

March 1992

FEDERAL RESEARCH

Small Business
Innovation Research
Shows Success but
Can Be Strengthened





United States
General Accounting Office
Washington, D.C. 20548

**Resources, Community, and
Economic Development Division**

B-243971

March 30, 1992

Congressional Committees

This report was required by the Small Business Innovation Development Act of 1982, as reauthorized in 1986. It is addressed to the committees of Congress listed at the end of this letter.

The report focuses on the aggregate commercial trends in Phase III of the Small Business Innovation Research (SBIR) Program and updates our report of January 1989 assessing Phases I and II of the program. In preparing this report, we analyzed questionnaire responses on Phase II awards during fiscal years 1984 through 1987. The report contains three matters for congressional consideration.

This work was performed under the direction of John M. Ols, Jr., former Director, Housing and Community Development Issues. Other major contributors are listed in appendix VI.

A handwritten signature in black ink, appearing to read 'J. Dexter Peach'. The signature is written in a cursive style with a large initial 'J'.

J. Dexter Peach
Assistant Comptroller General

List of Addressees

The Honorable Dale Bumpers, Chairman
The Honorable Robert W. Kasten, Jr.,
Ranking Minority Member
Committee on Small Business
United States Senate

The Honorable John J. LaFalce, Chairman
The Honorable Andy Ireland,
Ranking Minority Member
Committee on Small Business
House of Representatives

The Honorable George E. Brown, Jr., Chairman
The Honorable Robert S. Walker,
Ranking Minority Member
Committee on Science, Space, and Technology
House of Representatives

The Honorable John D. Dingell, Chairman
The Honorable Norman F. Lent,
Ranking Minority Member
Committee on Energy and Commerce
House of Representatives

Executive Summary

Purpose

As a nation competing in a global economy, the United States depends heavily on innovation through research and development (R&D). Because small business has been identified as a principal source of significant innovation, the Small Business Innovation Research (SBIR) Program was established in 1982 to strengthen the R&D role of small, innovative companies. As part of its oversight of the program, which is scheduled to expire in 1993, the Congress directed GAO to evaluate the aggregate commercial trends—primarily sales of products—in the third, or final, phase of the program.

Background

Eleven federal agencies participate in the program. Five of them—the Department of Defense (DOD), the National Aeronautics and Space Administration (NASA), the Department of Health and Human Services (HHS), the Department of Energy (DOE), and the National Science Foundation (NSF)—provide over 90 percent of SBIR funds. Each manages its own program, while the Small Business Administration (SBA) plays a central administrative role and has published policy directives and annual reports for the program.

SBIR legislation requires a three-phase process for SBIR projects. Phases I and II are intended to develop an innovative idea. Phase III generally involves the use of nonfederal funds for commercial application of a technology, or non-SBIR federal funds for government contracts for government application.

Results in Brief

Even though many SBIR projects have not yet had sufficient time to achieve their full commercial potential, the program is showing success in Phase III activity. As of July 1991, the program had generated about \$1.1 billion in Phase III sales and additional funding for technical development—two key indicators of the program's commercial trends. In addition, up to \$3 billion more is expected by the end of 1993. The majority of this activity occurred in the private sector, showing a trend toward one of the program's goals—increasing private-sector commercialization.

However, the major SBIR agencies differ in their responses to this goal, as shown by their wide variation in average sales per project, which ranged from a low of \$161,000 for NASA to a high of \$677,000 for HHS. Another difference is that the percentage of project sales to the private sector ranged from a low of 40 percent for DOD to a high of 92 percent for HHS.

Although the program is showing success in Phase III, three issues that affect Phase III activity need to be addressed: (1) the extent of DOD's commitment to the goal of increasing private-sector commercialization, (2) inconsistent practices in requiring competition for projects entering Phase III, and (3) the need to clarify the circumstances under which an agency may work on its own or continue working with the company through follow-on contracts after SBIR funding ends. Another issue, the lower Phase III sales and additional funding by companies with five or more Phase II awards, is being addressed by SBA.

Principal Findings

SBIR Firms' Sales and Funding

To obtain information on the Phase III results of SBIR, GAO surveyed all Phase II awards made in 1984 through 1987; the survey captures most projects now in Phase III. According to the survey responses for 1,457 projects, 939 active projects have achieved sales and/or additional developmental funding already or expect them by the end of 1993. Another 518 projects are no longer active for reasons such as insufficient additional funding for further technical development.

SBIR firms reported about \$1.1 billion in Phase III activity, consisting of \$471 million in sales and \$646 million in additional developmental funding, through July 1991. About 65 percent of the sales and 56 percent of the additional developmental funding occurred in the private sector. Companies foresee almost \$2 billion in sales from these SBIR projects between July 1991 and the end of 1993. They expect between \$335 million and about \$1 billion in additional funding through the end of 1993.

Varied Commercialization by Agencies

Agencies show wide variations in commercialization trends. Agency sales per project ranged from \$161,000 for NASA to \$677,000 for HHS, while the percentage of project sales to the private sector ranged from 40 percent for DOD to 92 percent for HHS. One reason for these differences is the wide variation in markets for SBIR products or processes. For example, many DOD projects are limited to specialized military applications within DOD, whereas HHS projects have access to a vigorous biomedical market in the private sector. In addition, DOD is emphasizing a closer link between its projects and its agency mission, while NASA, DOE, and NSF are taking steps to emphasize private-sector commercialization.

Issues in Phase III Activity

Four issues emerged from GAO's review of Phase III activity. The first issue involves differences between DOD and the other major SBIR agencies about the program goal of increasing private-sector commercialization. DOD is placing less emphasis on commercialization than on meeting its own R&D needs through the program; DOD's projects have also made a lower percentage of their sales to the private sector than those of the other major SBIR agencies. If DOD is to give greater emphasis to commercialization, one approach would be to select projects that involve "dual-use" technologies capable of meeting civilian as well as military needs. For example, nine DOD projects responding to the GAO survey achieved sales of \$500,000 or more to both DOD and the private sector.

A second issue involves a question about the need for further competition in awarding a Phase III contract when an SBIR project has already competed successfully in Phases I and II. DOD and NASA officials have expressed a need to clarify the contractual procedures that should be followed when entering into a follow-on, non-SBIR-funded production contract under Phase III. These officials are unsure how the competition requirements of the Competition in Contracting Act of 1984, as amended (CICA), apply to such contracts. Because the competition requirements are being applied inconsistently, GAO believes that clarifying this issue would help achieve uniformity in contract practices.

A third issue raises a question of who—the federal agency or the company that developed an SBIR technology—should perform additional work for the government after SBIR funding ends. This issue has led to serious conflict in one case, resulting in the loss of a possible multimillion-dollar contract for a company because an agency continued work on the company's project without further involving the company. No existing program guidance addresses this issue, but such guidance could help to avoid conflict between companies and federal agencies.

The fourth issue—the lower Phase III sales and additional developmental funding by companies with multiple Phase II awards—is being addressed by SBA. SBA initiated a study of the operating attributes of these firms in August 1991 and expects to complete the study in early 1992.

Matters for Congressional Consideration

To further the goal of increasing private-sector commercialization, the Congress may wish to consider whether DOD should place greater emphasis on commercialization through such means as giving preference for SBIR awards to projects that involve dual-use technologies. To eliminate

inconsistent agency practices in requiring competition for federal, non-SBIR-funded contracts after Phase II, the Congress may wish to clarify whether Phase III activity must comply with CICA's competitive procedures or whether the competition in the earlier phases of the program satisfies the CICA requirements. To avoid misunderstandings between companies and federal agencies, the Congress may wish to require the SBA Administrator to develop a policy directive for agencies that are planning to work on a company's SBIR technology after SBIR funding ends. Such a directive should clarify the circumstances under which it may be appropriate for an agency to continue working with a company through a follow-on, non-SBIR-funded contract.

Agency Comments

GAO obtained written comments from DOD, NASA, HHS, NSF, DOE, and SBA, which generally agreed with the factual information in the report. However, DOD objected to the comparison of DOD's commercialization results with those of other agencies because of major differences in agency mission that affect commercialization. GAO agrees that these differences do affect commercialization but believes that a comparison of sales achieved by agencies' projects helps in understanding the extent to which agencies' projects are able to develop federal and private-sector markets. In its matters for congressional consideration, GAO is suggesting that the Congress may wish to consider whether DOD should be doing more to enhance private-sector commercialization.

In the draft report, GAO recommended that the SBA Administrator develop a policy statement for agencies planning to work on a company's SBIR technology after SBIR funding ends. GAO believes that SBA has broad statutory authority to issue a policy directive on the general conduct of the SBIR Program. SBA does not disclaim such authority but did not concur with this recommendation because, in its view, present legislation does not specifically address SBA's authority to establish program policy over non-SBIR funding agreements entered into under Phase III. In light of this concern, the Congress may wish to consider requiring SBA to issue a policy directive for Phase III.

The agencies also suggested various technical changes that have been incorporated where appropriate.

Contents

Executive Summary		4
Chapter 1		12
Introduction	The Administration of the SBIR Program	12
	The Importance of Evaluating SBIR's Results	14
	Objectives, Scope, and Methodology	15
Chapter 2		20
Results of SBIR	Overview of the Status of Phase II SBIR Projects	20
Projects in Phase III	Actual and Expected Sales in Phase III	20
	Actual and Expected Developmental Funding in Phase III	24
	Discontinued Projects	26
	Projects Stress Innovation, but Minority Businesses Report Lower Phase III Activity	28
Chapter 3		30
Federal Agency	Results of Phase III Activity, Including Commercialization, Vary by Agency	30
Performance and	Agencies Vary in Their Emphasis on Commercialization	35
Issues in Phase III	Issues That Should Be Addressed to Strengthen Phase III Activity	41
	Conclusions	50
	Matters for Congressional Consideration	51
	Agency Comments	52
Chapter 4		54
Company Benefits,	Beneficial Effects of SBIR on Companies	54
Accomplishments,	Additional Efforts by Companies in Phase III	56
and Performance in	Comparison of Frequent Winners With Less Frequent	59
Phase III	Winners in Phase III	
	The Three Most Frequent Winners in Phase III	62
	Monitoring of Companies With Multiple Awards	67
	Conclusions	68
Appendixes	Appendix I: Comments From the Department of Defense	70
	Appendix II: Comments From the National Aeronautics and Space Administration	74
	Appendix III: Comments From the Department of Health and Human Services	80

Appendix IV: Comments From the National Science Foundation	84
Appendix V: Comments From the Small Business Administration	87
Appendix VI: Major Contributors to This Report	91

Tables

Table 2.1: Distribution of Total Sales	23
Table 3.1: SBIR Phase III Sales and Additional Developmental Funding Reported by Agency for Phase II Awards, 1984-87	32
Table 3.2: SBIR Phase III Sales to Federal Agencies, the Private Sector, and Export Markets for Phase II Awards, 1984-87	33
Table 3.3: SBIR Phase III Sources of Additional Developmental Funding for Phase II Awards, 1984-87	34
Table 4.1: Percentage of Company Growth Attributed to SBIR	55
Table 4.2: SBIR Phase III Total Sales and Additional Developmental Funding Reported Relative to Number of Phase II Awards Received, 1984-87	59

Figures

Figure 2.1: Federal and Private-sector Sales by Phase II SBIR Projects	22
Figure 2.2: Percentage of Projects That Made First Sales Between 1984 and 1991	24
Figure 2.3: Sources of Additional Developmental Funding	25
Figure 2.4: Factors Playing a Great or Moderate Role in Deciding to Discontinue Projects	27
Figure 3.1: Major SBIR Agencies' Percentage of Sales to Federal and Private Markets	31
Figure 4.1: Percentage of Projects Receiving Great or Moderate Benefits From Phase II Awards	56
Figure 4.2: Companies' Business Interactions With Other Domestic and Foreign Companies and Investors	58
Figure 4.3: Sources of Additional Developmental Funding by Award Frequency	61

Abbreviations

CICA	Competition in Contracting Act of 1984, as amended
DOC	Department of Commerce
DOD	Department of Defense
DOE	Department of Energy
DOEd	Department of Education
DOT	Department of Transportation
EPA	Environmental Protection Agency
GAO	General Accounting Office
HHS	Department of Health and Human Services
HMRL	Humbug Mountain Research Laboratory
JPL	Jet Propulsion Laboratory
LCL	Laser Centerline Localizer
LGI	Laser Glideslope Indicator
NAEC	Naval Air Engineering Center
NASA	National Aeronautics and Space Administration
NIH	National Institutes of Health
NRC	Nuclear Regulatory Commission
NSF	National Science Foundation
R&D	research and development
SBA	Small Business Administration
SBIR	Small Business Innovation Research
USDA	Department of Agriculture

Introduction

The Small Business Innovation Development Act of 1982, which authorizes the Small Business Innovation Research (SBIR) Program, emphasized the benefits of technological innovation and the ability of small businesses to transform research and development (R&D) results into new products. The act observed that, while small business is the principal source of significant innovation in the nation, the vast majority of federally funded R&D is conducted by large business, universities, and government laboratories.

In authorizing the SBIR Program, the Congress designated four major goals:

- To stimulate technological innovation.
- To use small business to meet federal R&D needs.
- To foster and encourage participation by minority and disadvantaged persons in technological innovation.
- To increase private-sector commercialization innovations derived from federal R&D.

The Administration of the SBIR Program

In addition to establishing goals, the legislation determined agency participation and funding for the program. Agencies spending more than \$100 million annually for external R&D are required to set aside not less than 1.25 percent of their total R&D funds for SBIR. At present, 11 agencies participate in the program. The five largest, accounting for well over 90 percent of all SBIR awards, include the Department of Defense (DOD), the Department of Energy (DOE), the Department of Health and Human Services (HHS), the National Aeronautics and Space Administration (NASA), and the National Science Foundation (NSF). The other six agencies, which account for the remainder of the awards, include the United States Department of Agriculture (USDA), the Department of Commerce (DOC), the Department of Education (DOEd), the Department of Transportation (DOT), the Environmental Protection Agency (EPA), and the Nuclear Regulatory Commission (NRC).

Each agency with an SBIR program is unilaterally responsible for targeting research areas and administering its own SBIR funding agreements. SBIR funding agreements include any contract, grant, or cooperative agreement entered into between a federal agency and any small business for the performance of experimental, developmental, or research work funded in whole or in part by the federal government.

The legislation requires agencies to issue a solicitation that sets the SBIR process in motion. The solicitation, a formal document issued by each agency, lists and describes the topics to be addressed by company proposals and invites companies to submit proposals for consideration.

The law required the Small Business Administration (SBA) to issue policy directives for the general conduct of the SBIR Programs within the federal government. The policy directives were to include such elements of the program as simplified, standardized, and timely SBIR solicitations; a simplified, standardized funding process; and minimization of the regulatory burden for small businesses participating in the program. The first policy directive was disseminated in November 1982. The current policy directive, issued in June 1988, provides that SBA may issue additional instructions (as additional or replacement pages for the directive) as a result of public comment or experience. Federal agencies were also required to report key data to SBA, which in turn has published annual reports on the progress of the program.

To be eligible for an SBIR award, SBA's SBIR Program policy directive states that small businesses must be

- independently owned and operated,
- other than the dominant firms in the field in which they are proposing to carry out SBIR projects,
- organized and operated for profit,
- the employer of 500 or fewer employees (including employees of subsidiaries and affiliates),
- the primary source of employment for the project's principal investigator at the time of award and during the period when the research is conducted, and
- at least 51 percent owned by U.S. citizens or lawfully admitted permanent resident aliens.

The law established a three-phase structure for the program. The first phase is designed to determine the scientific and technical merit and feasibility of a proposed idea. The second phase is designed to further develop the idea. According to SBA's 1988 directive, agencies should strive to ensure that the majority of Phase I awards be funded at \$50,000 or less and not exceed a 6-month period; agencies should also strive to ensure that the majority of Phase II awards be funded at \$500,000 or less and not exceed 2 years of work. Only about 1 in 25 original proposals for a Phase I award is eventually selected for a Phase II award.

The third phase of SBIR, which plays the central role in this report, is somewhat more flexible and difficult to define. Unlike Phases I and II, Phase III has no general limits in time or dollar amounts. In addition, it can include not only federal but private-sector funds. The law indicates that, where appropriate, the third phase should pursue commercial applications of the research or R&D and may also involve non-SBIR, government-funded production contracts with a federal agency for products or processes intended for government use.

The Importance of Evaluating SBIR's Results

Several points emphasize the importance of evaluating SBIR's results. As a nation competing in a global economy, the United States has become dedicated to innovation through R&D as a way of life. The theme of innovation as a critical factor in competitiveness is growing more evident.

In addition, the federal government and the private sector have committed huge sums of money for R&D. Based on the latest data available from NSF, which reported on R&D trends in 1990, total R&D expenditures were expected to reach \$150 billion in that year, the 15th consecutive year of expanding R&D spending. The federal government was expected to provide \$69 billion (or 46 percent) and industry \$74 billion (or 49 percent), with most of the remainder coming from universities and colleges. About \$21 billion was estimated to be spent on basic research, \$34 billion on applied research, and \$95 billion on development in 1990. Federal support for defense-related R&D programs accounted for much of the increase in the spending on R&D during the 1980s. This trend has slowed somewhat, but DOD still accounted for an estimated 62 percent of the 1990 federal R&D budget authority.

In this context, the evaluation of the SBIR Program's results is especially important for several reasons. First, the program covers a wide range of federal R&D activities and offers a unique opportunity for a "bird's eye" view of federally funded R&D. Second, the program emphasizes the applications of research, thus affording a further opportunity to examine the full process of R&D from initial concept through entry into the marketplace. Third, by itself, the program has expended more than \$2.6 billion in federal R&D and, since fiscal year 1989, has been providing more than \$400 million annually, a substantial federal outlay whose results should be reviewed.

We have issued six reports on the SBIR Program, the first only 3 years after the program began. A detailed review of the program's accomplishments

in Phase III is particularly timely because the program is scheduled to "sunset" in October 1993 and is again being considered for reauthorization. As part of congressional oversight of the SBIR Program, we have also testified before the House Small Business Committee on the findings and issues discussed in this report.¹

Objectives, Scope, and Methodology

Public Law 99-443 (dated Oct. 6, 1986) required GAO to submit two reports to the Congress. We issued the first report, Federal Research: Assessment of Small Business Innovation Research Programs (GAO/RCED-89-39), in January 1989. The report concluded that the SBIR agencies were making progress toward meeting SBIR's four goals and that the quality of SBIR research compared favorably with other federal R&D. The report also contained the views of the heads of all 11 federal agencies participating in the program; their views indicated a consistently favorable response to the value of the program. The report contained no recommendations or matters for congressional consideration.

The law mandated two objectives for the second study: an update of the previous report and an evaluation of Phase III, including a discussion of the aggregate commercial trends for products that are currently in or have completed the third phase of the program. As agreed in subsequent discussion with the offices of the congressional Committees, we limited the update of the previous report to further information on achievement of the four program goals and agency efforts to improve the program. Because the Committees considered information relating to the second objective to be a major factor in their decision about reauthorization, we have focused greater attention and resources on the evaluation of the second objective.

In responding to the first objective, we conducted a survey that sought information relating to the achievement of the four program goals by Phase II participants. This information was used to update the findings of the previous report by showing how SBIR projects in Phases II and III are responding to each of the goals. We talked with agency officials about their efforts to improve the program by enhancing commercialization and meeting agency R&D needs. At the request of the Committees, we did not obtain information updating the quality of SBIR research. The Committees consider our previous work in this area to have met their needs. In addition, we did not obtain information about the views of the heads of

¹Federal Research: Small Business Innovation Research Program Shows Success But Could Be Strengthened, Testimony before the Committee on Small Business, House of Representatives, Oct. 3, 1991 (GAO-T-RCED-92-3).

federal agencies. As stated, the previous report presented these views in detail.

To meet the second objective, we made use of the same questionnaire. Although not defined in the law, aggregate commercial trends relate to financial activity. For projects in Phase III, such financial activity primarily takes the form of sales and additional funding for further technical development. Throughout the report, we have focused on the level of total financial activity in Phase III because of its relation to aggregate commercial trends. In addition, we have focused on the distribution of this activity to the private and federal sectors because of its relation to the goals of private-sector commercialization and meeting agency R&D needs. If this activity occurs in the private sector, through additional developmental funding provided by private-sector sources or sales to private-sector customers, it can be related to the goal of commercialization.² By contrast, if it occurs in a federal agency through the agency's further developmental funding of a company's R&D or purchase of a company's product, it can be related to meeting agency R&D needs. The detailed information obtained by the survey enabled us to identify such activity in both the private and federal sectors, relate this activity to the goals of the program, and thus determine the program's aggregate commercial trends.

Although the legislation required us to evaluate Phase III, a lack of program criteria constrained the evaluation. As a consequence, we found that comparisons of the data obtained in our survey were more useful for such evaluation.

One of the main problems in evaluating Phase III is the absence of formal criteria by which to judge the results, once they are determined. Although SBIR legislation established four goals for the program, it provided no criteria for these goals. SBA's policy directive of 1988 also provides no criteria.

We discussed the problem of evaluating SBIR's Phase III results with SBA officials, who have also been reviewing Phase II winners and their accomplishments in Phase III. The SBA's Assistant Administrator, Office of Innovation, Research, and Technology, said that difficulties were

²For sales, the term "the private sector" includes domestic nonfederal and export markets. For additional developmental funding, sources of private-sector activity include all sources except non-SBIR federal funds and related SBIR award(s) received after the award. For example, these sources include the company itself, other private companies, and investors in the United States or foreign countries.

experienced in determining a suitable design and methodology for the conduct of SBA's study because no known similar study had been performed in federal R&D procurement.

Given the lack of criteria, we based our evaluation mainly on comparisons of data provided by our survey. These comparisons were a basic part of our methodology. For example, in analyzing the responses to the questionnaire, we compared agencies' project results to show how agencies respond differently to the goals of the program.

On the basis of discussions with the SBIR Program managers, we decided that the best source of information about Phase III activities would be the companies that had won Phase II awards. We sent a questionnaire for each of 2,090 Phase II awards made to 1,337 companies.³ This group consisted of all the Phase II awardees from the first 4 years—1984 through 1987—in which the agencies made Phase II awards. We chose the earliest recipients because studies by experts on technology development concluded that 5 to 9 years are needed for a company to progress from a concept to a commercial product. We did not include Phase II recipients from 1988 or later because, in most cases, they have not had sufficient time to “make or break” themselves in Phase III.⁴

Even with this early group of Phase II recipients, additional time is required for projects to mature. The earliest funded projects in our survey (those receiving Phase II awards in 1984) have had only about 7 years for development, whereas those funded in 1987 have not yet reached the minimum amount of time considered necessary for full development. About 10 percent of the projects responding to our survey had not even completed Phase II. Our findings, therefore, represent an early interpretation of the trends in Phase III.

Our survey included all of the Phase II awardees rather than only a selected sample during the 1984-87 time frame. This approach provided the most complete data that we could obtain regarding commercial trends. It also enabled us to analyze the performance of the five agencies with the largest SBIR Programs and compare them with each other.

³Because of the variety of names and addresses a company may use, we defined companies by creating an identifier that combined the company name, street address, and zip code. This procedure led to the 1,337 companies that we contacted in our survey.

⁴In addition, we did not include some companies that may have advanced directly from Phase I into Phase III, without receiving a Phase II award. A survey of thousands of Phase I awards to identify this additional Phase III activity would have been impractical and, in our view, not cost-beneficial.

For the Phase II recipients in our survey, we wanted to determine whether their SBIR projects remained active after completing Phase II. This represented the first step in identifying commercial trends. We also wanted to know the nature and the extent of any further activity. Our study focused on additional developmental funding and on actual or expected sales in Phase III as the most direct measures of commercial trends. In our survey, we defined "sales" to include all sales of product(s), process(es), service(s), or other sales to federal or private-sector customers resulting from the technology associated with the project. We defined "additional developmental funding" to include funding from federal or private-sector sources, from the companies themselves, or from other related SBIR awards used for further development of the technology associated with the phase II project.

We developed the questionnaire with assistance from the SBIR Program managers at the five agencies with the largest SBIR Programs and officials at SBA. We pre-tested it with 10 companies and made further revisions based on their suggestions. We mailed the questionnaires in January 1991 and followed up with two mailings to companies that did not initially respond. Although we surveyed 2,090 projects, 202 were eliminated because the questionnaires were undeliverable or the projects were incorrectly identified as Phase II awards. This left 1,888 projects, of which 1,457 responded, representing a 77-percent response rate. This provided the most complete data that we could obtain regarding commercial trends, forming a credible basis for evaluating the trends of the SBIR Program in Phase III.

Throughout this report, the responses to our survey are presented either as "actual" or "expected" results of company activity. The time frame for actual results extends from 1984, when agencies made the first Phase II awards, through the time when companies submitted their responses. We accepted no responses after July 1991, when we finalized the findings in the questionnaires. The time frame for expected results, based on company estimates, extends from the date a response was received (no later than the close of the survey in July 1991) through the end of 1993. Although companies responded to the survey as early as February and as late as July 1991, we are using the phrase "as of July 1991" as an easy reference to the whole set of 1,457 responses we analyzed. The date July 1991 is also used to differentiate between "actual" versus "expected" results.

To assess the performance of the SBIR Program, we used the total activity across all projects (regardless of individual project success) in our computations. For example, the reader should understand that the term "average dollars per project" (that is, sales and additional developmental funding per project) was derived by dividing the total dollars by the total number of projects responding. As reported by the 1,457 projects (some of which were discontinued), the total sales were \$470,533,109. Therefore, the average sales per project was \$322,947. Had we calculated averages by using only those projects that had sales or had received additional developmental funding, the result would have greatly overstated the averages stated in this report.

The report is organized to reflect three levels of analysis. Chapter 2 discusses the overall results of projects responding to our survey and thus summarizes the aggregate commercial trends. Chapter 3 analyzes the results in terms of the individual agencies that provided the awards, their policies regarding commercialization, and key federal issues relating to Phase III. Chapter 4 analyzes the results in terms of the companies that conducted the projects.

We conducted our audit work between August 1990 and August 1991 in accordance with generally accepted government auditing standards. We requested and received written comments on our draft of this report from SBA and the five major SBIR agencies—DOD, HHS, NASA, DOE, and NSF. The comments from each of these agencies except DOE are presented as appendixes. DOE's comments have not been included as an appendix because they were focused on technical matters; however, all of DOE's comments have been incorporated in our report. A brief discussion of the other agency comments is given at the end of chapter 3, and a more detailed response appears at the end of each agency's letter in appendixes I through V. We also discussed the report with USDA, DOC, DOEd, DOT, EPA, and NRC.

Results of SBIR Projects in Phase III

According to questionnaire responses involving 1,457 Phase II projects, 939 projects have remained active in Phase III while 518 have been discontinued. The majority of Phase III activity has occurred in the private sector, indicating that projects in general are moving toward the goal of private-sector commercialization. As of July 1991, the SBIR Program had generated about \$1.1 billion in Phase III sales and additional funding for technical development, with up to about \$3 billion more expected by the end of 1993. Minority and disadvantaged small businesses reported a substantially lower level of Phase III activity. Companies indicated that their projects are emphasizing innovation through developing new technologies rather than improving or adapting already proven technologies.

This chapter provides an overview of the status of the projects analyzed in our survey, their actual sales and additional developmental funding reported as of July 1991, and the expected results from that time through the end of 1993 for Phase III. It emphasizes the relation of this financial activity to increasing private-sector commercialization and meeting agency needs. It discusses the projects that have been discontinued, including their accomplishments and the reasons that they are no longer active. It also summarizes information relating to the program goals of stimulating innovation and fostering participation by minority and disadvantaged small businesses.

Overview of the Status of Phase II SBIR Projects

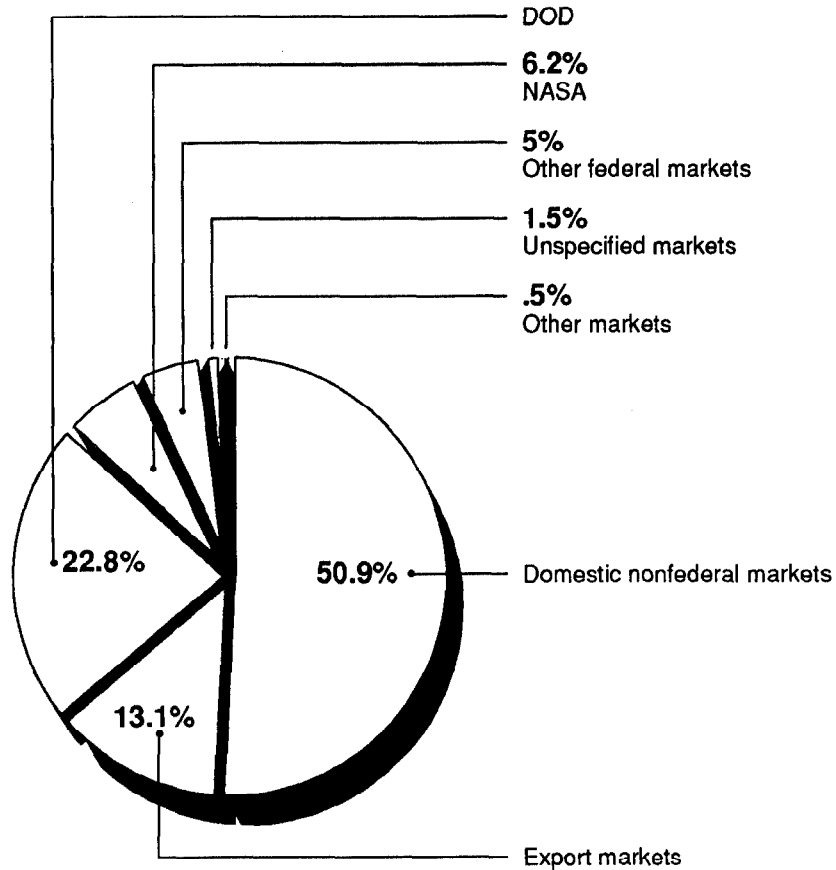
The 1,457 Phase II projects responding to our survey provided an overview of their status as of July 1991. Of the 939 projects that remain active, 700 indicated that they have achieved sales and/or additional developmental funding already; 238 have not yet achieved such results but expect them; and 1 project has remained active but did not specify whether it has achieved or expected any results. Of the 518 projects that have been discontinued, 96 achieved sales and/or additional developmental funding before they ended, while 422 were discontinued with no Phase III activity.

Actual and Expected Sales in Phase III

Our definition of sales attempted to cover all of the possible types of sales and customers that a small business might develop in Phase III. As defined in our questionnaire, sales included all sales of product(s), process(es), service(s), or other sales to federal or private-sector customers resulting from the technology associated with the specific Phase II project. A sale could also include the sale of technology or rights, which was counted as part of the total sales activity.

Figure 2.1 shows the total sales achieved by SBIR Phase II projects and the distribution of these sales to key customers as of July 1991. Overall, 515 projects (or about a third of the projects responding to our survey) reported \$471 million in actual sales through July 1991. Customers purchasing the results of SBIR activity in phase III included the private sector, export markets, the mission-related agencies (DOD and NASA), other federal agencies, and others such as state and local governments. The information on the distribution of sales to these customers can be related to both the achievement of private-sector commercialization and the meeting of agency R&D needs in Phase III. Combining private-sector with export sales, the private sector emerges as the major customer by a margin of about 2 to 1, indicating a general trend toward the goal of increasing commercialization.

Figure 2.1: Federal and Private-sector Sales by Phase II SBIR Projects



Total sales for 515 of 1,457 projects as of July 1991 were \$471 million.

Private-sector commercialization includes domestic nonfederal and export markets.

Total may not add to 100 percent due to rounding.

The distribution of sales by size provides additional information about the results of these projects. Table 2.1 summarizes the number of projects in categories of total sales ranging from less than \$100,000 to more than \$5 million.

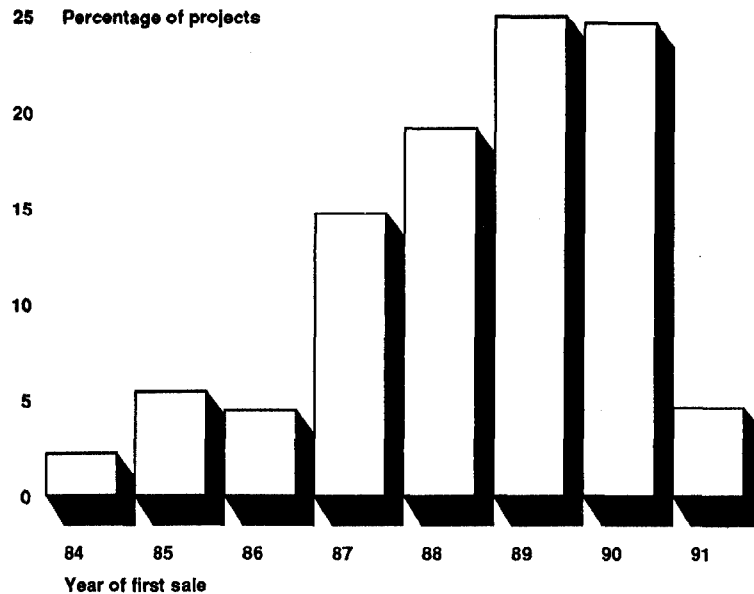
Table 2.1: Distribution of Total Sales

Number of projects	Total sales per project
175	Less than \$100,000
111	\$100,000 to \$249,999
60	\$250,000 to \$499,999
66	\$500,000 to \$999,999
81	\$1,000,000 to \$4,999,999
22	\$5,000,000 or more

As shown in table 2.1, a substantial sales activity resulted from relatively few awards. For example, the highest category of total sales (\$5 million or more) accounted for about \$232 million of the total amount. The two largest individual sales reached about \$25 million each, followed by one of \$20 million, one of \$17 million, and two of \$15 million each.

These overall sales results provide an early view of commercial trends. About half of the first sales reported for projects with sales occurred within 3 years of the time of the survey, as shown in figure 2.2, which summarizes the percentage of projects that made first sales in a given year from 1984 through 1991.

Figure 2.2: Percentage of Projects That Made First Sales Between 1984 and 1991



504 projects reported their first sale occurred between 1984 and 1991.

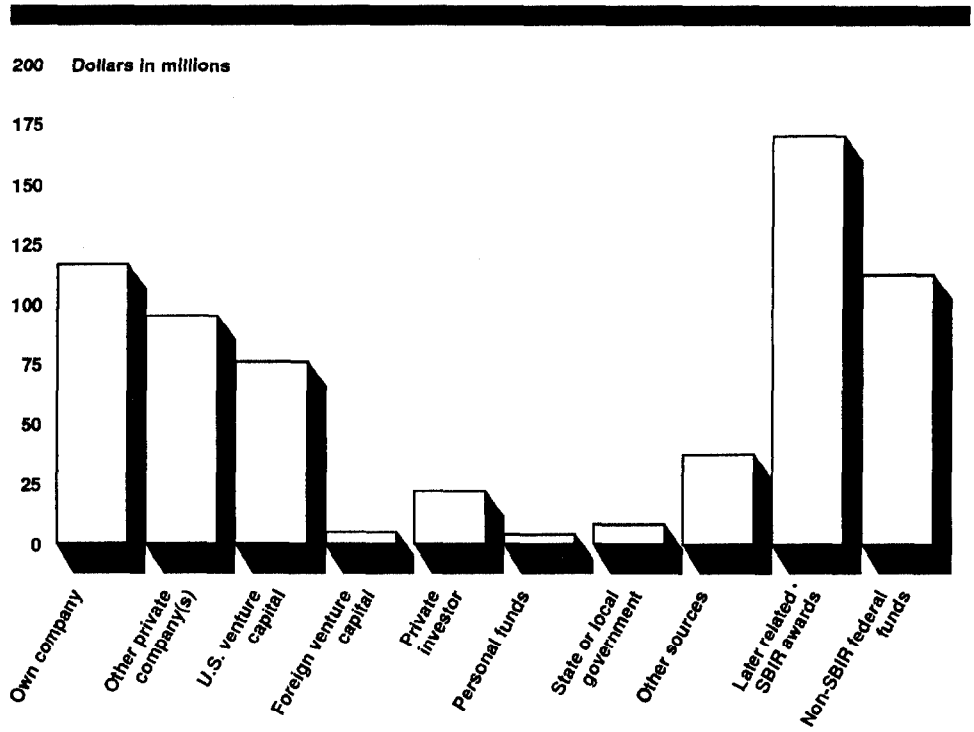
The amount of sales expected between July 1991 and the end of 1993 exceeds the amount for sales already reported. In fact, in addition to the \$471 million in actual sales, companies conducting 758 projects expect a further \$1.94 billion in sales to result from these projects by the end of 1993. One reason for this larger sales figure is that many projects that have already made sales expect to continue their sales and are being joined by other projects that expect their first sales to occur after July 1991. Only 43 projects that had already achieved sales indicated no expectation of continuing sales.

Actual and Expected Developmental Funding in Phase III

Among the 1,457 projects, about half (732) reported additional developmental funding that amounted to \$646 million as of July 1991.¹ Total additional developmental funding from private sources reached \$363.8 million, while \$282.2 million took the form of further federal funding. Figure 2.3 summarizes the sources of these funds in greater detail.

¹Our definition of additional developmental funding, as stated in the questionnaire, included funds from federal or private-sector sources, from the individual company performing the SBIR work, or from other related SBIR awards used for further development of the technology associated with the project.

Figure 2.3: Sources of Additional Developmental Funding



Sources of additional developmental funds

Total additional developmental funds for 732 of 1,457 projects as of July 1991 were \$646 million.

As a supplement to the \$646 million in additional developmental funding, projects remaining active expected a minimum of \$335 million and a maximum of \$1.07 billion in additional developmental funding between the time of the survey and the end of 1993. Combining the projects remaining active and those that have had additional developmental funding or sales yields 1,034 projects. Of these, 719 projects reported that slightly more than \$2 billion is needed to realize their full sales potential.

To determine the extent of SBIR's role in achieving Phase III sales and additional developmental funding, we asked companies to judge whether each project had played no role or a minor, moderate, or major role in sales and additional developmental funding. Overall, we found that the Phase II awards played a moderate to major role in achieving Phase III results.

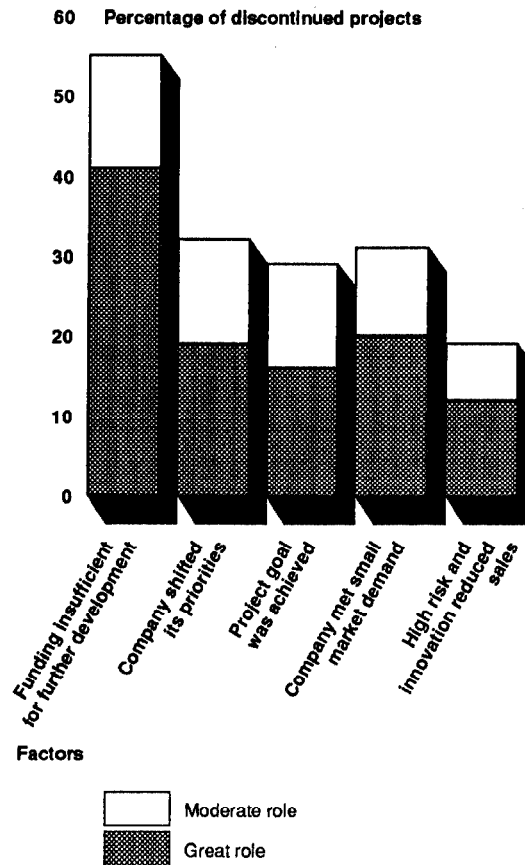
Discontinued Projects

A total of 518 projects have been discontinued, of which 96 indicated that funding and/or sales had occurred but that the project subsequently ended. For another 422 projects, funding and/or sales had not occurred and were not expected; no further work on these projects was under way.

Of the 96 projects reporting Phase III activity before being discontinued, 42 projects generated \$6.9 million of sales and 70 projects obtained \$36.9 million of additional developmental funding. Two of the projects reported sales of \$1.7 million and \$1 million; an additional 13 reported sales of at least \$100,000 but less than \$1 million.

Projects were discontinued for a wide variety of reasons. The most frequently cited reason proved to be the insufficiency of additional funding for further technical development. About 55 percent of the discontinued projects identified this factor as playing a moderate or great role in their discontinuation. Figure 2.4 shows the top five factors in this regard.

Figure 2.4: Factors Playing a Great or Moderate Role in Deciding to Discontinue Projects



Companies associated with the 518 discontinued projects were asked to rate separately 11 factors for their role in the decision to discontinue the projects. The figure shows the 5 most frequently cited factors.

Among the 518 projects that were discontinued, 35 percent were discontinued during or at the end of Phase II, 37 percent within 1 year after completing Phase II, and 20 percent more than 1 year later. Eight percent did not indicate when the company ended the project.

Projects Stress Innovation, but Minority Businesses Report Lower Phase III Activity

In addition to providing information about the goals of commercialization and meeting agency R&D needs, the survey yielded information relevant to the other two goals of the program: stimulating innovation and fostering participation by minority and disadvantaged small business enterprises.

Projects Stress Innovation

In general, projects have emphasized developing a new technology rather than improving or adapting an already proven technology. Our survey indicated that about 73 percent of the projects would probably or definitely not have been undertaken without assistance from SBIR. Among the 1,457 projects responding to our survey, 293 projects reported receiving 539 patents.² In addition, as noted earlier, about 18 percent of the discontinued projects reported that a high level of risk and innovation reduced their sales potential, and this reason was cited as playing a moderate or great role in discontinuing the project.

Companies commented on the importance of the SBIR Program as a source of innovation. For example, according to the president of Creative Optics, Inc., of Bedford, Massachusetts, the SBIR Program has permitted his company to compete on innovation, which he describes as a difficult commodity to price, rather than on price alone. He added that, without the SBIR bidding process, federal agencies would have to request and specify in detail desired results without knowing the optimum path to the results. He points out that this approach is completely unlike traditional bidding processes for the government, which are more suited to building aircraft or bridges of known size and type. Thus, according to the president of Creative Optics, Inc., the SBIR process can be described as "entrepreneurial bidding" because it allows the government to specify the desired end product in concept form while allowing the bidding companies to bid as entrepreneurs on what they think is the best way to achieve the goal.

The president of Photo-Catalytics, Inc., of Boulder, Colorado, also commented on innovation in the SBIR Program and contrasted it with "conservatism" elsewhere in the private sector. He sees the SBIR Program as essential for allowing a growing number of entrepreneurs with innovative ideas to help test, develop, and commercialize them. The private sector, he says, appears to be extremely conservative in undertaking R&D of ideas not proven commercially, even when such ideas have been successfully demonstrated in the laboratory.

²Thirty-two projects did not provide information on patents.

Minority and Disadvantaged Businesses Reported Lower Activity in Phase III

Minority and disadvantaged businesses conducting 147 projects responded to the survey, representing 10.1 percent of our response. These companies reported sales of \$20.9 million, or about 4.4 percent of the sales reported for all projects. Thus, the level of sales per project is substantially lower than the average for all projects responding to the survey.

A similar pattern holds for additional developmental funding, which amounted to \$43.4 million or 6.7 percent of the overall funding for further technical development. Sources of additional developmental funding were divided fairly equally among the private sector (\$13.7 million), related SBIR awards (\$15.4 million), and non-SBIR federal funds (\$14.3 million). No project reported any additional developmental funding from United States venture capital companies.

Regarding the status of these projects, some 96 (or 65 percent) remain active, while 2 percent have been discontinued after some Phase III activity and 33 percent ended with no Phase III activity. The reasons given for discontinuing projects followed a pattern generally similar to those cited earlier as playing a moderate or great role in discontinuing projects. Insufficient additional funding for further technical development, a company's shift of work to other priorities, and small market demand were the three leading factors cited in discontinuing projects.

Federal Agency Performance and Issues in Phase III

Although many projects were carried forward to Phase III, the sales averages for the projects varied greatly among the agencies. Projects funded by HHS and NSF reported substantially higher sales per project than those funded by DOD, DOE, and NASA. The percentage of private-sector commercialization achieved by the five major agencies' projects also varied widely—from 40 percent for DOD to 92 percent for HHS. Policies relating to commercialization also differ among agencies, with DOD placing greater emphasis on meeting agency R&D needs and several other agencies taking steps to emphasize the commercialization of their projects' R&D.

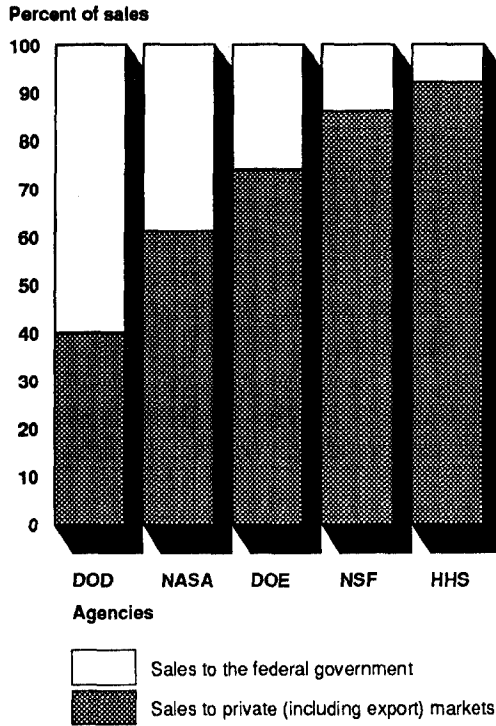
Three federal issues should be addressed to strengthen the program in Phase III. First, federal officials disagree on the emphasis they should give to private-sector commercialization. This issue primarily affects DOD because it has the largest SBIR Program and emphasizes the program goal of meeting its own R&D needs first, then increasing private-sector commercialization. Second, DOD and NASA officials told us of the use of inconsistent procurement practices in requiring competition for SBIR projects entering Phase III. Third, companies expressed concern about whether the company or the agency that funded its project should perform additional work after Phase II, if the agency wishes to continue work on the technology.

Results of Phase III Activity, Including Commercialization, Vary by Agency

This section provides an overview of the results achieved by projects for each agency. The data show the variation among agencies in their projects' sales, additional developmental funding, and response to the goals of commercialization and meeting federal agencies' R&D needs. Among the five major SBIR agencies, HHS achieved the highest level of sales per project as well as the highest percentage of private-sector activity for sales and additional developmental funding. In general, projects funded by two of the major SBIR agencies—HHS and NSF—reported substantially higher sales per project than the other major agencies. HHS' projects achieved an average of about \$677,000 and NSF's average was \$531,000 for each project responding to the survey. DOD, the largest SBIR agency, achieved a project average of about \$285,000; DOE, \$215,000; and NASA, \$161,000.

Variations in the percentage of sales to the private sector were also evident. Figure 3.1 provides an overview of the total sales for each of the major SBIR agencies' projects in terms of their distribution to the private and federal sectors.

Figure 3.1: Major SBIR Agencies' Percentage of Sales to Federal and Private Markets



Total sales for DOD were \$195.5 million; for NASA, \$36.4 million; for DOE, \$31.1 million; for NSF, \$58.9 million; and for HHS, \$127.3 million.

The above totals might exceed the sum of individual amounts allocated to various markets because some companies provided only their overall sales and did not specify the customer(s) for their projects.

These results show the difference between DOD and the other four major SBIR agencies regarding the response to private-sector commercialization and meeting agency R&D needs. DOD, in fact, is the only federal agency among the five largest ones in the program whose SBIR projects made more sales to the federal government than to the private sector (including export markets). For all other agencies, only 16 percent of their projects' total sales were to the federal government while 84 percent were to the private sector. The results of DOD's 686 projects responding to our survey substantially affected the percentage of total SBIR sales to the private sector in Phase III.

In greater detail, tables 3.1 through 3.3 show the sales and additional developmental funding activity for each of the 11 agencies. Table 3.1 shows the total reported sales and additional developmental funding for each agency's projects and the average per project. Projects funded by two of the major SBIR agencies—HHS and NSF—reported substantially higher sales per project than the other major agencies. HHS' projects achieved an average of \$677,000 and NSF's average was \$531,000 for each project responding to the survey. DOD achieved a project average of about \$285,000; DOE, \$215,000; and NASA, \$161,000. The five agencies with the larger SBIR Programs account for about 93 percent of the projects responding to our survey and exert by far the largest influence on the overall results.

Table 3.1: SBIR Phase III Sales and Additional Developmental Funding Reported by Agency for Phase II Awards, 1984-87

Agency	Number of survey responses	Sales		Additional developmental funding	
		Total	Average per project	Total	Average per project
DOD	686	\$195,482,040	\$284,959	\$217,254,552	\$ 316,698
HHS	188	127,312,135	677,192	195,645,446	1,040,667
NASA	226	36,427,005	161,181	77,982,636	345,056
DOE	145	31,142,319	214,775	66,346,376	457,561
NSF	111	58,949,296	531,075	48,566,924	437,540
USDA	30	7,292,668	243,089	21,593,350	719,778
DOC	5	818,000	163,600	1,095,000	219,000
DOEd	9	605,696	67,300	3,919,452	435,495
DOT	20	4,263,950	213,198	2,438,950	121,948
EPA	25	3,790,000	151,600	9,302,000	372,080
NRC	12	4,450,000	370,833	1,860,000	155,000

Table 3.2 indicates where the sales occurred, with customers including DOD, NASA, other federal agencies, the private sector, and export markets. As stated earlier, the results vary greatly among agencies in the percentage of private-sector commercialization for each agency's projects.

**Chapter 3
Federal Agency Performance and Issues in
Phase III**

Table 3.2: SBIR Phase III Sales to Federal Agencies, the Private Sector, and Export Markets for Phase II Awards, 1984-87

Agency	Federal agency			Private sector	Export markets	Total ^a
	DOD	NASA	Other			
DOD	\$96,132,827	\$16,539,244	\$3,571,202	\$59,150,907	\$18,573,570	\$195,482,040
HHS	949,396	150,000	8,978,250	92,935,090	22,900,803	127,312,135
NASA	4,446,588	9,004,421	734,750	14,148,895	7,777,350	36,427,005
DOE	2,054,706	238,129	5,822,001	19,227,643	3,799,840	31,142,319
NSF	3,113,750	3,136,250	1,202,950	40,107,878	5,926,468	58,949,296
USDA	0	0	31,000	5,943,668	886,000	7,292,668
DOC	0	0	0	558,000	260,000	818,000
DOEd	10,000	0	72,000	500,651	16,645	605,696
DOT	40,000	0	2,975,200	767,500	275,000	4,263,950
EPA	30,000	0	145,000	3,615,000	0	3,790,000
NRC	360,400	0	30,000	2,579,600	1,480,000	4,450,000

^aThe total may exceed the sum of the individual amounts because some companies provided only their overall sales and did not specify the customer(s) for their projects. In addition, the category called "other markets" in the survey is not presented in table 3.2. For the five major SBIR agencies, this category accounts for less than 1 percent of their total sales. For the remaining (smaller) agencies, DOC, EPA, and NRC had zero for "other market" sales; USDA had 6 percent; DOT had 5 percent; and DOEd, 1 percent.

Table 3.3 shows the sources of additional developmental funding provided by the private sector, non-SBIR federal funds, and later SBIR awards used for further development of a project. Additional developmental funding for DOD, NASA, and DOE projects came primarily from the federal government and took the form of non-SBIR federal funds or later SBIR awards. By contrast, HHS and NSF projects obtained the majority of their additional developmental funding from the private sector. The considerable amount of additional developmental funding attracted by HHS from the private sector—almost \$171 million—accounts for almost 47 percent of the total from the private sector. Overall, the private sector provided about 56 percent of additional developmental funding.

Table 3.3: SBIR Phase III Sources of Additional Developmental Funding for Phase II Awards, 1984-87

Agency	Private sector ^a	Non-SBIR federal funds	Later SBIR awards	Total
DOD	\$ 83,873,259	\$62,772,045	\$70,609,248	\$217,254,552
HHS	170,590,581	6,777,000	18,277,865	195,645,446
NASA	19,920,800	19,496,531	38,565,305	77,982,636
DOE	27,510,793	18,357,074	20,478,509	66,346,376
NSF	28,831,903	2,740,137	16,994,884	48,566,924
USDA	21,153,350	40,000	400,000	21,593,350
DOC	995,000	0	100,000	1,095,000
DOEd	1,116,210	0	2,803,242	3,919,452
DOT	410,000	1,278,950	750,000	2,438,950
EPA	7,920,000	300,000	1,082,000	9,302,000
NRC	1,480,000	280,000	100,000	1,860,000

^aThe sources for "private sector" additional developmental funding are the company itself; other private company(s); U.S. venture capital institution; foreign venture capital institution; private investor; personal funds; state or local government; college or university; and other sources.

Agencies also varied in the percentage of projects that were discontinued with no Phase III activity. HHS' 188 projects had the lowest percentage among the five major agencies; 38 projects (or 20 percent) ended without further activity after Phase II. DOD's 686 projects had the highest percentage; 238 projects (or 35 percent) were discontinued with no further activity. The percentage of projects discontinued without Phase III activity for NASA was 22 percent; for NSF, 27 percent; and for DOE, 31 percent.

Need for Caution in Judging Agency Performance

Although these results suggest some of the trends and differences among the agencies, several factors point to the need for caution in using the trends to judge agency performance. First, as noted in chapter 1, more time is required for SBIR projects to achieve maturity. Future trends may vary from current findings, leading to different results from those presented here. Second, the markets for SBIR projects vary widely from one agency to another. For example, HHS projects have access to a vigorous biomedical market, whereas many DOD projects may be limited to specialized military applications. Third, the amount of funding per project for Phases I and II varies among agencies and may lead to different sales results. Fourth, a high level of activity was concentrated in relatively few projects, a fact that exerts a substantial influence on individual agency performance. According to our survey, the five largest project sales in each of the five major SBIR agencies accounted for a substantial share of

the agencies SBIR projects' sales, ranging from 37 percent for DOD's projects to 79 percent for NSF's projects. This concentration of sales activity in relatively few projects—especially NSF's 79 percent—indicates that the use of "sales per project" as a measure of agency performance needs to be treated with caution.¹

Agencies Vary in Their Emphasis on Commercialization

Program managers at four of the five major SBIR agencies told us that they are making efforts to enhance activity in Phase III. SBIR officials in DOD are placing greater emphasis on meeting agency R&D needs. SBIR officials in NASA, DOE, and NSF are taking steps to place greater emphasis on private-sector commercialization, although NASA is also continuing to stress agency utilization of SBIR R&D. HHS' program manager told us that no particular steps were being taken, primarily because of the high level of activity already being achieved.

These variations in emphasis parallel the distribution of sales to the private sector and federal agencies. As shown earlier in figure 3.1, DOD was the only major SBIR agency whose project sales to the federal government exceeded sales to the private sector. As a matter of policy, DOD is also the only major agency that is emphasizing meeting federal R&D needs in contrast to private-sector commercialization.

DOD

Although DOD is the only one of the top five major SBIR agencies whose SBIR project sales to the federal government exceeded sales to the private sector (including export markets), DOD officials are further emphasizing the goal of meeting agency R&D needs. In particular, the program managers for the Army and Navy indicated that steps have been taken or are under way to strengthen their SBIR Programs by making them more responsive to the agency mission, which may further limit their potential for application in the private sector.

The Army SBIR Program manager discussed his efforts to strengthen the program and increase the likelihood of Army activity in Phase III. One of the most important efforts involves tightening up the review process for selecting topics and projects included in the SBIR Program, thus increasing the relevance of the SBIR Program to the Army's mission. For example,

¹As an example of a project only now achieving maturity and accounting for a large percentage of Phase III activity for an agency's projects, DOE's SBIR Program manager told us in October 1991 of a "breakthrough" by a 1985 Phase II awardee. The company has obtained \$37.3 million in additional developmental funding, consisting of equal amounts contributed by DOE and a major corporation for further development of a "clean coal" technology. This activity occurred after the close of our survey and could not be included in our analysis.

according to the program manager, the Army's Light Experimental Helicopter, a major weapons system, is generating a high "market demand." If a company proposal for Phase II work can be related to this weapons system, the program manager and an Army review board for SBIR proposals will see a greater chance of Phase III integration into the immediate needs of the Army and give the proposal higher marks.

A second effort involves a potentially greater use of cost-sharing for Phase II projects, in which SBIR funds would be combined with non-SBIR agency funds. This approach, according to the program manager, would increase the number of SBIR projects being funded and encourage greater Phase III participation by the agency because of the previous financial commitment. In addition, the Army program manager would like to require that Phase II proposals include evidence of non-SBIR funding support in the Army before the proposal is sent forward for further review.

The Navy SBIR Program manager also discussed his efforts to enhance the Navy's Phase III activity. These initiatives primarily center on the integration of the Navy's SBIR Program with the other ongoing Navy programs. However, the Navy's SBIR Program is not only designed to tap the innovative abilities of small businesses that are useful to the Navy; it also aims at providing small businesses with the opportunity to develop concepts and products that can help them grow in the commercial arena.

To illustrate the SBIR Program's integration with other Navy programs, the program manager noted several SBIR Phase II contracts in which non-SBIR funds had supplemented the contractors' efforts. He noted that the Navy's solicitation topics are generally product-specific and mission-oriented as a result of an earlier policy which gave the Navy commands responsibility for choosing the topics. But he added that the new policy of integration of the SBIR Program has allowed for broader topics in the solicitation. This new policy has provided the Navy's SBIR Program with an increase of non-SBIR funds amounting to approximately \$7 million in Phase II and more than \$25 million in Phase III from ongoing programs for fiscal year 1991.

The Navy program manager also recognized that the use of "sole-source" contracts could increase Phase III activity. He noted that on two occasions he discussed the use of such contracts with Navy personnel but indicated that such an approval has to be considered on a case-by-case basis. Approval for these two contracts is expected in fiscal year 1992.

To help enhance Phase III activity, the Air Force program manager told us that she has awarded a contract for a "Phase II-Phase III Guide." The guide will be slanted more toward "in-house" work at DOD than toward private-sector commercialization. It will also feature examples of projects that have moved successfully from Phase II into Phase III work for DOD.

NASA

The NASA program manager told us that he is taking steps to foster a greater degree of private-sector commercialization of NASA's SBIR projects. For example, in preparing NASA's 1991 SBIR solicitation, he required that at least half of its technical subtopics must have identifiable commercial potential.

The requirement was addressed to the nine NASA field centers, such as the Kennedy Space Center and the Jet Propulsion Laboratory (JPL), which submit the subtopics for the program manager's review, approval, and inclusion in the solicitation. Each center was expected to comply with the new policy. As an example, the program manager noted that JPL submitted 24 proposed subtopics; 1 of these subtopics addressed "High Performance Autonomous Guidance and Control Systems" for spacecraft. The commercial potential in this area, according to JPL, concerned the "stability, cost, and performance of commercial satellites."

The program manager also required that at least half of all Phase I NASA awards have a clear indication of a significant commercial application. He said that, although he had never made this a criterion for the program in the past, he included it as a basis for selecting projects in November 1991.

As a further example of efforts to enhance Phase III activity, the program manager published a NASA SBIR Product Catalog 1990, which presented information on products developed by SBIR contractors. The catalog featured those products that the contractors wished to exhibit at Technology 2000, a NASA-sponsored technology transfer conference held in Washington, D.C., in November 1990. The catalog will be updated as additional products of NASA's SBIR Program are identified.

DOE

To enhance private-sector commercialization, DOE has sponsored a Commercialization Assistance Project for its Phase II awardees for the past 3 years (1989-91). This three-stage project has been conducted by Dawnbreaker, a private firm from Rochester, New York, for the past 2 years. In the first stage, the companies were provided with weekly

instructions and individual advice and counsel, over a 4-month period, in the preparation of a business plan for potential sponsors. The second stage consisted of intensive assistance in putting together clear and concise visual materials describing a business opportunity that could be presented in 20 minutes to potential sponsors. In the final stage, about 25 companies made individual presentations to about 30 decision makers from large corporations and venture capital firms in an effort to interest them in either joint ventures, licensing, venture capital investments, or other teaming arrangements. One-on-one sessions between the SBIR awardees and the potential sponsors were also held. The sponsors included DuPont, General Dynamics, and Westinghouse Electric.

As a result of the 1990 project, several companies received substantial Phase III funding for their work. One company obtained more than \$500,000 to continue its project in particle accelerator technology. The DOE program manager expects this year's Commercialization Assistance Project to be even more successful because of the many improvements made this year.

All of the companies that participated in the project over the past 2 years, according to the DOE program manager, have developed skills in business plan development. He said that these skills will be very useful in pursuing other commercial opportunities, including future SBIR projects from any federal agency. He added that both the SBIR awardees and the potential sponsors felt the project was very worthwhile.

To increase the number of SBIR awards that have commercial potential, in 1986 DOE changed the proposal evaluation criterion on "anticipated benefits of the proposed research" to favor projects with potential to attract further funding for product or process development after the SBIR support expires.

Since 1988 DOE has sent its SBIR Commercialization Manual to all Phase I awardees. The manual gives comprehensive instructions and suggestions for obtaining Phase III funding. As part of this year's Commercialization Assistance Project, DOE has distributed the document "Business Planning for Scientists and Engineers" to its Phase II awardees. The document describes the process of developing a business plan, from which a clear summary of a business opportunity can be presented to potential funding sources.

NSF

As an important part of agency efforts to enhance private-sector commercialization, one NSF SBIR Program manager noted NSF's policy of placing strong emphasis on a follow-on funding commitment for potential Phase II awardees.² He said that potential awardees have to be encouraged as hard about the commercial applications as about the research.

Indicative of the emphasis on this funding commitment, NSF rates each of the projects on the quality of the support expected for it in Phase III. NSF has also developed formal guidelines and documents a company can consider when developing requests for follow-on funding commitments.

In some cases, where the project has seemed difficult to commercialize and the principal investigator has doubted that an immediate user could be found, the program manager has discussed the possible applications and encouraged the project leader to contact relevant companies. For example, one project involved sophisticated mathematics relating to slight movements of the earth's crust; the firm found that oil companies could use the mathematics in exploring for oil and received a total of \$430,000 in commitments from a combination of oil, instrument, and computer companies.

The program managers discussed more than 50 other examples of funding commitments that specified the amounts (ranging into seven figures), most with pledges contingent upon the successful completion of Phase II. In other cases, commitments led later to the larger business acquiring the small business. For example, one small business developed a special laser-related process and then obtained a \$500,000 commitment from a larger company to market it; the new partner eventually bought out the inventor.

In response to concerns about the lack of credibility regarding follow-on funding commitments, the NSF position is that the follow-on funding commitments are heavily weighted in the Phase II award process. Therefore, such commitments are carefully reviewed and evaluated. More than 90 percent of all Phase II awardees have obtained satisfactory follow-on funding commitments.

²The SBIR legislation provides that in a Phase II competition, where two or more proposals are evaluated as being of approximately equal scientific and technical merit and feasibility, special consideration shall be given to those proposals that have demonstrated third-phase, nonfederal capital commitments.

HHS

Because one component of HHS, the National Institutes of Health (NIH), has accounted for more than 90 percent of all HHS SBIR awards, we talked primarily with NIH's SBIR Program manager about the SBIR Program activities within HHS. NIH's program manager said that no specific efforts or program revisions are being made within NIH to enhance activity in Phase III. According to NIH's program manager, the agency's SBIR awardees have achieved a high level of activity in Phase III already, and additional agency efforts are not being considered at this time. The program manager noted that biomedical R&D lends itself easily to the development of products, such as new drugs, vaccines, and diagnostic tools, with commercial potential. In addition, since the companies know that there is little likelihood that NIH will award Phase III contracts, they are compelled to think in commercial terms from the start. The NIH program manager said that, in contrast to DOD, her agency places greater emphasis on private-sector commercialization. Thus, in general, the NIH SBIR Program starts with assumptions that differ greatly from those of DOD.

NIH's program manager stated that the NIH grants solicitation topics are very broad. In fact, NIH's SBIR grants program allows companies to propose whatever topics they want to pursue, subject only to the requirement that they be in line with NIH's mission.³ The program manager noted that, at the end of each topic subsection, the solicitation states that companies are free to propose any project they would like to develop. This, in fact, encourages small businesses to propose research that, in their opinion, is likely to have high commercial potential.

In selecting proposals for SBIR awards, the program manager stated that scientific and technical merit is the major criterion. NIH had used commercial potential as a factor during the first several years of the program but eliminated it because the scientists who reviewed the proposals were more adept at assessing scientific than commercial merit. At present, the reviewers provide only their opinion on commercial potential, but it does not affect the score that is assigned to the proposal.

³In commenting on the draft report, HHS noted that this is true only of its grants program, which accounts for about 85 percent of its SBIR activity. The research topics in its contracts program are more defined and more restricted in scope.

Issues That Should Be Addressed to Strengthen Phase III Activity

Several issues should be addressed to strengthen Phase III activity. Federal officials differ in their views about the emphasis to be given to private-sector commercialization. They also use inconsistent practices in requiring competition for projects entering Phase III. Disagreement or serious conflict has occurred regarding when it may be appropriate for the federal agency to enter into a Phase III award if the agency plans to perform additional work on a concept developed under previous SBIR awards.

Differing Agency Emphasis on Private-sector Commercialization

Agency officials disagree about the degree of emphasis they should place on increasing private-sector commercialization. Program managers at NSF and DOE, for example, supported the view that the success—and future—of the program depend primarily on private-sector commercialization.

NASA's program manager stated his uncertainty about the emphasis on program goals, especially private-sector commercialization, but indicated that the program seemed to be moving toward a greater role for commercialization. He told us that he was adjusting the NASA program in this direction.

However, the DOD SBIR coordinator, who coordinates the SBIR programs in DOD's agencies, stressed the need for more effective internal use of the R&D and viewed private-sector commercialization as the responsibility of the companies, not the DOD agencies. The coordinator told us that he does not believe DOD should be in the business of trying to foster commercialization through emphasis on commercial use rather than agency R&D needs.

DOD's Role in Private-sector Commercialization

Because DOD provides by far the largest amount of SBIR funds of any agency in the SBIR Program, its lower percentage in private-sector sales than the other four major SBIR agencies raises an issue about its emphasis on meeting agency R&D needs rather than private-sector commercialization. The issue divides into two questions: (1) Should DOD place greater emphasis than at present on achieving private-sector sales? (2) If so, what can DOD do to foster greater commercialization?

The first question raises a fundamental policy issue for the SBIR Program. In addressing it, several factors should be taken into consideration. First, according to our survey, about 40 percent of sales by DOD projects occurred in the private sector. Given the absence of criteria for evaluating the achievement of program goals, we cannot determine whether this 40

percent represents an adequate response to the goal of commercialization. As a ratio of total sales for DOD projects, however, it represents a substantial portion of the overall activity of DOD projects in Phase III.

Second, consideration of a policy to place greater emphasis on commercializing DOD projects should take into account the ability to evaluate private-sector potential. As noted earlier in this chapter, the most commercially "successful" agency, HHS, has discontinued its earlier policy of analyzing proposals for commercial potential, in part because its reviewers were better able to evaluate technical merit than commercial promise. An emphasis on greater commercialization for DOD projects would mean that reviewers of proposals must evaluate not only the anticipated benefits of the R&D to DOD and technical merit, as required at present, but private-sector potential as well.

Third, such a policy to emphasize commercialization should take into account the strongly stated position of DOD's SBIR officials that the SBIR Program must first meet the R&D needs of DOD and its basic mission of national defense. In this respect, private-sector commercialization should complement the primary agency mission.

If greater emphasis is to be given to private-sector commercialization, the question of what more DOD can do should be addressed. One approach is to examine those DOD projects that demonstrated a "dual-use" potential, that is, they achieved substantial sales to both DOD and to the private sector. In this regard, nine DOD projects in our survey showed total sales of \$500,000 or more to both DOD and the private sector. We talked with senior company officials about two of these nine projects.

The chairman and chief executive officer, II-VI Incorporated, in Saxonburg, Pennsylvania, discussed with us the dual-use potential of his company's project, which achieved \$15 million in sales to DOD and the private sector. He attributed the project's flexibility to its "process" orientation and its role as a generic technology. According to the chairman, the technology involves an improvement in manufacturing processes for producing optical coatings used with high-energy lasers. Such lasers eat away at flaws in the coatings of lenses and mirrors, reducing the quality and reliability of laser systems. As a result of the Phase II award sponsored by the Navy, II-VI Incorporated was able to characterize and measure these defects, build an entirely new manufacturing facility with \$1.25 million of its own money, and institute process controls minimizing such defects.

The improvements in the manufacturing process and the major role of lasers in high technology gave the project a great deal of flexibility for meeting both military and civilian needs. Of the \$15 million in total sales, 14 percent went to the federal government and 86 percent to the private sector. Of the \$13 million in nonfederal sales, about \$7 million went to the private sector and \$6 million to export sales.

The chairman told us that additional opportunities exist for developing dual-use technologies. He also noted that DOD's solicitation for SBIR proposals includes a requirement for companies to identify potential commercial spin-offs. According to the chairman, if DOD wants to increase the role of such dual-use technologies, it needs to make clear in the solicitation that commercial potential will be given somewhat greater weight than at present.

As another example of dual-use technology, a project conducted by Integrated Systems of Santa Clara, California, achieved about \$10 million in sales. The project involved development of software for a robot to load munitions. Despite the project's narrow focus, the core technology possessed a great deal of flexibility in its applications. The vice president of the company told us that the generic technology was equally adaptable to robots and automobiles; the controls needed to enable a robot to load munitions and a car to respond to road conditions have important features in common. The success of the DOD project led to spin-offs in the automobile industry and about \$5 million in sales to this sector.

In general, given the disagreements among agencies about the need for emphasis on private-sector commercialization, clarification of this issue would be helpful. Such a clarification would primarily affect DOD's SBIR Program. Several factors—DOD projects achieving 40 percent of their sales in the private sector, the difficulty of evaluating commercial potential, and the strongly stated views of DOD SBIR officials about the goal of meeting agency R&D needs—should be taken into account if further consideration is given to increasing the emphasis on commercialization. A greater emphasis on dual-use technologies might provide one means of meeting agency R&D needs and fostering private-sector commercialization as well.

Inconsistent Practices in Requiring Competition

One of the features of the SBIR Program, as identified in the legislation establishing the program, is the streamlined solicitation procedures for Phases I and II. Companies submit a brief proposal (of no more than 25 pages), which agencies evaluate in competition with other SBIR proposals.

Those proposals selected for Phase I and II awards receive SBIR funding without further competition. This process, however, tends to break down in Phase III because of inconsistent practices in requiring competition.

DOD and NASA officials have expressed a need to clarify the contractual procedures that should be followed when entering into a follow-on non-SBIR-funded production contract under Phase III. Specifically, these officials are unsure how the competition requirements of the Competition in Contracting Act of 1984, as amended (CICA), apply to such contracts.

CICA requires that executive agencies conducting a procurement for goods and services must obtain “full and open competition” and use the “competitive procedures”—or combination of competitive procedures—that are best suited under the circumstances of the procurement. The term “full and open competition” means that all responsible sources are permitted to submit sealed bids or competitive proposals on the procurement. “Competitive procedures” are defined under CICA to mean procedures under which an executive agency enters into a contract pursuant to full and open competition. Under CICA, “competitive procedures” include

. . . a competitive selection of research proposals resulting from a general solicitation and peer review or scientific review (as appropriate) solicited pursuant to [the SBIR program]. [41 U.S.C. § 259(b)(5).]

However, CICA also provides seven general exceptions to the requirement of full and open competition and use of competitive procedures. These include procurement where the property or services needed by the executive agency are available from only one source and no other type of property or service will satisfy the agency’s needs or where a statute expressly authorizes or requires that the procurement be made from a specified source. In most circumstances, a contracting officer must justify the use of a noncompetitive procedure in writing and certify the accuracy and completeness of the justification. In addition, the justification must

generally be approved at successively higher levels, depending on the contract amount.⁴

There is no question that the evaluation of research proposals under Phases I and II is a competitive procedure that meets the requirements of CICA. Phase III, however, is very different from the earlier phases. The focus of Phase III is on the commercial application of the research or R&D conducted in the earlier phases. Funding for the product and processes being purchased for use by the government is through non-SBIR sources. Thus, it is unclear how CICA applies to Phase III.

As a result, differing interpretations of the applicable law have emerged. One view is that since Phase III, unlike Phases I and II, is a procurement for products intended for government use and funded outside the SBIR Program, the competition requirements of CICA must apply. Under this interpretation, competition is required unless the proposed Phase III award fits within one of CICA's recognized exceptions to the competition requirements. The other view is that Phase III is an integral part of the SBIR Program and that sufficient competition has occurred in the previous phases to satisfy CICA competition requirements.

Because of this uncertainty, federal agencies have not developed a uniform approach to contracting under Phase III. Some contracting officers require full and open competition in all cases; others permit a sole-source award, but only if it can be justified; still others enter into Phase III contracts without requiring competition or justification. According to some program managers and contracting officers, the current uncertainties about the relationship between Phase III and CICA have resulted in a tendency by some contracting officers to remain within Phase II instead of moving forward to Phase III. In other words, contracting officers are modifying or extending Phase II or ending the SBIR project at Phase II instead of attempting to contract under Phase III.

⁴Under CICA the justification and approval requirements are not required

(A) when a statute expressly requires that the procurement be made from a specified source;

(B) when the agency's need is for a brand-name commercial item for authorized resale;

(C) in the case of a procurement conducted under subsection (c)(7) (where the head of an agency determines that it is in the public interest to conduct a noncompetitive procurement and notifies Congress); or

(D) in the case of a procurement conducted under the Wagner-O'Day Act (41 U.S.C. §§ 46 et seq.) or section § 637(a) of Title 15. (§ 8(a) of the Small Business Act).

41 U.S.C. § 253(f)(2).

Some of the program managers and contracting officers support an amendment to CICA that would exempt Phase III awards from the justification and approval requirements that CICA provides for procurements conducted under section 637(a) of title 15. Others favor the view that Phase III is an integral part of the SBIR Program and that sufficient competition has occurred in the earlier phases to satisfy CICA requirements.

Since the SBA Administrator issues policy directives on the general conduct of the SBIR Program, we requested and received SBA's views on this matter.⁵ In SBA's view, a Phase III award may be made without competition. SBA states that the SBIR Program is based upon the assumption that the same SBIR firm would advance through Phase I to Phase II and through Phase III. SBA states:

Congress would not have associated the commercialization of the products or processes developed in Phases I and II of the SBIR Program unless Congress intended there to be a continuation by the same small business in the production stage. In other words, if Congress had intended there to be open competition among small businesses in what is now Phase III, it could have accomplished that by not having a Phase III.

SBA offers two rationales for permitting Phase III awards without competition. First, SBA contends that competition has already occurred in Phases I and II of the program that would satisfy CICA. SBA states that approximately 22,000 proposals are submitted annually under Phase I; only about 2,000 SBIR Phase I awards are made. Of these, only about 40 to 45 percent receive Phase II awards. Second, SBA states that an argument could be made that a sole-source SBIR Phase III award is exempt from the competition requirements of CICA as a procurement otherwise authorized by law. According to SBA, the SBIR legislation can be read to authorize noncompetitive SBIR Phase III awards.

Although SBA is comfortable with its interpretation, it acknowledges that the possibility exists "that applicable law could be read otherwise." Therefore, SBA believes that a clear, unequivocal amendment to the SBIR legislation and/or CICA would be beneficial.

In general, federal officials support the view that the competition requirements of CICA should not apply to Phase III, in that these

⁵Letter from Martin D. Teckler, SBA's Acting General Counsel, to Martin E. Sloane, GAO Assistant General Counsel (June 10, 1991).

requirements have already been met in the earlier phases. However, most agree that the law is not clear on this point and suggest that a clarification of the law would be helpful. We agree that a clarification would be beneficial to achieve uniformity in contract practices.

Clarification of When a Phase III Award May Be Appropriate

Although many companies indicated important benefits obtained from participating in SBIR, a few companies told us about difficulties that they encountered. One of these difficulties that related directly to our review involved the issue of when it may be appropriate for an agency to enter into a Phase III award if it decides to continue working on a concept developed under previous SBIR awards. This question has arisen in at least two cases and has led to serious disagreement between the company and the agency in one of them. In this case, the company expects to lose a contract for about \$10 million because a Navy laboratory has continued to work on its own with the company's SBIR-developed technology after the end of Phase II funding. In addition, senior officials at several other companies, including three companies with numerous SBIR awards, told us that they had encountered competition with federal laboratories in their SBIR-related activities.

Humbug Mountain Research Laboratory Versus the United States Navy

The issue has led to serious disagreement in at least one case concerning Humbug Mountain Research Laboratory (HMRL) in Duarte, California. HMRL received a Phase II award from the Naval Air Engineering Center (NAEC) in Lakehurst, New Jersey, for the development of a new landing system aboard aircraft carriers. The Laser Centerline Localizer (LCL) uses a series of low-power but highly visible laser beams to guide the approach of aircraft. In addition, HMRL invented a Laser Glideslope Indicator (LGI) for helping pilots to descend safely; the LGI received a Phase I award from NAEC. Both technologies have become the focus of a controversy between HMRL and the Navy about who should perform additional work in Phase III.

The Navy has taken several steps to prove the value of these technologies. The Naval Air Test Center, which is the testing component for the Naval Air Command under which the work at NAEC was done, subjected both technologies to formal competition in a "fly-off" against other landing systems. The Navy identified the LCL and LGI as the "systems of choice" in announcing the results of the competition. The Navy technical manager for the HMRL work told us that the Navy intends to make full use of the systems on each of its 12 aircraft carriers and will also install them on a 13th carrier slated for construction.

As a result of its accomplishments in Phases I and II, HMRL fully expected to continue working with the Navy under a Phase III award. However, HMRL learned in early 1991 that the Navy had decided to develop the systems further on its own, using NAEC facilities rather than contractual support from HMRL. Subsequently, HMRL protested to the Navy that its decision runs counter to the intent of the Congress in establishing the SBIR Program. HMRL believes that the program was designed to foster the growth of innovative small businesses, not to provide a mechanism for the government to take over the best ideas from small businesses.

In response to letters from Senator Slade Gorton, the Assistant Secretary of the Navy for Research, Development, and Acquisition discussed the Navy decision in a letter dated June 4, 1991. The Assistant Secretary stated that HMRL's desire to install a prototype LCL system on an aircraft carrier appears well intentioned and merits serious consideration. He has requested a review of the feasibility of this proposal. Further, the Assistant Secretary provided his general views on the SBIR Program. He stated that, if an SBIR contract leads to a concept which the Navy wants to pursue, he would expect the Navy generally to involve the contractor in any further development or production efforts when it is practical and legally permissible to do so. He indicated that he has also asked for a review of the implications of NAEC's decision on the Navy's relation with small business.

In a meeting with HMRL in July 1991, HMRL's senior officials told us that NAEC was making a nominal effort to respond to the Assistant Secretary's statement of policy. Discussions between HMRL and NAEC were being resumed, but HMRL officials are strongly convinced that their future role in developing the technology for NAEC will be kept to a minimum. They do not believe that NAEC intends to carry out the Assistant Secretary's policy to any significant extent.⁶

As a result of the continuing difficulties, HMRL has released 7 of its 13 employees. In addition, company officials expect to lose a potential Phase III contract that they estimate at about \$10 million, unless they are able to play a significant role in outfitting the Navy's carriers with the LCL and the LGI. As an alternative, they are exploring other market possibilities, including the British Navy.

⁶In commenting on the draft report, DOD stated that the Navy has addressed this issue in testimony provided to the House Small Business Committee on November 26, 1991. According to the testimony presented by NAEC's commanding officer, HMRL's concerns must be resolved as early as possible in order to preserve the Navy's ability to pursue further development and eventual acquisition while balancing program requirements, the requirements of CICA, and fairness to HMRL.

As one further aspect of the confusion surrounding Phase III in this case, the Navy's technical manager for the project told us that, although he had managed about a dozen SBIR projects in Phase II, he had never heard of any references to Phase III. The projects had achieved the goals set for them by the Navy, and there had been no discussion of further activity. In 6 years of experience with SBIR projects, the technical manager had concluded that once the project reached the end of Phase II, it was on its own. The HMRL case had been the first time in his experience that further activity became a possibility.

A second company, which asked to remain unidentified, told us of a similar situation. In this case, involving another DOD laboratory, the SBIR Phase II winner believed its project was well on the way to developing a reliable, cost-effective technology. As a result, it expected a further role for itself in Phase III but found that the DOD agency assumed full responsibility for the work instead. The company's principal investigator for this project subsequently followed DOD's efforts to develop the technology. He said that DOD continued with the project for about 5 years and finally cancelled it because the design had become too expensive. He believed that his company could have proceeded to a demonstration of the technology within 2 years of the end of Phase II and could have produced the item at a lower unit cost than the DOD design.

Commenting on this concern, the Director of another Phase II winning company summarized his conclusions in a letter to us. He suspects that the government is using its SBIR funds to get innovative ideas from his company, and having extracted promising ideas, the government proceeds to develop these ideas at one of its own laboratories. He stated that the government's internal development of a technology initially proposed by a small business makes the small business feel that it is competing directly with the government for the technology development dollars. He further stated that such activities can frustrate a small business and will eventually destroy the spirit of cooperation between small businesses and the government. He added that the development of a technology at a government laboratory where the technology was not originally conceived may result in an inferior product. This can occur, according to the company president, when the small business individuals whose scientific understanding and ingenuity initially produced the concept are not permitted to develop and test the concept.

Senior officials in four other companies told us that, on the basis of their extensive interactions with federal agencies and laboratories, they felt a

pervasive sense of competition with federal laboratories. One of these officials, from a company that has won numerous SBIR awards, told us that he could cite some instances of laboratory support in Phase III, but he added that more often the federal laboratories are competing with his company.

In general, this issue raises a basic question about what a company can expect after it conducts R&D for federal agencies in Phases I and II. The uncertainties surrounding this issue have not been resolved, and further controversy remains a possibility. No policy statement, including SBA's 1988 policy directive, addresses this issue, but a general policy statement could help to clarify the circumstances under which it may be appropriate for an agency to continue working with a company through a follow-on, non-SBIR-funded contract. As the agency with responsibility for issuing policy directives for the general conduct of the SBIR Program, including Phase III, SBA could play a major role by including a general policy statement for dealing with this issue in its directive.

Conclusions

The sales averages for SBIR projects varied greatly among the agencies. HHS and NSF projects reported substantially higher sales per project than any of the other agencies, but several factors, such as the concentration of activity in a relatively few projects, point to the need for caution in judging agency performance. The percentage of private-sector commercialization also varies among the agencies, ranging from about 40 percent of DOD's project sales to 92 percent of HHS' project sales. SBIR Program managers have undertaken efforts to encourage Phase III activity. DOD is emphasizing the goal of meeting agency R&D needs, then increasing private-sector commercialization; NASA, DOE, and NSF are taking steps to emphasize private-sector commercialization, although NASA is continuing to stress agency utilization of SBIR R&D.

Three issues need to be addressed to strengthen Phase III activity. These issues include the extent of DOD's commitment to the goal of increasing private-sector commercialization, inconsistent practices in requiring competition for projects entering Phase III, and uncertainty and conflict concerning when it may be appropriate to enter into a Phase III award if the agency plans to perform additional work on an idea developed under previous SBIR awards.

Regarding the first issue, DOD's percentage of private-sector sales, which is lower than that of the other four major SBIR agencies, raises the question of

whether DOD should be placing greater emphasis on private-sector commercialization. In addressing this issue, several factors should be taken into consideration, including DOD's achievement of 40 percent of its sales in the private sector, the difficulty of evaluating private-sector potential for proposed projects, and DOD's strongly stated position that it must first meet the needs of DOD and its basic mission of national defense. If greater emphasis is to be given to private-sector commercialization, one approach would be to give preference to dual-use technologies capable of meeting both military and civilian needs.

Regarding the second issue, federal officials support the view that the competition requirements of CICA should not apply to Phase III, in that these requirements have already been met in the prior phases. However, most agree that the law is not clear on this point and suggest that a clarification of the law would be helpful. We agree that a clarification would be beneficial to achieve uniformity in contract practices.

Regarding the third issue, this problem raises a basic concern about what a company can expect after it conducts R&D for federal agencies in Phases I and II. The uncertainties surrounding this issue have not been resolved, and further controversy remains a possibility. As the agency with responsibility for issuing policy directives for the general conduct of the SBIR Program, including Phase III, SBA could play a major role by including a general policy statement for dealing with this issue in its directive.

Matters for Congressional Consideration

To further the goal of increasing private-sector commercialization, the Congress may wish to consider whether DOD should place greater emphasis on commercialization through such means as identifying and selecting dual-use technologies for SBIR awards.

To eliminate inconsistent agency practices in requiring competition for federal, non-SBIR-funded follow-on contracts, the Congress may wish to consider clarifying whether Phase III activity must comply with CICA's competitive procedures or whether the competition in the earlier phases of the program satisfies the CICA requirements.

To avoid misunderstandings between companies and federal agencies, the Congress may wish to consider requiring the SBA Administrator to issue a policy directive for agencies that are planning to work on a company's SBIR technology after the end of SBIR funding. Such a directive would clarify the circumstances under which it may be appropriate for an agency to

continue working with a company through a follow-on, non-SBIR-funded contract.

Agency Comments

In our draft report, we recommended that the SBA Administrator develop a policy statement for agencies planning to work on a company's SBIR technology after the end of SBIR funding. SBA did not concur with this recommendation because, in its view, present legislation (P.L. 97-219) does not address SBA's authority in establishing program policy over non-SBIR funding agreements.

SBIR legislation, however, requires SBA to issue policy directives for the general conduct of the SBIR Program within the federal government. We believe that SBA, pursuant to this broad statutory mandate, has authority to issue a policy directive concerning Phase III activity. SBA does not disclaim such authority. Nonetheless, the agency is concerned that the statute does not specifically address its authority to establish program policy over non-SBIR funding agreements entered into under Phase III. In light of this concern, we are now suggesting that the Congress specifically require SBA to issue a policy directive for Phase III.

SBA also stated that non-SBIR funding agreements should be subject to the procurement regulations of the participating agencies. While we agree with SBA in this matter, we nevertheless believe that an SBA policy directive would be helpful in avoiding further misunderstandings between agencies and companies regarding this issue.

HHS and NASA concurred with the recommendation that a policy statement is needed for agencies working on a company's SBIR technology after the end of SBIR funding. NASA also concurred with the matter for consideration concerning contractual procedures in Phase III and supported the view that Phase III contracts should normally require no further competition. Other agencies did not comment on the proposed recommendation or the matters for congressional consideration.

DOD questioned our comparison of commercialization achieved by DOD's SBIR projects and those of other federal agencies. DOD stated that the contrast in commercialization results is so striking because the comparison is inappropriate. According to DOD, the difference between mission-oriented agencies such as DOD, NASA, and DOE and non-mission-oriented agencies such as HHS and NSF makes the comparison

**Table 4.1: Percentage of Company
Growth Attributed to SBIR**

Number of projects	Percentage of growth
269	More than 75 percent
209	51 to 75 percent
359	25 to 50 percent
569	Less than 25 percent

The table shows that, for about 34 percent of the projects, the companies conducting them attributed more than half of their growth to SBIR.

Companies also reported that their SBIR projects contributed a wide variety of specific benefits. For example, companies indicated that they gained either a moderate or great benefit from an increase in staff skills from about 74 percent of their projects. Figure 4.1 shows the percentage of projects receiving great or moderate benefits from their Phase II awards.

Company Benefits, Accomplishments, and Performance in Phase III

The results of Phase III included a variety of benefits and accomplishments reported by SBIR companies. In general, companies endorsed the benefits of the SBIR Program. A majority of them cited moderate or great benefits, such as increases in staff skills, retention or hiring of valuable personnel, and increases in company credibility and financial stability. In addition, many companies undertook further efforts to stimulate Phase III activity, including interactions with other companies or investors in such areas as licensing or joint venture agreements.

One concern that relates to the aggregate commercial trends of Phase III is whether frequent winners of SBIR awards have demonstrated a commitment to Phase III activity. To address this issue, we compared frequent winners—those receiving five or more Phase II awards—with those receiving one to four awards. In general, the average sales per project in Phase III for the 45 companies with five or more awards is lower than that of companies with one to four awards. In addition, frequent winners received substantially less additional developmental funding from the private sector than nonfrequent winners—an average of about \$136,000 per project compared with about \$291,000 per project, respectively. A fairly broad spectrum of performance, however, exists among frequent winners; the range of total sales, for example, extends from no sales to \$15 million.

Frequent winners have received a large amount of money from the SBIR Program. For fiscal years 1983 through 1990, five companies have received almost \$100 million dollars. We are concerned that the somewhat lower performance of frequent winners diminishes the overall achievements of the program in Phase III while at the same time limiting participation by other companies. In response to our concerns, SBA initiated a study of the operating attributes of frequent winners in August 1991; it expects to complete this study in early 1992.

Beneficial Effects of SBIR on Companies

Involvement in the SBIR Program contributed substantially to companies' growth. Table 4.1 indicates the percentage of growth that companies attribute to the SBIR Program since receiving their first SBIR award. The table is based on the total number of individual projects in each growth category, as reported by the 1,406 projects that provided information on their company's growth.

whether DOD should be placing greater emphasis on private-sector commercialization. In addressing this issue, several factors should be taken into consideration, including DOD's achievement of 40 percent of its sales in the private sector, the difficulty of evaluating private-sector potential for proposed projects, and DOD's strongly stated position that it must first meet the needs of DOD and its basic mission of national defense. If greater emphasis is to be given to private-sector commercialization, one approach would be to give preference to dual-use technologies capable of meeting both military and civilian needs.

Regarding the second issue, federal officials support the view that the competition requirements of CICA should not apply to Phase III, in that these requirements have already been met in the prior phases. However, most agree that the law is not clear on this point and suggest that a clarification of the law would be helpful. We agree that a clarification would be beneficial to achieve uniformity in contract practices.

Regarding the third issue, this problem raises a basic concern about what a company can expect after it conducts R&D for federal agencies in Phases I and II. The uncertainties surrounding this issue have not been resolved, and further controversy remains a possibility. As the agency with responsibility for issuing policy directives for the general conduct of the SBIR Program, including Phase III, SBA could play a major role by including a general policy statement for dealing with this issue in its directive.

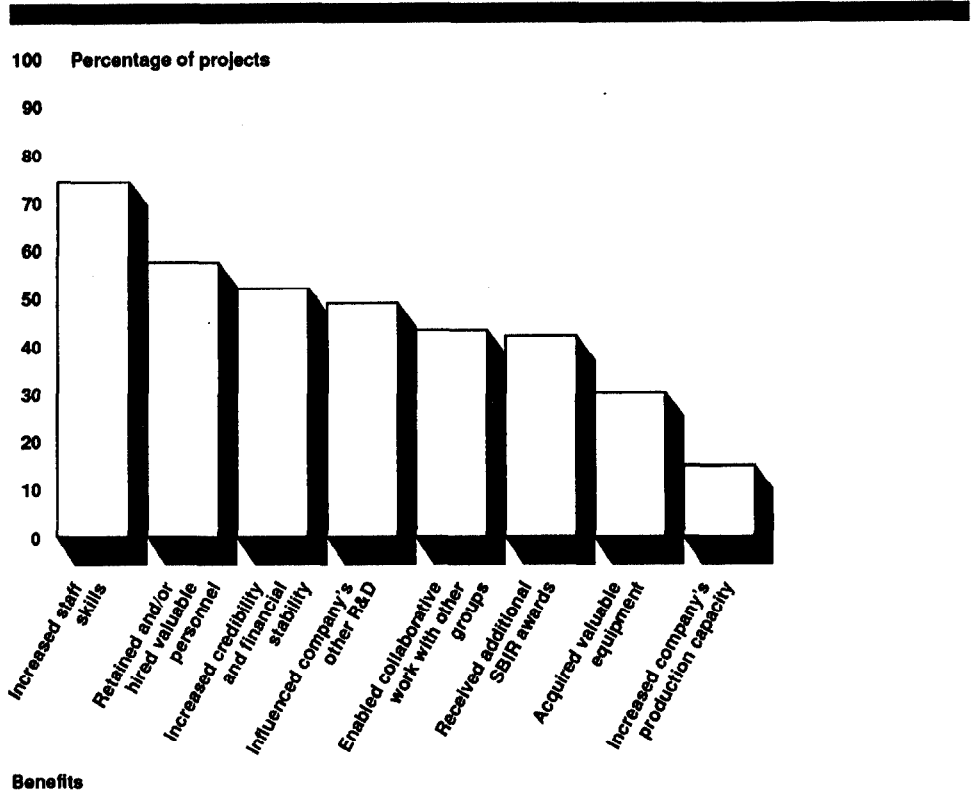
Matters for Congressional Consideration

To further the goal of increasing private-sector commercialization, the Congress may wish to consider whether DOD should place greater emphasis on commercialization through such means as identifying and selecting dual-use technologies for SBIR awards.

To eliminate inconsistent agency practices in requiring competition for federal, non-SBIR-funded follow-on contracts, the Congress may wish to consider clarifying whether Phase III activity must comply with CICA's competitive procedures or whether the competition in the earlier phases of the program satisfies the CICA requirements.

To avoid misunderstandings between companies and federal agencies, the Congress may wish to consider requiring the SBA Administrator to issue a policy directive for agencies that are planning to work on a company's SBIR technology after the end of SBIR funding. Such a directive would clarify the circumstances under which it may be appropriate for an agency to

Figure 4.1: Percentage of Projects Receiving Great or Moderate Benefits From Phase II Awards



Companies associated with the 1,457 Phase II awards were asked to rate separately 9 benefits gained from the technology associated with these projects. "Other benefits," marked for only about 2 percent of the projects, is not shown.

Among additional benefits resulting from the specific Phase II project, companies reported that 20 projects had resulted in their making an initial public stock offering. Ninety projects reported that they established spin-off companies. Of these, 86 projects reported establishing 102 spin-off companies. The remaining four projects did not specify the number of spin-off companies established.

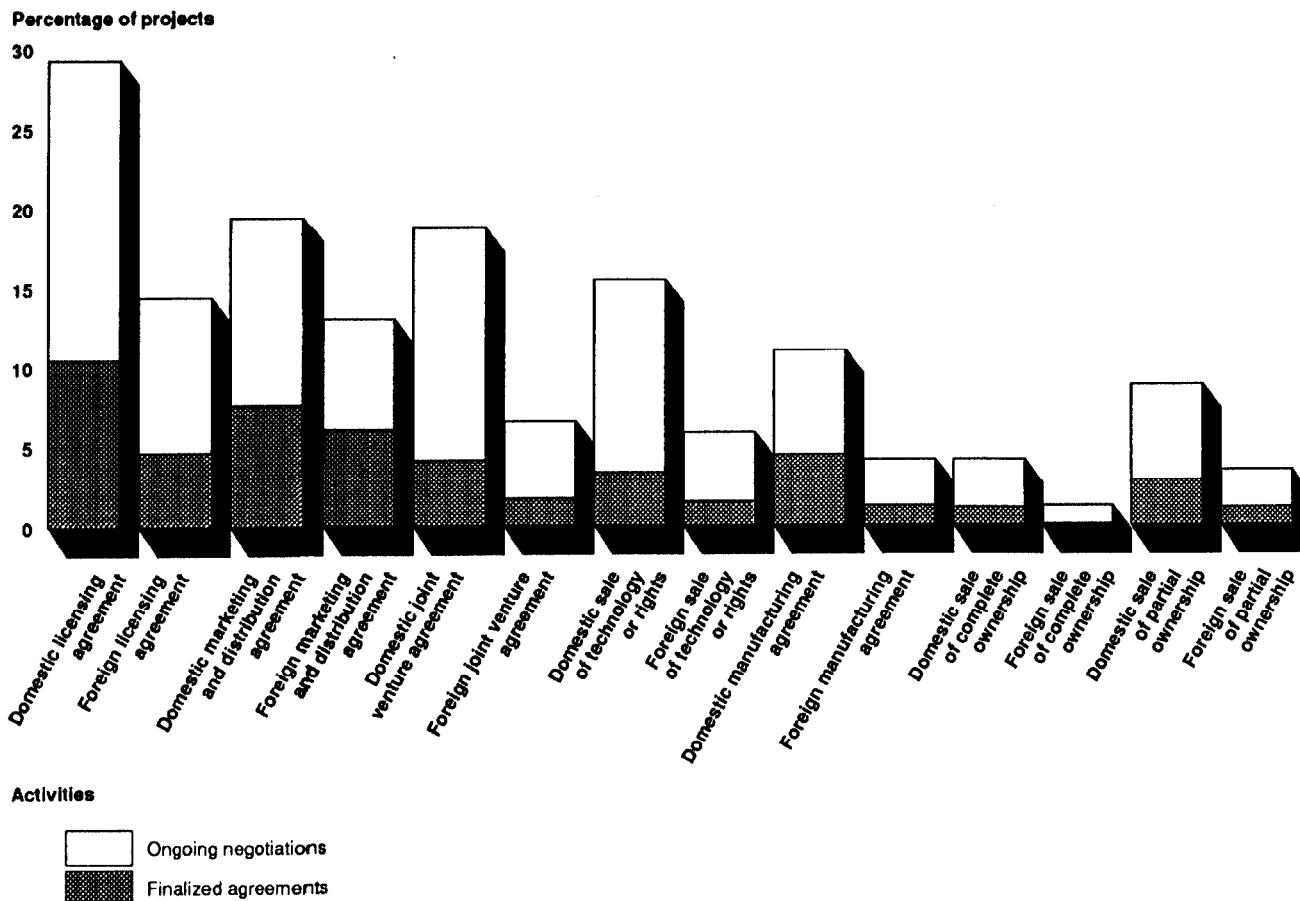
Additional Efforts by Companies in Phase III

Companies have undertaken additional efforts "behind the scenes" to help bring about the favorable results that they reported. These efforts include negotiations with other companies as well as marketing activities on behalf of the projects.

of their projects' commercialization results both inaccurate and misleading.

While we recognize that the agencies vary widely in their missions and that these differences affect commercialization, we believe that a comparison of commercial results achieved by agencies' projects remains valid. Such a comparison helps in understanding the extent to which each agency's projects are able to develop markets both in the federal government and the private sector. The difference between DOD and other agencies in their emphasis on private-sector commercialization and in the percentage of private-sector sales achieved by their projects is an issue for the Congress to consider. Because the SBIR Program lacks criteria by which to judge these differences, we are suggesting that the Congress may wish to consider whether DOD should be doing more to enhance private-sector commercialization. Our detailed responses to each of DOD's other comments on our draft report are provided at the end of appendix I.

Figure 4.2: Companies' Business Interactions with Other Domestic and Foreign Companies and Investors



Percentages are based on 1,034 projects which obtained or expected additional developmental funding and/or sales. Of these, 644 projects reported interactions with U.S. or foreign companies or investors.

Not shown are responses for domestic and for foreign: purchase of another company, investment in another company, and a general "other" category.

Companies reported that a marketing plan was completed for about 21 percent of all projects responding to the survey; it was being planned or already under development for another 33 percent while about 35 percent did not consider a marketing plan necessary. The remaining 10 percent did not provide information on this point. Companies indicated somewhat lower levels of activity for hiring of marketing staff, publicity and

**Table 4.1: Percentage of Company
Growth Attributed to SBIR**

Number of projects	Percentage of growth
269	More than 75 percent
209	51 to 75 percent
359	25 to 50 percent
569	Less than 25 percent

The table shows that, for about 34 percent of the projects, the companies conducting them attributed more than half of their growth to SBIR.

Companies also reported that their SBIR projects contributed a wide variety of specific benefits. For example, companies indicated that they gained either a moderate or great benefit from an increase in staff skills from about 74 percent of their projects. Figure 4.1 shows the percentage of projects receiving great or moderate benefits from their Phase II awards.

further on only the 13 most frequent winners, the project average was about \$291,000.

The results obtained from comparing total additional developmental funding for frequent and less frequent winners show a somewhat smaller difference. Frequent winners obtained additional developmental funding amounting to about \$382,000 per project, compared with about \$468,000 for companies with one to four awards. For only the top 13 companies, the average was about \$464,000.

However, the additional developmental funding obtained from federal and nonfederal sources varies substantially between frequent and less frequent winners. In general, as shown in figure 4.3, companies with one to four awards obtained considerably more additional developmental funding per project from the private sector than did frequent winners—about \$290,000 compared with \$136,000.

Interactions with other companies and investors in Phase III were reported for 644 projects. These interactions could be finalized agreements, ongoing negotiations, or unsuccessful negotiations in the United States and in foreign countries. In each of the major areas of interaction, companies reported a higher percentage of finalized agreements in the United States than overseas. Licensing and marketing/distribution agreements represented the two most frequently cited forms of finalized agreements in both domestic and foreign arenas. The overall results are shown for these projects in figure 4.2.

specialized, nuclear-related technologies for DOD. In the case of one project that did show commercial potential, the principal investigator moved to another company. The contracts manager also noted that CICA has made it more difficult to move a project into Phase III with a federal agency. Because Jaycor has grown to 700 employees, it is no longer eligible to compete for SBIR awards and has no SBIR projects under way.

The contracts manager at PDA told us that most of PDA's work is DOD-related and that commercial applications are not easy to identify. She noted that most of the SBIR awards had gone to one specific division of the company; this division was dissolved in December 1990, and its staff no longer works for PDA. She added that PDA expects an award from NASA to move forward into Phase III.

The Three Most Frequent Winners in Phase III

For a closer look at the frequent winners, we focused on the three with the most Phase II awards between 1984 and 1987. Two of these three companies—Foster-Miller and Physical Sciences Inc. (PSI)—expect a substantial increase in their sales between July 1991 and the end of 1993. In addition, PSI officials stated that they have developed a commercial strategy to boost their Phase III activity. Our analysis is based on the questionnaires that the three companies answered and on written documents or discussions.

Foster-Miller, Inc., Waltham, Massachusetts

Foster-Miller, Inc., received the most Phase II awards (29) of any company during the 1984-87 time frame covered by our survey and responded to each of the 29 questionnaires concerning these awards. The company received the majority of these awards—20 of 29—from DOD. It reported that, for 14 of 29 projects, funding and/or sales have occurred, and further work is under way. For five other projects, funding and/or sales have not yet occurred but are expected. The remaining 10 projects have been discontinued.

Foster-Miller reported almost \$13 million in additional developmental funding. Of this, subsequent SBIR awards used to develop the technology accounted for about \$9.8 million and non-SBIR federal funds for slightly more than \$1 million. Private-sector funding totaled about \$2.2 million, with the company committing about \$270,000 of its own funds and obtaining about \$790,000 from other companies. Colleges or universities and other sources accounted for about \$1.1 million of private-sector funding.

advertising, and test marketing. Activities in each of these areas, however, were planned, under way, or completed for more than a fourth of all projects responding to the survey.

Comparison of Frequent Winners With Less Frequent Winners in Phase III

One concern about the SBIR Program is whether frequent winners of SBIR awards have demonstrated a commitment to Phase III activity. To explore this issue, we compared the level of Phase III activity for frequent and less frequent winners. In making this comparison, we defined "frequent" winners as companies receiving five or more awards and compared them with companies receiving one to four awards. As a further step, we analyzed the results achieved by the top 13 winners, which reported on 191 projects for an average of about 15 Phase II awards each. In general, as shown in table 4.2, frequent winners are achieving lower levels of activity.

Table 4.2: SBIR Phase III Total Sales and Additional Developmental Funding Reported Relative to Number of Phase II Awards Received, 1984-87

Companies by number of awards	Number of survey responses	Total sales		Additional developmental funding	
		Total	Average per project	Total	Average per project
1 to 4 awards	1,076	\$380,346,741	\$ 353,480	\$500,540,378	\$ 467,757
5 or more awards	381	90,186,368	236,710	145,464,308	381,796
13 most frequent winners (total)	191	56,602,930	291,115	88,701,508	464,397
Foster-Miller, Inc.	29	1,622,000	55,931	12,976,109	447,452
Creare, Inc.	21	7,687,000	366,048	18,763,000	893,476
Physical Sciences, Inc.	18	5,770,000	320,556	2,382,000	132,333
Radiation Monitoring	12	2,860,000	238,333	9,154,000	762,833
Scientific Research	13	2,367,000	182,077	2,461,000	189,307
Bend	14	16,762,000	1,197,286	25,350,417	1,810,744
Spire	11	10,980,000	998,182	4,166,000	378,727
EIC	13	287,000	22,077	5,566,000	428,153
Thermacore	12	104,930	8,744	2,685,085	223,757
Quest	16	980,000	61,250	2,420,000	151,250
PDA	11	0	0	50,000	4,545
Jaycor	12	0	0	199,897	16,658
Sparta	9	6,183,000	687,000	2,528,000	280,889

Overall, frequent winners are achieving lower levels of activity in total sales per project. The project average for frequent winners was about

entire small company or a specific product, but they are less effective at reaching out to obtain research results.

Regarding SBIR's effect on Foster-Miller, the vice president told us that, before SBIR, the company had only a limited technical capability in specific areas, especially the energy business. SBIR awards have allowed the company to build up additional capabilities in other areas such as materials and optics. In general, the program has changed Foster-Miller from an engineering company working mainly with established technologies to a company working with technologies at a much earlier, more innovative point in their development.

**Creare, Inc., Hanover, New
Hampshire**

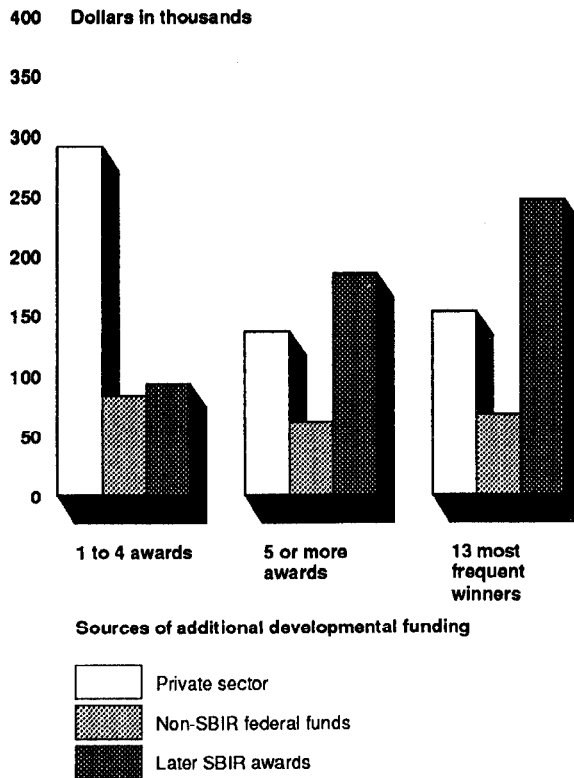
Creare responded to each of the questionnaires concerning its 21 awards. DOD and NASA provided six awards apiece, DOE five, and NIH two. Education and NRC each provided one award. Creare reported that, for 13 projects, funding and/or sales have occurred, and further work is under way. In one other instance, funding and/or sales have not yet occurred but are expected. Seven projects have been discontinued, four of them with Phase III activity and three with neither sales nor funding.

Creare reported about \$18.8 million in additional developmental funding. Subsequent SBIR awards used for development accounted for about \$12.2 million and non-SBIR federal funds for about \$5.2 million. Private-sector funding totaled about \$1.3 million, almost all of it provided by Creare itself.

Creare reported about \$7.7 million in total sales as of July 1991. The vast majority of the sales went to the private sector, which accounted for almost \$7 million. Of the eight projects reporting sales, four achieved their first sales in 1985 and four between 1988 and 1990. Creare expected additional sales totaling \$5 million between early 1991 and the end of 1993.

In its interactions with other companies, Creare indicated that it has finalized one licensing and three joint venture agreements in the United States. It has also finalized one agreement with foreign companies or investors in each of the following areas: licensing, purchase of another company, investment in another company, joint venture, and marketing/distribution.

Figure 4.3: Sources of Additional Developmental Funding by Award Frequency



1,076 awards went to companies with 1 to 4 awards; these companies received \$500.5 million in additional developmental funding.

381 awards went to companies with 5 or more awards; these companies received \$145.5 million in additional developmental funding.

191 awards went to the 13 most frequent winners; these companies received \$88.7 million in additional developmental funding. These 191 awards are a subset of the 381 awards to companies with 5 or more awards.

In follow-up discussions with PDA and Jaycor, the two frequent winners of Phase II awards that reported no Phase III sales activity, the contracts manager at each company told us that their projects involved DOD work with virtually no commercial market. The contracts manager at Jaycor said that many of his company's SBIR projects were focused on very

Based on technology associated with its Phase II awards, PSI applied for four patents and has received two. In 11 instances, it indicated that a marketing plan is planned, under way, or completed.

The company, founded in 1973, has grown from 50 employees at the time of its first SBIR award to 125. Its gross revenues are between \$5 million and \$20 million, with less than 25 percent of them derived from SBIR awards. It attributes 25 to 50 percent of its company growth to SBIR since receiving its first award.

The chairman, PSI, told us that he prefers to start with a commercial strategy and then bid on SBIR solicitation topics and projects that fit that strategy. Thus, the company views SBIR as a means of pursuing the ultimate goal of commercialization, not as an end in itself.

PSI attributes this emphasis on commercialization primarily to its involvement with SBIR. In a written summary of the company's views, PSI's contracts manager stated that the company has historically concentrated on applied R&D, with little interest and no experience in commercialization of research results. Largely because of the SBIR Program, a corporate reorganization in July 1987 established a division whose specific charter is to focus on potential commercial applications of its research results (primarily those evolving out of the SBIR Program), protection of patent rights, licensing, formation of joint ventures, and acquisition of third-party investments. PSI believes that the SBIR Program's funds and focus have enabled PSI and a host of small R&D companies to begin this transition and that, without the SBIR Program, these products and services either would not have existed or would never have "gone to market."

PSI believes that an analysis of sales anticipated before 1993 will not reveal the extent of commercial successes resulting from SBIR efforts. PSI has taken a longer view of the commercialization process; it is making investments in continued development and does not expect to realize the full return within the first 5 years after Phase II completion. It is optimistic about the potential of some of the SBIR-related products over the next 10 years and considers that to be a more appropriate time frame for judging the success of SBIR Phase III achievements. In addition, PSI believes that its corporate change in emphasis resulting from participation in SBIR will yield an even higher percentage of commercially viable innovations for SBIR topics pursued in fiscal year 1988 and after.

Foster-Miller reported about \$1.6 million in total sales as of July 1991 resulting from the technology associated with these projects. The majority of its sales (about \$1.1 million) were to DOD. Of the 10 projects reporting sales, 8 indicated that their first sale occurred in 1989 or 1990. Foster-Miller expected additional sales totaling about \$15.4 million between the time it completed the questionnaires in early 1991 and the end of 1993.

Foster-Miller's activities with other companies and investors in the United States and foreign countries were focused mainly on licensing agreements, the sale of technology or rights, and marketing/distribution agreements. It has finalized two licensing agreements and four marketing/distribution agreements in the United States. It has also sold the technology or rights associated with two projects to foreign companies or investors.

Among its other activities, the company applied for 28 patents based on these projects and has received 19 of them. In 19 cases, it indicated that a marketing plan is planned, under way, or completed.

The company, founded in 1956, has grown from 166 employees at the time of its first SBIR award to a current level of 266. Its gross revenues exceed \$20 million, with between 25 and 50 percent derived from SBIR. It attributes between 25 and 50 percent of its company growth to SBIR since receiving its first award.

A Foster-Miller vice president gave us additional information about the company. The Vice President noted that two of the company's most significant achievements resulted from projects that went directly from Phase I to Phase III and were not included in our survey. In one of these cases, involving a composite material for bridges, Foster-Miller won a \$6 million competitive procurement contract from DOD to continue with work begun in Phase I. In the second case, involving a special Velcro fastener material, it received a \$1 million sole-source contract from DOD, followed by a further \$2 million contract during the buildup for the Desert Storm operation in the Middle East.

The vice president also commented that small businesses are prolific producers of ideas but that they have a difficult time in transmitting their ideas to larger companies. What American industry needs, according to the vice president, is a mechanism for small companies to interact more effectively with the larger ones. Large companies tend to buy either the

Monitoring (\$14.7). Collectively, these companies have received 702 SBIR awards, consisting of 529 Phase I awards and 173 Phase II awards.

Because the large amount of funds provided to frequent winners limits participation by other companies while the somewhat lower level of sales by frequent winners in Phase III diminishes the overall achievements of the program, we concluded that further review of Phase III activity among frequent winners is needed. SBA officials told us that they agree on the need to develop further information concerning frequent winners. In response to our concerns, SBA initiated a study of frequent winners in August 1991 to determine the operating attributes of these firms and expects to complete the study in early 1992.²

Conclusions

In general, companies endorsed the benefits of the SBIR program. A majority of them cited moderate or great benefits such as increases in staff skills, the hiring or retention of valuable personnel, and increases in company credibility and financial stability. Companies also reported activities such as finalized or ongoing negotiations with other companies or investors at home and abroad to stimulate activity in Phase III; these negotiations frequently involved licensing and marketing/distribution agreements.

A comparison of frequent winners—those receiving five or more Phase II awards—with less frequent winners showed that, in general, frequent winners are achieving lower levels of total sales per project. Although total additional developmental funding was more nearly equal in the two groups, frequent winners obtained substantially less additional developmental funding per project from the private sector than companies with one to four awards. The majority of additional developmental funding for frequent winners came from the federal government.

The top five winners have received almost \$100 million in SBIR funds and more than 700 Phase I and II awards since the inception of the SBIR Program. The limitation of participation for other companies as a result of the large amounts of funds to frequent winners and the somewhat lower level of performance among frequent winners in general raise concerns about their role in the SBIR Program. Because SBA has initiated a further study of frequent winners to determine the operating attributes of these firms, we are making no recommendations concerning frequent winners.

²In commenting on our draft report, SBA stated that while it is undertaking a study to determine the operating attributes of these firms, SBA has in no way assumed that such firms can or should be characterized as having a lower or higher level of performance.

The company has applied for and received two patents based on these projects. It reported, for all 21 of its projects, that the preparation of a marketing plan was not needed.

The company, founded in 1961, has grown from 50 employees at the time of its first SBIR award to 120 as of July 1991. Its gross revenues are between \$5 and \$20 million, with between 25 and 50 percent derived from SBIR. It attributes between 51 and 75 percent of its company growth to SBIR since receiving its first award.

**Physical Sciences Inc.,
Andover, Massachusetts**

As with Foster-Miller and Creare, Physical Sciences Inc. (PSI) responded to each of the questionnaires relating to its 18 Phase II awards received from 1984 to 1987. DOD provided 10 of these awards, NASA 5, and DOE, NIH, and NSF 1 each. PSI reported that, for 9 of these 18 awards, funding and/or sales have occurred, and further work is under way. In five other instances, funding and/or sales have not yet occurred but are expected. The remaining four projects have been discontinued.

PSI reported about \$2.4 million in additional developmental funding. Subsequent SBIR awards used for development accounted for \$508,000 and non-SBIR federal funds for almost \$400,000. Private-sector funding totaled about \$1.5 million, with the company committing about \$225,000 of its own funds. It obtained \$550,000 from U.S. and \$700,000 from foreign venture capital.

PSI reported about \$5.8 million in total sales as of early 1991. Almost three-quarters of these sales (about \$4.2 million) went to DOD. About \$605,000 were to NASA and \$305,000 to other federal agencies. About \$584,000 went to export markets and \$104,000 to the private sector. PSI expected additional sales of about \$17.5 million between the time it completed the questionnaires in early 1991 and the end of 1993.

PSI indicated that, in the United States, it had finalized one agreement in each of the following areas: licensing, sale of partial ownership, investment in another company, sale of technology or rights, and joint venture. Seven other negotiations are under way in the United States. A licensing agreement, sale of partial ownership agreement, and marketing/distribution agreement have also been finalized with foreign companies or investors.

Comments From the Department of Defense

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



OFFICE OF SMALL
BUSINESS AND SMALL
DISADVANTAGED
BUSINESS UTILIZATION

OFFICE OF THE UNDER SECRETARY OF DEFENSE FOR ACQUISITION
WASHINGTON, DC 20301-3061

2 JAN 1992

Mr. John M. Ols, Jr.
Director, Housing and
Community Development Issues
Resources, Community, and
Economic Development Division
U. S. General Accounting Office
Washington, DC 20548

Dear Mr. Ols:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report entitled--"FEDERAL RESEARCH: Small Business Innovation Research Shows Success But Can Be Strengthened" (GAO Code 385513/OSD Case 8853-A). Generally, the DoD agrees with the information presented in the report and has provided needed factual and technical corrections separately. The DoD agrees with the information in the body of the report. The Executive Summary does not, however, reflect the report content accurately, which misleads the reader.

See comment 1.

The DoD is complying, and has always complied, with the legislated requirements for Small Business Innovation Research specified by Congress. The GAO acknowledges that there is no established standard for measuring the achievement of the goal to increase private sector commercialization derived from Federal Research and Development. Even with the absence of a standard, the DoD has achieved a commendable 40 percent private sector commercialization.

See comment 2.

Throughout the report, the DoD is compared to other Federal Agencies without explaining the differences. Mission oriented agencies, such as the DoD, the Department of Energy and the National Aeronautics and Space Administration, have a commitment to promoting research and development projects that meet the internal needs of the agencies. Non-mission oriented agencies, like the National Institutes of Health and the National Science Foundation, foster research and development work that is primarily used outside the agency. In the report, mission oriented agencies and non-mission oriented agencies are grouped together and comparisons made between unlike agencies. The contrast is so striking because the comparison is inappropriate -- due to the underlying assumption that, with some Small Business Innovation Research procedural differences, the agencies are the same. That assumption is both inaccurate and misleading.

See comment 3.

The DoD Small Business Innovation Research program funds high innovation, leading-edge technology where often the commercial market has yet to be established. As mentioned in the GAO report, years of research and development and marketing are necessary to develop

Monitoring of Companies With Multiple Awards

Given the concerns about comparative levels of performance in Phase III, especially as they relate to frequent winners, we explored the question of monitoring company performance. Although several SBIR Program managers were opposed to monitoring, a review of frequent winners' Phase III activity may be appropriate because of the large amount of SBIR money received by frequent winners and the somewhat lower performance among frequent winners in general. In addition, the large amount of SBIR funds provided to the frequent winners limits participation by other companies.

Among the SBIR Program officials who were opposed to monitoring, DOD's program coordinator told us that DOD has procedures in place to ensure that unqualified companies do not receive SBIR awards. He added that even seemingly less productive companies are performing a valuable R&D service that may not be captured through the criteria of additional developmental funding and/or actual or pending sales in Phase III. NASA's program manager said that SBIR companies have no responsibility other than to meet their Phase I and II commitments. He added that, until the language of the law and policy direction state unequivocally that Phase III activity must be demonstrated before further awards can be received, it would be wrong to penalize companies with lower levels of Phase III activity.

In a few instances, however, program managers told us that company performance in Phase III might influence their decisions about who receives SBIR awards. The DOE program manager, for example, said that in the evaluation of both Phase I and Phase II proposals, consideration is given to the amount of Phase III funding received for previous DOE Phase II projects. This modification to the evaluation process was introduced at the beginning of 1991.¹

The large amount of SBIR money received by frequent winners makes the concern about frequent winners more important. According to data provided by SBA, for example, the five companies obtaining the most SBIR money from fiscal years 1983 through 1990 have received a total of \$97.4 million. These companies include Foster-Miller (\$31 million), Creare (\$19.2 million), Sparta (\$16.7 million), Spire (\$15.8 million), and Radiation

¹In commenting on the draft report, SBA stated that the agency use of company performance, i.e., commercialization, as a factor in SBIR selections may be legally questionable and that company performance in Phase III should not be a factor in agencies' SBIR procurement selection decisions. In discussing this issue with us, DOE SBIR program officials told us that, when selecting among competing projects for SBIR awards, they are using follow-on funding as a criterion only for tie-breaking purposes as permitted by current legislation.

The following are GAO's comments on DOD's letter dated January 2, 1992.

GAO Comments

1. We disagree with DOD's general statement that the executive summary does not reflect the report content accurately. DOD's letter does not discuss this statement in greater detail, and DOD's technical annotations to our draft executive summary focused only on the portions comparing DOD's SBIR project results with those of other agencies. However, in response to DOD's technical annotations, we have revised the executive summary to focus more directly on DOD's increasing emphasis on meeting its agency R&D needs while its percentage of private-sector commercialization remains lower than that of the other four major SBIR agencies.
2. We neither state nor imply anywhere in the report that DOD is not complying with the legislated requirements for SBIR specified by the Congress. Because there are no established criteria by which to evaluate DOD's 40-percent rate of private-sector commercialization, we have made the issue of increasing DOD's commercialization rate a matter for congressional consideration. While DOD considers the 40-percent commercialization rate "commendable," we remain concerned that this is the lowest rate among the major SBIR agencies and that, at the same time, DOD is taking steps to make the SBIR Program more responsive to the agency mission. As we stated in the report, this step may further limit the potential of DOD's projects for application in the private sector.
3. We have added a reference incorporating DOD's concern about the differences between the agencies on page 5 of our executive summary. However, we disagree that such differences invalidate a comparison between the agencies. Because DOD's concerns about a comparison of its project results with those of other agencies are central to DOD's comments on our draft report, we have discussed this portion of DOD's comments in the main body of the report. Our views in this regard are provided on pages 7 and 52 and 53.
4. We agree with DOD's view that the government market should be included as part of the SBIR Program's commercialization trends. In developing our data about sales achieved by agencies' projects, we clearly included sales to the federal government as part of the aggregate activity. However, we are also concerned about private-sector commercialization, one of the goals of the SBIR Program. Throughout the report, we have carefully distinguished between the private and federal markets to show the extent to which companies are able to develop private-sector markets

Comments From the National Aeronautics and Space Administration



National Aeronautics and
Space Administration

Washington, D.C.
20546

Office of the Administrator

DEC 16 1991

Mr. John M. Ols, Jr.
Director, Housing and
Community Development Issues
Resources, Community, and
Economic Development Division
United States General Accounting Office
Washington, DC 20548

Dear Mr. Ols:

This is the National Aeronautics and Space Administration's (NASA) response to the General Accounting Office (GAO) draft report GAO/RCED-92-37, entitled "Federal Research: Small Business Innovation Research Shows Success But Can Be Strengthened," which was received with your letter dated November 26, 1991, for our review and comment.

The enclosed represents detailed comments to the report. Overall, our comments address points or conclusions made in the report which need clarification or, in some cases, correction. I hope these will be of assistance in completing the final version. We appreciate the opportunity of offering these comments and working with the GAO Evaluator-in-charge.

Sincerely,

John E. O'Brien
Assistant Deputy Administrator

Enclosure

See comment 4.

a private sector market for an emerging technology. Since the DoD has taken the lead in developing new technology through Small Business Innovation Research funding and this technology meets DoD requirements, sales to the Federal Government (in addition to sales to the private market) are expected. The report shows that small firms participating in the five major Small Business Innovation Research agency programs have commercialized in the Government and private market places. The Government market should be included as part of the Small Business Innovation Research commercialization goal.

See comment 5.


The GAO ignores the central thrust of the DoD Small Business Innovation Research program, which offers small companies the opportunity of marketing their innovative concepts in response to the unique DoD research and technology needs. The DoD provides a mixture of solicitation topics that vary from broad to focused research, allowing small firms to pursue a variety of new technologies that have DoD and commercial potential applications. As the report indicates, significant commercial spinoffs from Small Business Innovation Research projects have occurred.

See comment 6.

The GAO also mentions that some projects are discontinued without Phase III activity. Developing a new technology is risky and finding private funding for basic research is very difficult or impossible. The DoD is sharing the risk with high-technology small firms by providing funding for research and development, exploring technologies that would otherwise not be pursued. However, less than 100 percent success in any research program is expected. Not all innovative ideas are strong enough to succeed. Knowledge is, however, often gained from such unsuccessful projects that leads to eventual success.

The Department of Defense appreciates the opportunity to review and comment on the GAO draft report. (Suggested factual and technical changes were provided separately.)

Sincerely,



HORACE J. CROUCH
Director

**Appendix II
Comments From the National Aeronautics
and Space Administration**

Phase I and Phase II have satisfied the requirements for competitive selection including logical Phase III follow-on government applications. A satisfactory proposal and determination of the capability of the firm to perform the desired Phase III work should then be considered sufficient basis for selection.

3. We know of no specific problems in the NASA program related to Issue (3), but we agree that it is desirable that there be established more specific guidelines clarifying the rights of government for in-house development and the rights of SBIR firms to receive contracts for follow-on work subsequent to Phase II, so that both parties may benefit equitably.

4. With regard to Issue (4) we believe the Phase III commercialization performance of SBIR contractors who have received numerous Phase II awards should be further assessed to determine whether there are ways to encourage their wider achievement of commercial applications, if in fact they have been less successful in their efforts or have made minimal efforts in that direction.

However, it must not be overlooked that the success of such firms in winning several -- and in some instances, many -- Phase II awards suggests they are fulfilling other legislative objectives for SBIR, including stimulating technological innovation and assisting federal agencies in meeting their R&D needs, including Phase III government applications. In so doing they are adding to U.S. technical competence and competitiveness, and are contributing to economic growth and employment through their innovations and development activities.

Achievement of commercial applications may sometimes depend more on the inherent commercial potential of projects solicited by the agencies than on factors under the control of the small business. For agencies such as NASA, which are required to achieve unique and technologically specialized mission objectives, it has happened that not all Phase II projects have possessed readily identifiable and achievable commercial applications. However, as GAO noted in the report, one effort by NASA to change this situation is to choose a larger fraction of technical subtopics for our annual SBIR solicitation that involve the development of "dual use" innovations and technologies, those which suggest reasonable prospects for commercial application potential while satisfying NASA R&D needs.

In addition to the foregoing comments on the general content and issues identified by GAO, we offer the following detailed comments on particular sections of the report which should be incorporated as corrections to the draft report.

See comment 1.

for their R&D. We also noted the differing emphasis on private-sector commercialization by program managers at various agencies and DOD's increasing emphasis on meeting its own agency R&D needs, another program goal. Thus, while our report already acknowledges the important role of sales to the agencies, the issue that needs to be addressed is whether DOD should be giving somewhat more emphasis to projects with a greater "dual use" or private-sector commercialization potential.

5. We disagree with DOD's statement that we ignored the central thrust of the DOD SBIR Program, which allows companies to market their concepts to meet DOD needs. Our report presents detailed data concerning the amount of sales by companies to DOD (and other federal agencies). These sales were presented as part of our aggregate data in chapter 2 and our agency-specific data in chapter 3. We also discussed the efforts that DOD is making to focus SBIR R&D on its agency needs and thus enhance Phase III activity. Rather than ignoring this thrust of the program, we pointed out that DOD's concern about meeting agency R&D needs is a factor that the Congress should take into consideration in deciding whether to place more emphasis on private-sector commercialization.

6. We agree with DOD's comments on the risks as well as potential benefits associated with discontinued projects. As shown in figure 2.4 of our report, high risk and innovation played a great or moderate role in discontinuing about 19 percent of the projects that were no longer active at the time of our survey.

The following are GAO's comments on NASA's letter dated December 16, 1991.

GAO Comments

1. While agreeing with our concerns about the need to further assess the performance of frequent Phase II award winners in Phase III, NASA makes two additional points: (1) the receipt of several or many awards suggests that frequent winners are fulfilling other (noncommercial) legislative objectives of SBIR and (2) the achievement of commercial applications may sometimes depend more on the agency solicitation than on the small business.

Regarding the first point, we focused our review of frequent winners on their Phase III commercialization results rather than on other program goals because of congressional concerns about the commercialization issue. We do not agree with NASA's statement that the receipt of many awards—by itself—suggests that other program objectives (such as stimulating innovation) are being fulfilled. While acknowledging that frequent winners may be achieving other program goals, we believe that attention should remain focused on the primary issue under discussion—the extent of commercialization among the frequent winners.

Regarding the second point, NASA makes an important comment: An agency can contribute significantly to commercialization through the projects it solicits. While NASA cites this point in connection with the performance of frequent winners, we believe that it applies to projects conducted by nonfrequent winners as well. Variations in agency emphasis on commercialization, which we discussed in detail beginning on page 35, do affect agency solicitations, the selection of projects, and the type of markets achieved by SBIR technologies. For this reason, we compared the initiatives being undertaken by several major SBIR agencies to meet agency R&D needs or to boost the potential for private-sector commercialization.

2. We have made the requested changes.

3. We have made the requested changes.

4. We disagree with the suggested changes but have made slight revisions to clarify our statements. Our data were based on "great or moderate benefits"; the suggested deletion of "great or moderate" would be inaccurate. We agree with NASA that the projects benefited the companies;

**Appendix II
Comments From the National Aeronautics
and Space Administration**

Comments on the GAO Draft Report Entitled:

**Federal Research: Small Business Innovation Research
Shows Success But Can Be Strengthened**

The subject draft report concludes there has been significant Phase III activity in both sales and additional development aimed at both government and private sector markets, and that most companies endorse the SBIR program, often attributing growth and successful expansion of capabilities and markets substantially or in part to their SBIR projects. It recommends that four issues should be addressed by the congress in considering re-authorization and ways to increase the achievement of legislative objectives in Phase III.

The issues identified are (1) the extent of the Department of Defense (DOD) commitment to increasing private sector commercialization (the DOD funds more than half the total SBIR program), (2) inconsistent practices among agencies in requiring competition for projects entering Phase III contracts by the government, (3) the need to clarify the circumstances under which an agency may pursue in-house continuation of developments initiated under SBIR, and (4) the relatively lower commercial performance (both sales and additional development funding) of many companies which have received five or more Phase II awards, which is an issue currently being addressed by the Small Business Administration (SBA).

We found the report to be a comprehensive attempt to assess Phase III progress as measured by sales and additional development funding following Phase II projects. However, since we have not seen the data GAO used as the basis of their study, we cannot comment on the accuracy or completeness of the results shown, particularly those which relate to the NASA SBIR program. The following comments are made on the four identified issues.

1. We have no comment to offer on Issue (1) relative to DOD SBIR program emphasis and commitment to commercialization of SBIR results.

2. With regard to Issue (2), we agree that existing legislation regarding competition in contracting does not seem consistent with the legislative intent for SBIR. We agree that clarification is required, and support the position that non-SBIR Phase III follow-on contracts with Phase II performers should normally require no further competition, on the basis that

Comments From the Department of Health and Human Services



DEPARTMENT OF HEALTH & HUMAN SERVICES

Office of Inspector General

Washington, D.C. 20201

JAN 3 1992

Mr. John M. Ols, Jr.
Director, Housing and
Community Development Issues
United States General
Accounting Office
Washington, D.C. 20548

Dear Mr. Ols:

Enclosed are the Department's comments on your draft report, "Federal Research: Small Business Innovation Research Shows Success But Can Be Strengthened." The comments represent the tentative position of the Department and are subject to reevaluation when the final version of this report is received.

The Department appreciates the opportunity to comment on this draft report before its publication.

Sincerely yours,

A handwritten signature in black ink, appearing to read "R. Kusserow".

Richard P. Kusserow
Inspector General

Enclosure

**Appendix II
Comments From the National Aeronautics
and Space Administration**

Now on p. 35.

See comment 2.

Page 39: The first paragraph states that "Program managers at four of the five major SBIR agencies told us that they are making efforts to enhance activity in Phase III. SBIR officials in DOD are placing greater emphasis on meeting agency needs. By contrast, SBIR officials in NASA, DOE, and NSF are taking steps to emphasize private sector commercialization." This statement, while true, could lead readers to infer that NASA's Phase III emphasis may be exclusively on private sector commercialization, when in fact we emphasize both agency utilization -- helping us achieve our mission objectives is mandatory -- and increasing commercialization. We suggest an appropriate modification of this potentially misleading statement in the report.

Now on p. 37.

See comment 3.

Page 41: The fourth paragraph states that "...at least half of its topics (and subtopics) must have identifiable commercial potential." The word "topics" should be deleted, and the phrase should read: "...at least half of its technical subtopics must have identifiable commercial potential." Topics are broad, e.g. Materials and Structures, and do not change from year to year. "Technical subtopics" are the specific areas in which small businesses are invited to submit proposals and are frequently modified each year. It is the subtopics in which we are requiring greater opportunity for commercial applications. Such can be thought of as "dual use" subtopics, in the meaning of the term used elsewhere in the report.

The fifth paragraph states: "...which submit the topics for the program manager's review." The word "subtopics" should be substituted for "topics" in this sentence, consistent with the above comment.

Now on p. 55.

See comment 4.

Page 63: The last sentence reads: "Figure 4.1 shows the percentage of projects reporting moderate or great benefits for their projects." It would appear that this should read "Figure 4.1 shows the percentage of projects reporting benefits for their companies." Similarly, it would seem that Figure 4.1 should be labeled "Percentage of Phase II Projects Providing Great or Moderate Benefits to their Companies". And, from the context of the paragraph following Figure 4.1, it seems likely that the reference to "Ninety projects..." should instead be to "Ninety companies...".

See comment 5.

TECHNICAL COMMENTS

Now on p. 12.

Page 10. The Administration of the SBIR Program.

See comment 2.

The second and third paragraphs refer to solicitations and proposals used for contracts, but omit announcements and applications which are used for grants.

See comment 24.

Page 23. Figure 2.2: Percentage of Projects that Made First Sales Between 1984 and 1991.

See comment 3.

It would be more informative to have a figure which shows the number of years elapsed between the end of the Phase II project period and the first sale. This would provide a more accurate picture of the time required for full development of a product.

Now on p. 40.

Page 46. Agencies Vary in Their Emphasis on Commercialization

See comment 4.

The second paragraph states "...the NIH SBIR program allows companies to propose whatever topics they want to pursue, subject only to the requirement that they be in line with NIH's agency mission." This may be true for grants, but is incorrect for contracts.

however, we wish to emphasize that the benefits were derived from the Phase II awards.

5. NASA is correct in noting an inconsistency in our draft report; however, our unit of analysis is projects, not companies. We have corrected our statement to reflect projects and make the statement consistent.

Comments From the National Science Foundation

NATIONAL SCIENCE FOUNDATION
WASHINGTON, D.C. 20550



OFFICE OF THE
DIRECTOR

December 13, 1991

Mr. John M. Ols, Jr.
Director, Housing and
Community Development Issues
United States General Accounting Office
Washington, DC 20548

Dear Mr. Ols:

This letter responds to your request of November 26, 1991 for NSF's review and comments on your draft report entitled "Federal Research: Small Business Innovation Research Shows Success But Can Be Strengthened" (GAO/RCED-92-37). In our view, the report presents a well reasoned and balanced review of the program.

It is not surprising that there is a variance in Federal Agency commercialization efforts from results obtained in Phases I and II of the SBIR Program. This could stem from the wide and varying objectives and missions of the agencies. Your findings relative to issues that should be addressed to strengthen Phase III activity raise questions and opportunities that need to be clarified if a coordinated, government-wide effort is to be successful. NSF does not support any Phase III activities; instead, we rely on the private sector to bring the results to the market place. Our own review of the Program indicates that research of high quality has been carried out by small technology-intensive firms and that many of these firms have been successful in bringing new technology, products and services to the market.

The following comments and suggestions are provided to clarify statements related to NSF's activities:

- a. Page 44, 1st paragraph: NSF has three SBIR Program Managers. Suggested rewrite: "As an important part of agency efforts to enhance private sector commercialization, one NSF program manager noted NSF's policy of placing strong emphasis on a follow-on funding commitment for potential Phase II awardees. He said that potential awardees have been encouraged as hard about the commercial applications as about the research."
- b. Page 44, 2nd paragraph, 2nd sentence: NSF does not require that a company complete the NSF forms. The sentence should read "NSF has also developed formal

See comment 1.

Now on p. 39.

Now on p. 39.

**Appendix III
Comments From the Department of Health
and Human Services**

**COMMENTS OF THE DEPARTMENT OF HEALTH AND HUMAN SERVICES
ON THE GENERAL ACCOUNTING OFFICE (GAO) DRAFT REPORT,
"FEDERAL RESEARCH: SMALL BUSINESS INNOVATION RESEARCH SHOWS
SUCCESS BUT CAN BE STRENGTHENED," NOVEMBER 1991**

General Comments

We are pleased that the GAO draft report reflects the significant commercialization success in the private sector of projects funded by the Department of Health and Human Services (DHHS) under the Small Business Innovation Research (SBIR) Program. The small business community's products have made important contributions to the improvement of the Nation's health as a result of their participation in the SBIR Program.

It is our understanding that the data in the report does not include any information on projects funded by other PHS components and includes only the National Institutes of Health (NIH) projects. However, both the SBIR Contracts and Grants Announcements are entitled "Solicitation (or Omnibus Solicitation) of the Public Health Service for Small Business Innovation Research (SBIR) Contract Proposals (or Grant Applications)." SBIR solicitations always include NIH and the Alcohol, Drug Abuse and Mental Health Administration and often include the Centers for Disease Control, Food and Drug Administration, and other PHS agencies. Consequently, the report should refer to the Public Health Service or the Department of Health and Human Services, rather than NIH, as the participating agency.

Although the report contains no recommendations for the Department of Health and Human Services, we have the following comments on the recommendation to the Small Business Administration (SBA).

GAO Recommendation

To avoid conflict between companies and federal agencies, the SBA Administrator should develop a policy statement for agencies that are planning to work on a company's SBIR technology after the end of SBIR funding. Such a policy statement should clarify the circumstances under which the agency will continue working with the company through a follow-on, non-SBIR-funded contract.

Department Comments

We concur. The agencies that intend to work on a company's SBIR technology following expiration of federal funding would benefit from the recommended policy statement.

See comment 1.

**Appendix IV
Comments From the National Science
Foundation**

The following are GAO's comments on NSF's letter dated December 13, 1991.

GAO Comments

1. The revisions and deletions that NSF requested have been made at appropriate places in the report.

The following are GAO's comments on HHS' letter dated January 3, 1992.

GAO Comments

1. HHS' statement that our data include only NIH projects for HHS is correct. However, NIH has accounted for more than 90 percent of all HHS SBIR awards, and we therefore focused our survey efforts on NIH's awardees. As suggested by HHS, we have changed our report to refer to HHS as the participating agency. We have retained references to NIH only in discussing the comments provided to us by the NIH program manager.
2. We have modified the report to indicate that SBIR funding agreements may include contracts, grants, or cooperative agreements.
3. We believe that figure 2.2 provides important information about the SBIR Program. In measuring the aggregate commercial results of the program, the distribution of projects by time of first sale helps to understand how recently much of the initial SBIR sales activity has occurred. In conjunction with our further finding that most of these projects reporting actual sales also expect further sales, the data give a valuable overview of the progress of the program.
4. We have added a footnote on page 40 in response to HHS' clarification.

**Appendix V
Comments From the Small Business
Administration**

further competition by exemption from the Competition in Contracting Act. In any case, the agreements should be subject to the procurement regulations of the participating agency, not SBA. The program legislation (P.L. 97-219) does not address the authority of SBA in establishing program policy over non-SBIR funding agreements.

See comment 4.

- The report discusses those firms in the SBIR program that have won more than five Phase II awards. The report infers that SBA is undertaking a study of these winners of multiple awards to examine the "somewhat lower level of performance" among them. While SBA is undertaking a study to determine the operating attributes of these firms, we have in no way assumed that they can or should be characterized as having a lower or higher level of performance.

See comment 5.

- The report discusses the National Science Foundation (NSF) policy of requiring proof of a third party follow-on funding commitment for potential Phase II awardees as essential for receiving the SBIR Phase II award. In addition to the concerns expressed in the report, the NSF requirement exceeds the legislation. Under the law, consideration of third party follow-on funding commitments is only appropriate in instances where there is a tie between two or more proposals. Requiring such commitments also places additional work on the contractor.

See comment 6.

- The report discusses agencies that are considering using company performance, i.e. commercialization, as a factor in their SBIR selections. We believe this may be legally questionable and could result in legal action by bidders who failed to receive contracts due to this factor. There are many reasons why procedures resulting from research are not commercialized, such as (1) the procedure proved to be technically infeasible, (2) the procedure could be part of a larger system under development, and (3) the procedure may require a three-contract phase to reach full development. Therefore, company performance in Phase III should not be a factor in agencies' SBIR procurement selection decisions.

See comment 7.

- The report states that SBA's Assistant Administrator, Office of Innovation, Research and Technology, said his "... office found major difficulties in using the SBIR data from its survey to evaluate the program." Another sentence should be substituted which states, "The SBA's Assistant Administrator, Office of Innovation, Research and Technology, said that difficulties were experienced

**Appendix IV
Comments From the National Science
Foundation**

- 2 -

guidelines and documents that a company can consider when developing requests for follow-on funding commitments."

Now on p. 39.

- c. Page 44, 3rd paragraph, 2nd sentence: The firm received a total of \$430,000 in commitments from a combination of oil, instrument, and computer companies. The second sentence should read "For example....; the firm found that oil companies could use the mathematics in exploring for oil and received a total of \$430,000 in commitments from a combination of oil, instrument and computer companies."

Now on p. 39.

- d. Page 44, 4th paragraph: The first and second sentences should be combined and read as follows: "The program managers discussed more than 50 other examples of funding commitments that specified the amounts (ranging into seven figures), most with pledges contingent upon the successful completion of Phase II." The word "microscope" in the last line on page 44 should be changed to "laser sintering process."

Now on p. 39.

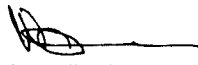
- e. Page 45, 1st paragraph: Part of the 2nd sentence, "companies knew that the commitments were not necessary," does not reflect NSF's position and should be deleted as should the related, following sentence. The paragraph would then read "In response to concerns about the lack of credibility regarding follow-on funding commitments, the NSF position is that the follow-on funding commitments are heavily weighted in the Phase II award process. Therefore, such commitments are carefully reviewed and evaluated. More than 90 percent of all Phase II awardees have obtained satisfactory follow-on funding commitment."

Now on p. 39.

- f. Page 47, 1st paragraph, 2nd sentence: NSF takes no position on actions taken by other agencies. Therefore, we believe that reference to NSF should be deleted from that sentence.

Thank you for the opportunity to comment on your draft report.

Sincerely,


Walter E. Massey
Director

The following are GAO's comments on SBA's letter dated January 14, 1992.

GAO Comments

1. We discuss this comment on pages 7 and 52 of our report.
2. All references to SBA "policy statements" have been deleted from the report and replaced with "policy directives."
3. SBA describes our draft report as containing "several suggestions that SBA issue policy directives to participating agencies concerning the solicitation and award of non-SBIR Phase III funding agreements." In our draft report, we clearly presented this issue as a matter for congressional consideration. We also made two references to SBA's policy role in this regard. In one, we stated that SBA policy guidelines do not address this issue; in the other, we stated that we were informally advised that SBA was considering a change to its policy directive regarding CICA competition requirements. Although both references were accurate, we have deleted them to avoid any implication that this issue was directed to SBA. As stated in our draft report, the issue remains a matter for congressional consideration.
4. We have revised the executive summary to clarify that SBA is undertaking a study of the operating attributes of frequent winners. We have also added a footnote on page 68 to indicate that SBA is making no assumptions about the level of performance among frequent winners.
5. NSF clarified its position regarding this issue in its agency comments on our report. We have made the changes requested by NSF. In our view, NSF's clarification responds to the concerns expressed by SBA.
6. We have added a footnote on page 67 to clarify this issue.
7. We have made the revision requested by SBA.

Comments From the Small Business Administration



U.S. SMALL BUSINESS ADMINISTRATION
WASHINGTON, D.C. 20416

OFFICE OF THE ADMINISTRATOR

JAN 14 1992

Mr. J. Dexter Peach
Assistant Comptroller General
Resources, Community and Economic
Development Division
United States General Accounting Office
Washington, D.C. 20548

Dear Mr. Peach:

We have reviewed your draft report entitled "Federal Research: Small Business Innovation Research Shows Success But Can Be Strengthened" (GAO/RCED-92-37).

While we found the report to be professionally accomplished and a very meaningful examination of specific aspects of the Small Business Innovation Research (SBIR) program activities, the Small Business Administration (SBA) does not concur in GAO's recommendation that the Administrator should develop a policy statement for agencies that are planning to work on a company's SBIR technology after the end of SBIR funding. The present legislation (P.L. 97-219) does not address the authority of SBA in establishing program policy over non-SBIR funding agreements. We believe these agreements should be subject to the procurement regulations of the participating agencies.

In addition, we are providing the following comments for clarification of certain issues:

- In several sections of the report, there are references indicating that the SBA publishes "policy guidelines". The word guidelines is somewhat misleading. We issue SBIR Policy Directives which, in effect, establish how things must be done. The first Policy Directive was disseminated in November of 1982.
- There are several suggestions in the report that SBA issue policy directives to participating agencies concerning the solicitation and award of non-SBIR Phase III funding agreements. These suggestions concern the need for competition for funding agreements past Phase II. As you are aware, the SBA provided our views on this matter to GAO in a letter to your Office of General Counsel on June 10, 1991. In that letter, we expressed our opinion that participating agencies could allow SBIR firms to proceed into Phase III without

See comment 1.

See comment 2.

See comment 3.



**Appendix V
Comments From the Small Business
Administration**

in determining a suitable design and methodology for the conduct of SBA's study because no known similar study had been performed in Federal R&D procurement."

Thank you for the opportunity to comment on the draft report. If you need additional information, please contact Mr. Peter L. McClintock, Assistant Inspector General for Auditing, at 205-6590.

Sincerely,



Patricia Saiki
Administrator

United States
General Accounting Office
Washington, D.C. 20548

Official Business
Penalty for Private Use \$300

First-Class Mail
Postage & Fees Paid
GAO
Permit No. G100

Major Contributors to This Report

Resources,
Community, and
Economic
Development Division,
Washington, D.C.

Lowell Mininger, Assistant Director, (202) 566-1111
Dennis Carroll, Evaluator-in-Charge
Alice Feldesman, Supervisory Social Science Analyst

Office of the General
Counsel

Mindi Weisenbloom, Senior Attorney

Ordering Information

The first copy of each GAO report is free. Additional copies are \$2 each. Orders should be sent to the following address, accompanied by a check or money order made out to the Superintendent of Documents, when necessary. Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

U.S. General Accounting Office
P.O. Box 6015
GaitHERsbuRg, MD 20877

Orders may also be placed by calling (202) 275-6241.