and they are not likely to be able to do so until products and services resulting from their research begin to generate revenue for them. Until then, augmentation funds will likely be an important means for financing the centers' access to space.

Centers' Views on Self-Sufficiency

Center officials were pessimistic about the prospects for self-sufficiency anytime soon. For example, none of the directors believed that their center would be able to continue at its present level of activity if OCP grant support was withdrawn before 1995. However, most believe that OCP is satisfied with their progress toward self-sufficiency and, given enough time, most believe their center will eventually be independent.

Center directors do not believe that their centers can be self-sufficient after 5 years of OCP grants, and only three of these officials believe that their centers have a better than even chance of doing so after 7 years. Although five center directors do not foresee ever being able to operate at their present levels of effort without OCP grant assistance, the rest believe they will be able to do so beginning sometime between 1995 and 2000.

Most directors believe that OCP is satisfied with their center's progress toward self-sufficiency. Ten center directors believe that OCP would rate their progress as satisfactory, while three others felt that OCP would rate their progress as unsatisfactory. The remaining three said they had no idea how OCP would rate their progress. These last three centers, as well as all other centers, should become aware of OCP's current views on their progress as a result of feedback to be provided on the results of OCP's

annual evaluation of each center conducted in late 1990, as discussed in chapter 4.

Conclusions

OCP has had some success in establishing centers capable of attracting and sustaining industry interest and support. While it is too soon to gauge the extent to which the program may ultimately achieve its goals, it is clear that whatever level of success is eventually achieved will take longer than 5 to 7 years to accomplish.

In concept, a goal that delimits the period of grant support is essential to convey an appropriate sense of urgency to grantees to stimulate their efforts to leverage the grants in the near term and to eventually supplant them. But there are differences in the commercial maturity levels of the areas of specialization; in each center's focus within its area of specialization; in the timing and magnitude of industry interest in and support for each center; and, therefore, in the likely pace of each center's ability to develop commercial products and services. Consequently, a single fixed period of grant support for all centers to achieve self-sufficiency has little or no incentive value because it is seen as impractical. A single fixed period made sense when the program began because of the lack of any prior experience with a grant program of this type and the dearth of information about industry interest and willingness to make commitments. However, circumstances are significantly different today. Each center has at least 3 years' operating experience, and OCP personnel have had 3 to 5 years to identify and understand the strengths and weaknesses of each.

Using the knowledge gained so far in the program, OCP should, in partnership with each center, identify and establish goals for the remaining period of grant support. Once established, the goals should be periodically reviewed and revised, if warranted, by changing circumstances. The goals should be used to help evaluate each center's progress toward self-sufficiency. If progress becomes inadequate and corrective actions ultimately fail to sufficiently quicken the pace, OCP should terminate the grant. NASA should immediately undertake such efforts for those centers that so far have demonstrated little progress toward self-sufficiency.

Recommendation

We recommend that the Administrator, NASA, establish, in consultation with each center, a grant support goal with interim targets against which to track progress toward self-sufficiency and to determine the need for, and help measure the results of, corrective actions.

Agency Comments and Our Evaluation

NASA said that this recommendation was reasonable and could be implemented but required some explanation. In essence, NASA took issue with our description of a grant support period as a goal of the program. Instead, it preferred to view self-sufficiency as a by-product of facilitating the applied research necessary to develop commercial markets and products, together with the development of the space infrastructure and transportation systems for supporting such products and markets. NASA also indicated that the approach to and timing of grant support goals would be determined in the future.

We disagree with NASA on both points. A limited period of grant support was initially a major goal under the program which, until now, had not been officially changed. However, regardless of whether it is now a secondary goal or, as NASA calls it, a by-product of the program's primary goal, the achievement of self-sufficiency is still intended under the program. Therefore, as a management monitoring tool, a grant support goal is a quantitative expression of the performance expectations associated with each grant. Both the establishment of such goals for each center, as well as the rationales for any subsequent changes to them, would be readily determinable and reviewable. Also, we see no reason for waiting to establish such goals since our recommendation does not envision an arbitrary, inflexible approach where such goals are not adjusted as circumstances warrant.

Potential for Improved Program and Fiscal Management

When the grant program began OCP did not have a process that focused on evaluating the centers' progress toward the program's commercialization goals. Development of such a process began in the program's third year and has since evolved into a systematic evaluation with primary focus on such goals. Additional changes to the process are anticipated, but they are not expected to be major. In finalizing the evaluation process, OCP should ensure that it adequately provides for timely feedback of evaluation results to each center.

In addition, other management oversight processes need to be assessed. The process for evaluating the centers' flight requests should be examined to ensure that adequate coverage is provided in an efficient manner. NASA should also examine its internal controls related to obtaining and processing fiscal information on the centers and other NASA grantees to ensure that it is timely, complete, and accurate.

Evaluation Process Still Evolving

OCP's strategy for establishing the centers and helping them become self-sustaining entities requires early and direct industry involvement in planning and developing commercially oriented research activities. Therefore, the assessment of the center's policies, operations, and plans should focus on the development and implementation of efforts geared to eventual commercialization, including obtaining and sustaining adequate industry participation and support and developing and implementing self-sufficiency plans and approaches. However, at the program's inception, there was no established comprehensive mechanism with such a focus for use in evaluating center performance.

OCP efforts to develop an evaluation process with significant focus on achieving the commercialization goals of the program began about 3 years after the selection of the initial group of centers. Since that time, the evaluation process has been evolving. Currently, its principal component is a structured annual assessment of each center that strongly emphasizes activities and plans that enhance the prospects of ultimately achieving the commercialization goals.

The primary vehicle for accomplishing the evaluation is an annual review each fall, which is conducted when each center's suitability for another year's grant support is determined. The centerpiece of this review is a formal presentation that is keyed to a pre-established, mutually agreed upon, standardized format. The reviewers consider both the contents of each center's formal presentation and other sources of information about each center and its operating activities. These other

sources of information include technical and business meetings and workshops held throughout the year.

The first annual evaluations focusing on the centers' efforts to address the program's commercialization goals were done in 1989. According to OCP officials, the evaluations were primarily based on the informal views of OCP senior staff using a pilot evaluation approach developed by OCP with input from the centers, along with the results of an opinion survey of industry participants.

Further refinements were made to that initial effort, again with input from the centers. According to OCP officials, the evaluation process was adjusted to enhance the centers' awareness of what OCP felt were the most important evaluation factors. For the recent 1990 assessments, each center's performance was evaluated on 12 factors. A number of these factors related to the commercialization goals of the program, including the centers' use of grant funds to generate support from other sources (leveraging), the commercial potential of their major projects, their attention to developing marketable products and services, and their planning to eventually become self-sufficient. OCP officials told us that the evaluation process would be reviewed each year at one of the centers' working group meetings to ensure that they understand its value and to obtain their views on the need to change or adjust it. These officials do not believe any extensive changes will be made to the assessment factors in the future.

The 1990 assessment report generally summarizes both the perceived key strengths and weaknesses of the centers and includes recommendations for improvement. There was at least one weakness identified or recommendation for improvement made to just about every center on activities related to making progress toward self-sufficiency. The specific concerns included

- insufficient commercialization planning,
- inadequate numbers of industry affiliates and/or level of industry support,
- insufficient leveraging of grant funds, and
- inadequate evaluations of the market potential of project results.

Each of the centers that has developed little or no financial support from industry received some criticisms and/or recommendations for improvement. Specifically, the Vanderbilt center was seen as weak in its leveraging of grant funds; OCP recommended that the center develop a

plan for doing so. The Michigan center was also criticized for its inability to adequately leverage grant funds; OCP recommended that the center increase the level of industry involvement and funding in its program. OCP officials noted that, as a result of the previous year's assessments, the Vanderbilt and Michigan centers had already made changes to the management and scope of their programs before the 1990 assessments. They believe that both centers improved in 1990. The Ohio State center has emphasized royalty payments in the future over current cash contributions. This approach was questioned by some OCP reviewers; however, it is consistent with the overall goal of commercial development and eventual self-sufficiency, according to OCP officials.

At the completion of our fieldwork in December 1990, the 1990 review had been completed except for the process of formal feedback to each center. In completing this feedback, OCP should ensure that each center fully understands how its efforts are perceived, especially in those areas having the greatest implications for self-sufficiency, because it is not clear that the centers are completely aware of how their efforts are viewed. For example, just a few months before the 1990 assessments, in response to our questions about the feedback they receive from OCP,

- 14 centers thought OCP would rate them "satisfactory" for their responsiveness to commercial needs,
- the same number thought OCP would rate them "satisfactory" in obtaining financial contributions from their industry affiliates, and
- 10 centers thought OCP would rate them "satisfactory" for their progress toward self-sufficiency.

Perhaps more significantly, three centers said they did not know how OCP would rate them on their progress toward self-sufficiency. OCP officials told us that they will make sure that their concerns and recommendations for improvement are clearly communicated to each center.

Payload Review and Approval Process Can Be Improved

When a center determines that it needs to fly an experiment using a NASA-sponsored launch vehicle, it submits a flight request and payload plan to OCP to initiate a series of reviews and approvals within NASA leading to the assignment of the payload to a particular mission and to its integration with the launch vehicle. Currently, the process is limited to requests to fly as secondary payloads on the Space Shuttle. The process will also be applied in the future to flight requests using expendable launch vehicles.

The flight request provides basic descriptive information about the payload and its technical characteristics and requirements. The payload plan generally describes the experiment and its objectives, outlines the payload's development schedule, and summarizes the commercial opportunity related to the experiment and how the experiment will be financed.

OCP uses a Payload Selection Board to review these requests. Board members recommend approval, conditional approval, deferral, or rejection after considering the adequacy of the request and plan in providing specific information related to

- the payload's commercial applicability;
- its overall suitability and readiness for flight;
- the requester's capability to accomplish the flight;
- the readiness and integration of the experiment's hardware and other instrumentation;
- the coordination of testing and operations plans; and
- the availability of financing, including industry sources.

The individual assessments are aggregated, and a joint meeting or teleconference is held to discuss the individual review results, arrive at an overall Board consensus, and identify any action items or conditions that the requesting center needs to address. Conditions identify major problems that must be resolved before flight, while action items identify less serious problems, usually in the form of additional information requirements. A request can be fully approved by the Board only if no major problems have been identified. OCP management considers the views of the Selection Board before forwarding the request to NASA's Office of Space Flight for Space Shuttle flight assignment.

OCP's current flight request and approval process began in early 1989. By August 1990, 12 centers had submitted 67 requests covering 72 flight projects. OCP encourages the centers to submit flight requests early in their development to assist OCP in planning future potential flight activities. Therefore, not all of the requests were complete enough to submit for Board review. However, 27 requests had been or were under Board review through early August 1990, as shown in table 4.1.

Table 4.1: Centers' Flight Request Status

Status	Number
Approved	7
Conditionally approved	12
Deferred[a]	3
Rejected	0
Other[b]	5
	27

[a]These cases are partial deferrals in combination with one approval and two conditional approvals.

[b]Includes cases pending and under review.

Based on estimates of future flight requirements, many more flight requests and related payload plans will be submitted to OCP in the future.

Payload Selection Board's Membership Should Be Reviewed

The Payload Selection Board provides for 11 members, about half are OCP personnel. Membership is also provided for representatives from other NASA headquarters' offices—the Offices of Space Flight and Space Science and Applications—and for three representatives from private industry. One or more ad hoc members also review requests when requested by OCP officials. Most ad hoc members are from NASA's space and research centers. Ad hoc members review flight requests depending on the expertise OCP officials believe they can contribute to the review.

OCP officials told us that a primary focus of the payload selection process was on the commercial potential of the products and services to be ultimately derived from the results of the proposed experiment. In addition, before submitting a flight request to the Office of Space Flight, OCP is interested in knowing that the proposed experiment's design and hardware can be successfully integrated with its intended launch vehicle. OCP officials specifically noted that the Selection Board is not expected to evaluate the science embodied in the experiment. In their opinion, this judgment is best left to the requesting center and its corporate partners.

However, little specific guidance has been provided to Payload Selection Board members on the purposes of their reviews. Our discussions with some members, and reviews of members' evaluations of payload requests, indicated the following uncertainty and concern about the process and their role in it:

- One ad hoc member wanted to be replaced because he was being asked to review payload requests that were primarily related to a research area in which he had no expertise.
- Another ad hoc member said that he would not judge projects or parts of projects he knew little or nothing about, including life science experiments and related hardware, and the marketability of research results.
- After reviewing a payload request, one member's action item called for a review by an expert. That review noted the lack of sufficient detail to adequately assess the experiment's scientific value and chances of success—considerations outside the scope of the Board's review.

The limited perspectives that restrict some Selection Board members' review contributions are borne out by review documentation. In some cases, the reviewer's lack of knowledge in certain areas was noted. There was also liberal use of the phrase "no comment" throughout many of the evaluations. In frustration, one Board member outside of OCP characterized his participation in the payload selection process as a "waste of time."

In addition to the concerns expressed about the roles and responsibilities of those who are asked to participate in the process, there is a question about those initially scheduled to participate but who do not. With the primary focus of the selection process on the commercial potential of the products and services to be ultimately derived from the experiment, having representatives from private industry on the Board is advantageous, if not critical. Originally, the Payload Selection Board was supposed to have three members from private industry, but the Board has not had more than one. Two planned positions for industry representatives as Payload Selection Board members have not been filled.

OCP officials agreed to review the payload approval process, including the membership and operations of the Payload Selection Board.

Fiscal Information Should Be More Timely, Complete, and Accurate

Timely, complete, and accurate fiscal information on the center's activities is not routinely available from NASA's accounting system because NASA has not effectively enforced grantee reporting requirements to ensure the timely receipt of complete and accurate fiscal reports. Furthermore, when the fiscal information is received, it has not been routinely recorded in the accounting system in a timely manner, regardless of whether the report was on time or late.

NASA accounting personnel contend that they lack sufficient resources to ensure grantee compliance with all reporting requirements and keep grantee financial information in NASA's accounting system current. NASA accounting officials told us these requirements will be assessed in the March through April 1991 time frame as part of the review of management controls and financial systems done periodically in support of the Administrator's statement of compliance required by the Federal Managers' Financial Integrity Act of 1982.

Incomplete, Inaccurate, and Late Fiscal Reports

Under an established governmentwide system, NASA and its grantees use a funds transfer process that enables the grantees to request money as it is needed to meet the expenses chargeable to their grants.[1] Under the process, called a letter of credit, grantees periodically request and, with NASA's permission, usually receive funds overnight by electronic transfer. This process enables the grantee to quickly receive funds to pay bills close to their due dates, while, at the same time, helping the government to economically manage its funds.

Grantees are required to summarize and report their federal funds transfer activities to NASA within 15 working days after the end of each quarter of the year. Each quarterly federal cash transaction report starts with the ending balance from the preceding report, adds grant funds received during the reporting period, deducts disbursements or other expenses chargeable to the grant during the reporting period, and shows either a balance of federal grant funds on hand or the amount of funds still needed to cover grantee expenses. Generally, any federal fund balances on hand require further explanation since the concept of timely transfer should eliminate the transfer of federal funds significantly in advance of when needed to pay expenses. If the federal grant funds on hand will be needed to meet expenses during the first 3 days of the next quarter, the grantee can hold the funds. Otherwise, federal funds held by grantees at the end of a quarter are generally required to be returned to the government. Finally, grantees are supposed to estimate and report their federal grant fund requirements for each of the next 4 months. NASA can deny grantees' funds transfer requests for a variety of reasons, including late and incomplete reporting.

Our examination of selected quarterly reports indicated problems with their completeness, accuracy, and timeliness, ranging from the sporadic

[1]This process is available for use by many federal agencies to periodically transfer funds to numerous grantees. NASA uses it for many grantees, not just the centers.

to the persistent. Specifically, grantee federal funds quarterly reports have not always contained all of the required information, and some reports have contained inaccurate information that was not identified and corrected by NASA in a timely fashion. In addition, many reports have been habitually late, and late reporting grantees have been routinely allowed to continue to receive grant funds.

Various grantees filed incomplete reports that did not contain the required information about federal fund balances on hand or did not show the required monthly cash projections.

In addition, one grantee filed quarterly federal funds transaction reports containing numerous substantial errors. For example, an ending balance of over $200,000 changed on the next quarterly report to a beginning balance of $1,449, and cash available of $1,449 minus disbursements of $250,000 was shown as equaling $62,500. These reporting errors continued without correction for about a 2-year period. An audit initiated by another federal agency that was also funding the same grantee subsequently raised questions about the grantee's operations. NASA missed the opportunity to identify and correct problems at the outset of its relationship with this grantee because it did not take timely corrective action on the grantee's inability to prepare accurate reports.

Finally, some grantees are consistently late in filing their federal cash transaction reports covering their center grants. Overall, NASA accounting personnel estimate that 60 to 75 percent of the reports are late. In some cases, reports are received well after the 15-day limit. For example, over 30 reports from 4 grantees during the period from mid-1987 to early 1990 were an average of more than 14 days late, ranging up to 60 days late.

NASA instructs its grantees on the proper procedures for requesting and obtaining grant funds and on related reporting requirements. It is NASA's general policy to reject grant fund requests when reporting requirements are not complied with. However, NASA accounting personnel have not always exercised this authority, preferring instead to work with the grantees to help them voluntarily improve their performance. Even though such efforts did correct problems in most instances, they did not always result in timely corrective actions. The same four late-reporting grantees noted above withdrew more than $4.6 million on 19 occasions before NASA received their late reports. NASA accounting personnel explained that they sometimes do not reject withdrawal requests because they have received a facsimile copy of the quarterly report

before the receipt of the mailed report is recorded, or because they are told by the grantee that the report is on its way or would be mailed soon. They also said that they have rejected withdrawal requests because of late reporting.

NASA's Accounting Information on Grantees Is Not as Current as It Should Be

Federal agencies are responsible for establishing and operating financial management systems capable of providing timely, accurate, and complete accounting information. As a practical matter, financial information should enter an agency's accounting records as close as possible to the actual transaction. In the case of grantees, information summarizing their receipt and use of federal grant funds comes from their quarterly reports. After a grantee's federal funds report is received and accepted by NASA, the information in it is supposed to be routinely posted to NASA's official financial records in a timely manner.

However, the information from these reports is not always routinely entered into NASA's accounting system soon after it is received, regardless of whether the report is on time or late. In some cases, a series of two or more consecutive quarterly reports will be aggregated and posted together. Various NASA program officials told us that they do not routinely rely on the grantee financial information in NASA's accounting records because they know it is not likely to be current. NASA accounting personnel said that when there are posting delays they frequently receive complaints about the lack of current financial information about grantees in NASA's financial management data base.

Conclusions

Based on its first 2 years of operating experience and in expectation of an increasingly heavy work load, OCP needs to validate its center flight request and approval process to ensure that the Payload Selection Board efficiently provides the desired review coverage and that its members clearly understand their roles and responsibilities. In this assessment, OCP should especially consider the technical assistance and reviews available within NASA after OCP approval for those center experiments to be flown on the Space Shuttle as secondary payloads.

In the fiscal management area, our work was generally limited to grantees reporting on the use of their center grants and NASA's handling of the reported information. However, the procedures for receiving and processing fiscal reports extends to many other NASA grantees. Based on the identified concerns about timely, complete, and accurate information from grantees reporting on their center grants, NASA should review the

adequacy of its internal controls for acquiring and processing grantee fiscal reports to produce timely, complete, and accurate accounting information.

Recommendations

We recommend that the Administrator, NASA,

- review the flight request and approval process to ensure that the necessary expertise for such reviews is available in the most efficient manner possible and that those who are asked to assess flight requests fully understand the intended scope of their participation and
- assess and, as necessary, strengthen the internal controls for ensuring that timely, complete, and accurate fiscal information on grantees is available in NASA's accounting system.

Agency Comments

NASA said that the recommendations were reasonable and could be implemented. Specifically, NASA noted that the program's payload selection process will be revamped to ensure appropriate expertise is available and that the process will include adequate industrial and NASA involvement. NASA did not specifically comment on our internal control recommendation.

Some Key Standard Interview Questions Directed at Center Officials

1. We would like to know whether you think your Centers for the Commercial Development of Space (CCDS) will ever be able to operate at its present level of effort without a NASA CCDS grant. Do you think that, given enough time, your center could continue at its present level of effort without the NASA CCDS grant or do you think that will never be feasible? If yes, when (year) would you expect that your center would be able to continue at its present level of effort without NASA support?

2. It was initially expected that CCDSs would become self-sufficient within 5 years. Have you formulated alternative plans for expected levels of effort and sources of income for 19—, the year in which you would need to be self-sufficient if NASA support lasted for 5 years?

3. Some people are now advocating a longer time span of at least 7 years. If a new 7-year program were followed, you would be expected to obtain self-sufficiency by 19—. In your own best judgment, on a scale of 0 to 100 percent, how likely is it that your CCDS can be self-supporting at its present level of effort in 19— after having received 7 years of NASA support?

4. Now we need to know what types of feedback you have been receiving from the NASA Commercial Program Office. I will mention four aspects of your program. For each one, please indicate whether you feel that NASA rates your CCDS's performance as being successful or unsuccessful. If you do not know how NASA rates your program on some aspect, please say so. First, consider the NASA rating of the technical quality of the research at your center. Do you believe that NASA rates the technical quality of the research as very satisfactory, moderately satisfactory, moderately unsatisfactory, very unsatisfactory, or do you not have any idea. (This question was also asked about the following: responsiveness to commercial needs, amount of financial contributions from industry affiliates, and progress toward self-sufficiency.)

Comments From the National Aeronautics and Space Administration

Note: GAO comments supplementing those in the report text appear at the end of this appendix.

National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

April 3, 1991

Mr. Frank C. Conahan
Assistant Comptroller General
National Security and International
Affairs Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Conahan:

This is the National Aeronautics and Space Administration's (NASA) response to the General Accounting Office (GAO) draft report GAO/NSIAD-91-142, entitled, "Commercial Space: Many Grantees Making Progress But NASA Oversight Can Be Improved," dated March 18, 1991.

The draft report provides useful commentary on one of NASA's newest and fastest growing commercial space programs. NASA is proud of the impressive progress the Centers for the Commercial Development of Space (CCDS) have made in obtaining private sector commitments to commercial space. At the same time, NASA has observed many of the issues raised in the report and has, or is in the process of, correcting many of them (see enclosure). In some instances, this was recognized in the body of the draft report, however, we are concerned that the executive summary does not adequately capture the thrust of the language in the body of the report because it tends to portray a more negative image than the body does. We request that you review the executive summary to ensure adequate balance.

See comment 1.

We consider the proposed recommendations contained in the draft report to be reasonable and implementable, however, some amplification may be helpful with regard to the first recommendation dealing with grant support termination goals. Although NASA management may have originally contemplated definitive time limitations to grant support at the inception of the CCDS program, there have been some significant intervening events, such as the approval of the U.S. Commercial Space Policy Guidelines by the President last January. Also, the Challenger accident, and the consequent interruption of planned manifesting, denied access to space for a prolonged period of time.

Furthermore, the pace at which the program is moving toward the goal of developing space based and space derived markets has been somewhat slowed due to the need to develop a

commercial space infrastructure and the lack of cost effective space transportation. Because of this, our continuing assessment of how and when to establish grant support termination goals will necessarily take into account national policies and the degree of success an individual CCDS enjoys in meeting the goals that the program envisions.

In this regard, NASA is pleased that the draft report recognizes the diversity of the CCDS's technical disciplines and does not recommend across-the-board termination dates. NASA has learned through experience that to initiate private sector commitment and work on new technology, there must be "seed money." The initial commitment of the Government, in general, and NASA specifically, in providing CCDS funding is important to industry. It is especially true in providing flight hardware and transportation to the new, high technology and somewhat unforgiving environment of space. New opportunities following successful maturing of a technology, with royalties and market development, will facilitate the independence of the CCDS's.

The enclosure provides more specific comments and suggestions that we believe will clarify NASA's concept of the CCDS's, strengthen the report, and minimize possible misinterpretations. We appreciate the cooperation and professional courtesies extended by your staff during the development of this report and efforts to solicit and consider NASA's views through the data collection and review process.

Sincerely,

John E. O'Brien
Assistant Deputy Administrator

Enclosure

COMMENTS ON GAO REPORT
GAO-NSIAD-91-142, entitled COMMERCIAL SPACE: Many Grantees Making Progress but NASA Oversight Can be Improved, dated March 18, 1991

1. PAGE 2 - EXECUTIVE SUMMARY/PURPOSE

   In its inception, the Centers for the Commercial Development of Space (CCDS) were envisioned to be oriented to applied industry research using the attributes of space. They have generated considerable non-NASA investment in space, thereby achieving substantial leverage of NASA funds.

2. PAGE 2 - RESULTS IN BRIEF/FIRST PARAGRAPH

   Grant support goals are currently set based on the completion of the approved CCDS flight test projects which will establish a commercial space data base. The goal of self-sufficiency is an objective with a yet to be determined milestone.

Now on page 3.

3. PAGE 4 - CENTERS WILL NOT BE SELF-SUFFICIENT SOON/FIRST PARAGRAPH/LAST SENTENCE

   The primary reason for the increase in NASA grant contributions is to provide support for the CCDS flight hardware and to provide alternative space transportation beyond that available on the Shuttle (e.g., Sounding Rocket, Commercial Experiment Transporter (COMET). It was deemed more appropriate and cost efficient for the CCDS's to obtain their own transportation system (COMET) since they are more familiar with their requirements.

Now on page 3.

4. PAGE 4 - LAST PARAGRAPH

   In the past two years, there has been an emphasis on the primary goal of the CCDS's. The primary goal is to facilitate the applied research leading to the development of commercial products and markets, along with the development of infrastructure and transportation to support these products and markets. This is accomplished through specific CCDS projects. Self-sufficiency is a fallout of the goal and accomplished when the projects are completed; however, it should not be confused as a goal.

Now on page 4.

See comment 2.

Now on page 4.

Now on page 14.

Now on page 14/last paragraph.

Now on page 14/top of page 15. Second paragraph.

See comment 3.

Now on page 15. Last paragraph

Now on page 20.

See comment 4.

5. PAGE 5 - STRUCTURE OF THE PAYLOAD REVIEW PROCESS SHOULD BE REVIEWED/SECOND SENTENCE
Specific guidance has been given to the Payload Selection Board, both in written evaluation criteria and verbally during each Board meeting; however, this will be reinforced.

6. PAGE 6 - RECOMMENDATIONS/FIRST PARAGRAPH
The recommendation should be to establish objectives. Self-sufficiency will result from the completion of each commercial project.

7. PAGE 16 - SECOND PARAGRAPH/SECOND ITEM
NASA Field Center personnel assist in developing hardware and meeting safety requirements only on specific projects. Even for these projects, this is normally in the start-up phase of the CCDS and the intent is to transition this responsibility to the CCDS's as they obtain expertise.

8. PAGE 16/TOP OF PAGE 17/LAST SENTENCE
Starting in 1988, OCP recognized this as a focus that would result as the program matured, as per comment on page 4, last paragraph.

9. PAGE 17 - CENTER'S ACCOMPLISHMENTS AND NASA'S FUTURE PLAN/THIRD PARAGRAPH/LAST SENTENCE
The Office of Commercial Programs (OCP) is also funding the leasing of additional middeck space on SPACEHAB. Another primary OCP objective is being satisfied through the funding of the Sounding Rockets, SPACEHAB lease, and COMET. Not only are the space flight requirements of the CCDS's being satisfied, but commercial transportation opportunities are being developed as part of the space infrastructure market.

10. PAGE 18 - CENTER'S ACCOMPLISHMENTS AND NASA'S FUTURE PLAN/PARAGRAPH 3
Should read "up to two" more centers. Also, NASA will allow CCDS affiliations with foreign entities only where the CCDS can show an advantage to U.S. industry. OCP maintains right of approval for each foreign activity (with General Counsel's concurrence).

11. PAGE 24 - SOME CENTERS ARE ATTRACTING LITTLE FINANCIAL SUPPORT FROM INDUSTRY
This title singles out a negative factor and excludes a balance of positive results. The point needs to be made that each CCDS is structured with a variety of business partners and each Center receives funding augmentation based on its specific number of projects. This limited number of projects, in itself, will limit the number of industries involved.

Now on page 22.

12. PAGE 27 - SECOND PARAGRAPH
OCP is satisfied with the CCDS's progress because self-sufficiency is not the primary goal but a fallout of the primary goal of developing products, markets, and infrastructure for U.S. industry. The CCDS's are aggressively pursuing more cost effective approaches to space flight and research, thus having the added potential to benefit the entire civil space program. The activities of the CCDS's will receive a substantial boost from the advent of systematic, sustained research and development on the Space Station. In addition, the CCDS's provide an important role for industry participation in the use of Space Station Freedom.

Now on page 22.

13. PAGE 28 - LAST PARAGRAPH
NASA contributions have increased due to redirection after 1987 to a more flight-oriented program and also due to the more appropriate utilization of the CCDS's as a provider of alternative and accelerated access to space. This is the purpose of almost all of the augmentation funding.

Now on page 23. Second paragraph
See comment 5.

14. PAGE 29- NEXT TO LAST PARAGRAPH
The main reason for dependence on OCP grants is for reasons stated in comment 13.

Now on page 23, last paragraph/top of page 24.

15. PAGE 30 - SECOND PARAGRAPH
The words "special studies" are misleading since the funding is mainly for hardware development and/or space transportation. The point needs to be made that the main reason OCP is funding access to space or alternative transportation has resulted from the reduction in Shuttle opportunities and the requirements for longer experiment time in microgravity.

Now on page 24/top of page 25.

16. PAGE 30/TOP OF PAGE 31 - CENTER's VIEW ON SELF-SUFFICIENCY/FIRST PARAGRAPH
Same as comment 12.

Now on page 25.

17. PAGE 32 - CONCLUSIONS/LAST PARAGRAPH
Goals are project oriented, not primarily towards self-sufficiency. The corrective action on CCDS performance began in FY 1989 and is continuing.

Now on page 25. Top of page 26.

18. PAGE 32 - RECOMMENDATION
Grant termination should not be a goal. The CCDS's are providing an important technology linkage between the government, academia, and industry which assures the direct transfusion of technology between NASA and the private sector and vice versa. The end point of this benefit is downstream and should be based upon national priorities that deliver space-driven commercial projects and markets.

Now on page 31.
Now on page 32.
See comment 2.
Now on page 32.
Now on page 36.

19. PAGE 40 - LAST PARAGRAPH/PAGE 41/FIRST PARAGRAPH
Specific guidance has been provided, including written criteria and verbal direction at each Board meeting. It was the original intention to obtain specific expertise within NASA to address the technical feasibility and compatibility questions; for example, Kennedy Space Center could address ground processing concerns, Johnson Space Center could address Shuttle concerns, and the Office of Space Science and Applications (OSSA) at Headquarters could respond to science questions. NASA identified those organizations that could supply that expertise. OSSA specified a representative of the Shuttle Program who could have access to their science divisions, depending on the specific discipline being reviewed. It was decided not to preclude those organizations from commenting on areas outside of their direct involvement.

20. PAGE 41 - NEXT TO LAST PARAGRAPH
OCP had asked the Commercial Programs Advisory Committee (CPAC) to identify commercial organizations to serve on the Payload Selection Board. Thus far only ALCOA has been identified. OCP will be more assertive in obtaining commercial support.

21. PAGE 46 - RECOMMENDATIONS - FIRST POINT
OCP is going to revamp the payload selection process to assure that appropriate offices will address their specific areas of expertise. This is also necessary as the process will be selecting payloads to fly on non-Shuttle carriers such as Sounding Rockets and COMET. OCP will also obtain adequate industrial and internal NASA membership.

GAO Comments

The following are GAO's comments on NASA's letter dated April 3, 1991.

1. We reviewed the executive summary and believe that it presents a reasonably balanced summary of the body of the report.

2. The report recognizes that guidance has been provided; however, it has been insufficient to prevent uncertainty and concern among some of the Selection Board members.

3. We added additional examples to those already in the report.

4. This part of the report is a factual presentation based on self-reporting by the centers. We draw no conclusions about changes in the numbers of affiliates. The primary focus is on the financial support from industry reported by the centers.

5. We revised the language in the chapter to clearly note that augmentation funding is the primary reason in the increasing level of NASA grant support for the centers.

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