SBIR

AN ASSESSMENT OF THE SMALL BUSINESS INNOVATION RESEARCH PROGRAM

PROJECT METHODOLOGY

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

An Assessment of the Small Business Innovation Research Program

Project Methodology

Committee on
Capitalizing on Science, Technology, and Innovation:
An Assessment of the Small Business Innovation Research Program

Division of Policy and Global Affairs

THE NATIONAL ACADEMIES PRESS
Washington, D.C.
www.nap.edu

THE NATIONAL ACADEMIES PRESS 500 Fifth Street, N.W. Washington, DC 20001

NOTICE: The project that is the subject of this report was approved by the Governing Board of the National Research Council, whose members are drawn from the councils of the National Academy of Sciences, the National Academy of Engineering, and the Institute of Medicine. The members of the committee responsible for the report were chosen for their special competences and with regard for appropriate balance.

This study was supported by Contract/Grant No. DASW01-02C-0039 between the National Academy of Sciences and U.S. Department of Defense, N01-OD-4-2139 (Task Order #99) between the National Academy of Sciences and the U.S. Department of Health & Human Services, NASA-03003 between the National Academy of Sciences and the National Aeronautics and Space Administration, DE-AC02-02ER12259 between the National Academy of Sciences and the U.S. Department of Energy, and DMI-0221736 between the National Academy of Sciences and the National Science Foundation. Any opinions, findings, conclusions, or recommendations expressed in this publication are those of the author(s) and do not necessarily reflect the views of the organizations or agencies that provided support for the project.

Printed in the United States of America

THE NATIONAL ACADEMIES

Advisers to the Nation on Science, Engineering, and Medicine

The **National Academy of Sciences** is a private, nonprofit, self-perpetuating society of distinguished scholars engaged in scientific and engineering research, dedicated to the furtherance of science and technology and to their use for the general welfare. Upon the authority of the charter granted to it by the Congress in 1863, the Academy has a mandate that requires it to advise the federal government on scientific and technical matters. Dr. Bruce M. Alberts is president of the National Academy of Sciences.

The **National Academy of Engineering** was established in 1964, under the charter of the National Academy of Sciences, as a parallel organization of outstanding engineers. It is autonomous in its administration and in the selection of its members, sharing with the National Academy of Sciences the responsibility for advising the federal government. The National Academy of Engineering also sponsors engineering programs aimed at meeting national needs, encourages education and research, and recognizes the superior achievements of engineers. Dr. Wm. A. Wulf is president of the National Academy of Engineering.

The **Institute of Medicine** was established in 1970 by the National Academy of Sciences to secure the services of eminent members of appropriate professions in the examination of policy matters pertaining to the health of the public. The Institute acts under the responsibility given to the National Academy of Sciences by its congressional charter to be an adviser to the federal government and, upon its own initiative, to identify issues of medical care, research, and education. Dr. Harvey V. Fineberg is president of the Institute of Medicine.

The **National Research Council** was organized by the National Academy of Sciences in 1916 to associate the broad community of science and technology with the Academy's purposes of furthering knowledge and advising the federal government. Functioning in accordance with general policies determined by the Academy, the Council has become the principal operating agency of both the National Academy of Sciences and the National Academy of Engineering in providing services to the government, the public, and the scientific and engineering communities. The Council is administered jointly by both Academies and the Institute of Medicine. Dr. Bruce M. Alberts and Dr. Wm. A. Wulf are chair and vice chair, respectively, of the National Research Council.

www.national-academies.org

Committee for Capitalizing on Science, Technology, and Innovation: As Assessment of the Small Business Innovation Research Program*

Chair
Jacques S. Gansler
Interim Dean and Roger C. Lipitz Chair, School of Public Affairs
University of Maryland

David B. Audretsch
Ameritech Chair of Economic Development
and Director of the Institute
for Development Strategies
Indiana University

Gene Banucci
Chairman and CEO
Advanced Technology Materials, Inc.

Jon Baron
Director
Coalition for Evidence-Based Policy

Michael Borrus
Managing Director
The Petkevich Group, LLC

Gail Cassell
Vice President, Scientific Affairs
and Distinguished Research Fellow
Eli Lilly and Company

Elizabeth Downing
CEO
3D Technology Laboratories

Kenneth Flamm
Dean Rusk Chair in International Affairs
Lyndon B. Johnson School of Public Affairs
University of Texas at Austin

M. Christina Gabriel
Vice Provost and Chief Technology Officer
Carnegie Mellon University

Trevor O. Jones
Chairman and CEO
BIOMEC, Inc.

Charles Kolb
President
Aerodyne Research, Inc.

Henry Linsert, Jr.
Chairman and CEO
Martek Biosciences Corporation

W. Clark McFadden
Partner
Dewey Ballantine

Duncan T. Moore
CEO
Infotonics Technology Center

Kent Murphy
Chairman and CEO
Luna Innovations

Linda F. Powers
Managing Director
Toucan Capital Corporation

Tyrone Taylor
President
Capitol Advisors on Technology

Charles Trimble
CEO (ret)
Trimble Navigation

Patrick Windham
President
Windham Consulting

* As of April 2004

Project Staff

Charles W. Wessner
Study Director

Tabitha M. Benney
Program Associate

McAlister T. Clabaugh
Program Associate

Sujai J. Shivakumar
Program Officer

David E. Dierksheide
Program Associate

Christopher S. Hayter
Program Associate

Research Team

Zoltan Acs
University of Baltimore

Alan Anderson
Consultant

Philip A. Auerswald
George Mason University

Grant Black
Georgia State University

Peter Cahill
BRTRC, Inc.

Robert Carpenter
University of Maryland

Julie Ann Elston
University of Central Florida

David H. Finifter
The College of William and Mary

Michael Fogarty
University of Portland

Robin Gaster
North Atlantic Research

Albert N. Link
University of North Carolina

Ken Jacobson
Consultant

Rosalie Reugg
TIA Consulting

Donald Siegel
Rensselaer Polytechnic Institute

Paula E. Stephan
Georgia State University

Nicholas Vonortas
George Washington University

DIVISION OF POLICY AND GLOBAL AFFAIRS

Ad hoc Oversight Board for
Capitalizing on Science, Technology, and Innovation:
An Assessment of the Small Business Innovation Research Program

Robert M. White, Chair
Professor and Director
Data Storage Systems Center
Carnegie Mellon University

Anita K. Jones
Lawrence R. Quarles Professor
of Engineering and Applied
Science
School of Engineering
and Applied Science
University of Virginia

Mark B. Myers
Visiting Professor of Management
The Wharton School
University of Pennsylvania

PREFACE and ACKNOWLEDGMENTS

This document provides an initial version of the methodological approaches to be taken in the Congressionally-mandated study of the SBIR program at the five agencies accounting for 96 percent of the SBIR program expenditures.[1] The proposed methodology draws extensively on the methodologies developed for the review of the previous NRC assessment of the SBIR at the Department of Defense, *SBIR: An Assessment of the Department of Defense Fast Track Initiative.* [2]

While this previous experience has provided a valuable point of departure, the methodologies proposed here reflect a new effort to determine the best means of assessing the SBIR program. The methodology, developed by the National Academies' Research Team and approved by the Committee, is the result of many months' work by the Research Team in consultation with private sector participants, congressional staff, and program managers. Indeed, the proposed methodology has benefited from substantial input of senior staff from the five agencies involved in the study. The agency contributions have been particularly important, providing a collegial environment for the analysis of one of the nation's most significant programs for early-stage finance for small firms. Through the two public symposia and multiple private meetings, agency managers have provided valuable expertise and insights into the diverse goals and operations of the program. Indeed many agency representatives have come to see the study as a useful vehicle for assessing the mechanics and outcomes of their SBIR programs, and as a means of benchmarking their own policies and procedures.

This report has been reviewed in draft form by individuals chosen for their diverse perspectives and technical expertise, in accordance with procedures approved by the NRC's Report Review Committee. The purpose of this independent review is to provide candid and critical comments that will assist the institution in making its published report as sound as possible and to ensure that the report meets institutional standards for objectivity, evidence, and responsiveness to the study charge. The review comments and draft manuscript remain confidential to protect the integrity of the deliberative process.

We wish to thank the following individuals for their review of this report: John Bailar III, University of Chicago; Anthony DeMaria, Coherent DEOS; Irwin Feller, Pennsylvania State University; Fred Gault, Statistics Canada; Mary Good, Venture Capital Investors, LLC; Stephen Kohashi, Department of Housing and Urban Development; Peter Moulton, Q-Peak Inc.; Roger Noll, Stanford University; Maxine Savitz, Honeywell, Inc. (Ret.); Todd Watkins, Lehigh University; Richard Wright, III, National Institute of Standards and Technology (Ret.); and Leo Young, Department of Defense (Ret.).

Although the reviewers listed above have provided many constructive comments and suggestions, they were not asked to endorse the conclusions or recommendations, nor did they see the final draft of the report before its release. The review of this report was overseen by Lewis Branscomb, Harvard University, and Robert White, Carnegie Mellon University. Appointed by the National Research Council, they were responsible for making certain that an independent examination of this report was carried out in accordance with institutional procedures and that all review comments were carefully considered. Responsibility for the final content of this report rests entirely with the authoring committee and the institution.

[1]These are the Department of Defense, National Institutes of Health, National Aeronautics and Space Administration, Department of Energy, and National Science Foundation.

[2]See National Research Council. 2000. Charles W. Wessner, ed. *The Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative*, Washington, D.C.: National Academy Press.

CONTENTS

Executive Summary

The Small Business Reauthorization Act of 2000, H.R. 5667, Section 108, enacted in Public Law 106-554, requests that the National Research Council undertake a review of the of the Small Business Innovation Research program (SBIR) at the five federal agencies with SBIR programs with budgets in excess of $50 million. These five agencies, in order of program size, are the Department of Defense, the National Institutes of Health, the National Aeronautics and Space Administration, the Department of Energy, and the National Science Foundation.

The Study Charge
This study will review the SBIR program at the five agencies with regard to parameters such as the quality of the research projects being conducted under the SBIR program, the commercialization of the research, and the program's contribution to accomplishing agency missions. To the extent possible, the evaluation will include estimates of the benefits (both economic and non-economic) achieved by the SBIR program. The study will also examine broader policy issues associated with public-private collaborations for technology development and government support for high technology innovation. The project will encourage cross-fertilization among program managers, agency officials, and participants by convening national experts from industry, academia, and the public sector to review and discuss research findings. Where appropriate, operational improvements to the program will be considered.

The Objectives of the Study
The objectives of the study are to:

- Satisfy the Congressional mandate for an objective, external assessment of the program;
- Provide an empirical analysis of the operations of the SBIR program, in particular rates and sources of commercialization, for agency officials and program managers;
- Address research questions relevant to the program's operation and evaluation derived from the legislation and that emerge in the course of the study;
- Develop a rigorous assessment of the program and contribute to Congressional understanding of its multiple objectives, measurement issues, operational challenges, and contributions as described in the legislation.

Focus of the Evaluation
Following the passage of HR 5667 in December 2000, extensive discussions were held between the NRC and the five leading agencies regarding the scope and nature required to fulfill the Congressional mandate. Agreement on the terms of the study was reached in December 2001, and the requisite funding for the Academies to begin the study was received in September 2002. The study was officially launched on 1 October 2002. The Memorandum of Understanding between the NRC and the agencies reflects the Congressional mandate by specifying a particular focus for the evaluation on four aspects of the SBIR Program:

1. **Commercialization**. Congress established the SBIR program partly to support commercialization of Federal research. The agencies have in general interpreted this to mean support for research activities, which could result in successful commercialization, measured in different ways, while also meeting other objectives.

2. **Mission support**. Congress has also mandated that SBIR programs should support the mission of the funding agency. Of course, each agency has a different mission, which means that, at least in part, different indicators or metrics will be needed. Indeed, initial research indicates that there are very significant differences in this area among agencies that fund high tech research in order to eventually purchase the outputs from goods and services that may emerge from it (DoD, NASA, parts of DoE) and those that do not (NSF, NIH, parts of DoE). This basic difference suggests the need for quite different research strategies, but, in both cases, the study seeks to establish the extent to which SBIR programs meet this component of the Congressional mandate.

3. **Knowledge base**. All federal research includes the objective of expanding the nation’s knowledge base. SBIR programs are also charged with this objective, which appears to be doubly important for the non-procuring agencies. For these non-procuring agencies, a substantial part of the agency mission could also be described as to the expansion of the knowledge base, through intermediate and final products.

4. **Program management**. The charge to the Committee includes the provision of recommendations for improving the SBIR program (although not for assessing its continued existence). That charge requires review and assessment of how each agency SBIR program operates, and—where possible—the identification of best practices and possible improvements.

Limits of the Committee Charge

The objective of the study is *not* to consider if SBIR should exist or not—Congress has already decided affirmatively on this question. Rather, the NRC Committee conducting this study is charged with providing assessment-based findings of the benefits and costs of SBIR (described in the Objectives section above) to improve public understanding of the program, as well as recommendations to improve the program's effectiveness. It is also important to note that, in accordance with the Memorandum of Understanding and the Congressional mandate, the study will *not* seek to compare the value of one area with other areas; this task is the prerogative of the Congress and the Administration acting through the agencies. Instead, the study is concerned with the effective review of each area.

A Two-Phase Study Structure

The project is divided into two phases. Phase I has focused on data collection and the development of the methodology. Per the agreement with the agencies as outlined in the Memorandum of Understanding,[3] this Methodology was submitted to an intensive Academy review process, involving 12 reviewers with recognized expertise in economics, statistics, program evaluation, survey methodology, innovation policy, federal R&D programs, and both large and small high-tech firms.

Extensive revisions and elaborations were required as a result of this review and they are now reflected in this document. The second phase of the study will now implement the research methodology developed in Phase I. Phase I included an initial symposium for the program as a whole, followed by a number of committee meetings and a series of workshops to address the specific features of each agency's program. This phase has focused on the development of survey instruments, case study templates, and related research to the extent possible. Additional details regarding the study methodologies to be used have been deferred in some cases because they cannot be defined precisely until some initial Phase II work has been completed. At the conclusion of Phase I, the overall methodology and evaluation tools will be submitted for review. In Phase II, research papers on general topics will be commissioned, and preliminary results of field research will be assessed and cross-checked. A symposium will be convened to discuss publicly the results of the research, and final reports will be prepared for each agency and for the program as a whole.

Summary of Methods to be Used

The purpose of this document is to describe the methodological approaches developed under Phase I of the study. They build from the precedents established in several key studies already undertaken to evaluate various aspects of the SBIR. These studies have been successful because they identified the need for utilizing not just a single methodological approach, but rather a *broad spectrum of approaches*, in order to evaluate the SBIR from a number of different perspectives and criteria.

This diversity and flexibility in methodological approach are particularly appropriate given the heterogeneity of goals and procedures across the five agencies involved in the evaluation. Consequently, this document suggests a broad framework for methodological approaches that can serve to guide the research team when evaluating each particular agency in terms of the four criteria stated above. Table 1 illustrates some key assessment parameters and related measures to be considered in this study.[4]

3 See Annex C in this volume.

[4] See also Annex F in this volume.

TABLE 1: OVERVIEW OF APPROACH TO SBIR PROGRAM ASSESSMENT

SBIR Assessment Parameters →	**Quality of Research**	**Commercialization of SBIR Funded Research/ Economic and non-Economic benefits**	**Small Business Innovation/ Growth**	**Use of Small Businesses to Advance Agency Missions**
Questions	How does the quality of SBIR funded research compare with that of other government funded R&D?	What is the overall economic impact of SBIR funded research? What fraction of that impact is attributable to SBIR funding?	How to broaden participation and replenish contractors? What is the link between SBIR and state/regional programs?	How to increase agency uptake while continuing to support high risk research
Measures	Peer review scores Publication counts Citation analysis	Sales; follow up funding; progress; IPO	Patent counts and other IP / employment growth, number of new technology firms	Agency procurement of products resulting from SBIR work
Tools°	Case Studies, Agency Program Studies, Study of Repeat Winners, Bibliometric Analysis	Phase II surveys, Program Manager Surveys, Case Studies, Study of Repeat Winners	Phase I and Phase II surveys, Case Studies, Study of Repeat Winners, Bibiometric Analysis	Program Manager Surveys, Case Studies, Agency Program Studies, Study of Repeat Winners
Key Research Challenges	Difficulty of measuring quality and of identifying proper reference group	Skew of returns; Significant interagency and inter-industry differences	Measures of actual success and failure at the project and firm level; Relationship of federal and state programs in this context	Major interagency differences in use of SBIR to meet agency missions

° Supplementary tools may be developed and used as needed.

Multiple Methodologies

Over the iterative development of the study's methodology, it became clear that no single research methodology would suffice to assess a program as differentiated as SBIR—one with multiple objectives, distinctive agency missions, and varied participants (ranging from small start-ups to relatively large, well-established companies, with product cycles ranging from months to decades). Instead, a complement of methodological tools has been crafted to address different facets of the program's operation.

These tools are firmly grounded in economics and, as noted, draw from the experience of successful approaches pioneered by previous NRC studies of SBIR. They will necessarily have to be implemented in a flexible manner, with additional approaches to be drafted as new research challenges emerge. This document is, in this sense, a *working draft*, reflecting the current state of the Research Team and Committee discussions. It represents the Committee's considered understanding of the tasks at hand, and methodological tools that can be applied to address these tasks. The elaborated methodologies are, thus, not *exclusive*, precluding the adoption of other tools and approaches; nor are they *definitive*, representing a fixed and final statement. Instead, the document provides a summary of current thinking on the project, as it has evolved from the discussions of the Research Team and the Steering Committee, as well as other interested parties. Despite these necessary limitations, this document constitutes a clear statement of the research goals and the tools the Committee plans to use to address them.

Methodology Paper

1. Introduction

As the Small Business Innovation Research (SBIR) program approached its twentieth year of operation, the U.S. Congress requested that the National Research Council (NRC) conduct a "comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet federal research and development needs," and to make recommendations on improvements to the program.[1]

Mandated as a part of SBIR's renewal in 2000, the NRC study is to assess the SBIR program as administered at the five federal agencies that together make up 96 percent of SBIR program expenditures. The agencies, in order of program size, are DoD, NIH, NASA, DoE, and NSF.

The objective of the study is not to consider if SBIR should exist or not—Congress has already decided affirmatively on this question. Rather, the NRC Committee conducting this study is charged with providing assessment-based findings to improve public understanding of the program as well as recommendations to improve the program's effectiveness.

In addition to setting out the study objectives, this report defines key concepts, identifies potential metrics and data sources, and describes the range of methodological approaches being developed by the NRC to assess the SBIR program. Following some historical background on the SBIR program, this introduction outlines the basic parameters of this NRC study.

A Brief History of the SBIR Program

In the 1980s, the country's slow pace in commercializing new technologies—compared especially with the global manufacturing and marketing success of Japanese firms in autos, steel, and semiconductors—led to serious concern in the United States about the nation's ability to compete. U.S. industrial competitiveness in the 1980s was frequently cast in terms of American industry's failure "to translate its research prowess into commercial advantage."[2]

The pessimism of some was reinforced by evidence of slowing growth at corporate research laboratories that had been leaders of American innovation in the postwar period and the apparent success of the cooperative model exemplified by some Japanese *kieretsu*.[3]

Yet, even as larger firms were downsizing to improve their competitive posture, a growing body of evidence, starting in the late 1970s and accelerating in the 1980s, began to indicate that small businesses were assuming an increasingly important role in both innovation and job creation.[4] Research by David Birch and others suggested that national policies should promote and build on the competitive strength offered by small businesses.[5]

In addition to considerations of economic growth and competitiveness, SBIR was also motivated by concerns that small businesses were being disadvantaged vis-à-vis larger firms in competition for R&D contracts. Federal

---

[1] See Public Law 106-554, Appendix I – H.R. 5667, Section 108. Also Annex A in this volume.

[2] David C. Mowery, "America's Industrial Resurgence (?): An Overview," in David C. Mowery, ed., *U.S. Industry in 2000: Studies in Competitive Performance*. Washington, D.C.: National Academy Press, 1999, p. 1. Mowery examines eleven economic sectors, contrasting the improved performance of many industries in the late 1990s with the apparent decline that was subject to much scrutiny in the 1980s. Among the studies highlighting poor economic performance in the 1980s are Dertouzos, et al. *Made in America: The MIT Commission on Industrial Productivity*, Cambridge, MA: The MIT Press, 1989 and Eckstein, et al. *DRI Report on U.S. Manufacturing Industries,* New York: McGraw Hill, 1984.

[3] Richard Rosenbloom and William Spencer, *Engines of Innovation: U.S. Industrial Research at the End of an Era.* Boston: Harvard Business Press, 1996.

[4] For an account of the growing importance of the small firm in employment and innovation, see Zoltan J. Acs and David B. Audretsch, *Innovation and Small Business.* Cambridge, Massachusetts: MIT Press, 1991, p. 4. For specifics on job growth, see Steven J. Davis, John Haltiwanger, and Scott Schuh, "Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts," *Business Economics*, vol. 29, no. 3, 1994, pp. 113-22. More recently, a report by the Organisation for Economic Co-operation and Development (OECD) notes that small and medium-sized enterprises are attracting the attention of policy makers, not least because they are seen as major sources of economic vitality, flexibility, and employment. Small business is especially important as a source of new employment, accounting for a disproportionate share of job creation. See OECD, *Small Business Job Creation and Growth: Facts, Obstacles, and Best Practices*, Paris, 1997.

[5] David L. Birch, "Who Creates Jobs?" *The Public Interest*. Vol. 65, 1981, pp. 3-14

commissions from as early as the 1960s had recommended the direction of R&D funds toward small businesses.[6] These recommendations, however, were opposed by competing recipients of R&D funding. Although small businesses were beginning to be recognized by the late-1970s as a potentially fruitful source of innovation, some in government remained wary of funding small firms focused on high-risk technologies with commercial promise.

The concept of early-stage financial support for high-risk technologies with commercial promise was first advanced by Roland Tibbetts at the National Science Foundation (NSF). As early as 1976, Mr. Tibbetts advocated that the NSF should increase the share of its funds going to small business. When NSF adopted this initiative, small firms were enthused and proceeded to lobby other agencies to follow NSF's lead. When there was no immediate response to these efforts, small businesses took their case to Congress and higher levels of the Executive branch.[7]

In response, a White House Conference on Small Business was held in January 1980 under the Carter Administration. The conference's recommendation to proceed with a program for small business innovation research was grounded in:

- Evidence that a declining share of federal R&D was going to small businesses;
- Broader difficulties among small businesses in raising capital in a period of historically high interest rates; and
- Research suggesting that small businesses were fertile sources of job creation.

Congress responded under the Reagan Administration with the passage of the Small Business Innovation Research Development Act of 1982, which established the SBIR program.[8]

The SBIR Development Act of 1982

The new SBIR program initially required agencies with R&D budgets in excess of $100 million to set aside 0.2 percent of their funds for SBIR. This amount totaled $45 million in 1983, the program's first year of operation. Over the next 6 years, the set-aside grew to 1.25 percent.[9]

The legislation authorizing SBIR had two broad goals:

- "to more effectively meet R&D needs brought on by the utilization of small innovative firms (which have been consistently shown to be the most prolific sources of new technologies) and
- to attract private capital to commercialize the results of federal research."

SBIR's Structure and Role

As conceived in the 1982 Act, SBIR's grant-making process is structured in three phases:

- Phase I is essentially a feasibility study in which award winners undertake a limited amount of research aimed at establishing an idea's scientific and commercial promise. Today, the legislation anticipates Phase I grants as high as $100,000.[10]
- Phase II grants are larger – normally $750,000 – and fund more extensive R&D to further develop the scientific and technical merit and the feasibility of research ideas.
- Phase III. This phase normally does not involve SBIR funds, but is the stage at which grant recipients should be obtaining additional funds either from a procurement program at the agency that made the award, from private investors, or from the capital markets. The objective of this phase is to move the technology to the prototype stage and into the marketplace.

Phase III of the program is often fraught with difficulty for new firms. In practice, agencies have developed different approaches to facilitating this transition to commercial viability; not least among them are additional SBIR awards.[11]

---

[6] For an overview of the origins and history of the SBIR program, see James Turner and George Brown, "The Federal Role in Small Business Research," *Issues in Science and Technology*, Summer 1999, pp. 51-58.

[7] Ibid.

[8] Additional information regarding SBIR's legislative history can be accessed from the Library of Congress. See http://thomas.loc.gov/cgi-bin/bdquery/z?d097:SN00881:@@@L

[9] Today, the set aside is fixed at 2.5 percent.

[10] With the accord of the Small Business Administration, which plays an oversight role for the program, this amount can be higher in certain circumstances; e.g., drug development at NIH, and is often lower with smaller SBIR programs, e.g., EPA or the Department of Agriculture.

Some firms with more experience with the program have become skilled in obtaining additional awards. Previous NRC research showed that different firms have quite different objectives in applying to the program. Some seek to demonstrate the potential of promising research. Others seek to fulfill agency research requirements on a cost-effective basis. Still others seek a certification of quality (and the additional awards that can come from such recognition) as they push science-based products toward commercialization.[12] Given this variation and the fact that agencies do not maintain data on Phase III, quantifying the contribution of Phase III is difficult.

The 1992 and 2000 SBIR Reauthorizations

The SBIR program approached reauthorization in 1992 amidst continued worries about the U.S. economy's capacity to commercialize inventions. Finding that "U.S. technological performance is challenged less in the creation of new technologies than in their commercialization and adoption," the National Academy of Sciences at the time recommended an increase in SBIR funding as a means to improve the economy's ability to adopt and commercialize new technologies.[13]

Accordingly, the Small Business Research and Development Enhancement Act (P.L. 102-564), which reauthorized the program until September 30, 2000, doubled the set-aside rate to 2.5 percent.[14] This increase in the percentage of R&D funds allocated to the program was accompanied by a stronger emphasis on encouraging the commercialization of SBIR-funded technologies.[15] Legislative language explicitly highlighted commercial potential as a criterion for awarding SBIR grants. For Phase I awards, Congress directed program administrators to assess whether projects have "commercial potential" in addition to scientific and technical merit when evaluating SBIR applications.

With respect to Phase II, evaluation of a project's commercial potential was to consider, additionally, the existence of second-phase funding commitments from the private sector or other non-SBIR sources. Evidence of third-phase follow-on commitments, along with other indicators of commercial potential, was also sought. Moreover, the 1992 reauthorization directed that a small business' record of commercialization be taken into account when considering the Phase II application.[16]

The Small Business Reauthorization Act of 2000 (P.L. 106-554) again extended SBIR until September 30, 2008. It also called for an assessment by the National Research Council of the broader impacts of the program, including those on employment, health, national security, and national competitiveness.[17]

Previous NRC Assessments of SBIR

Despite its size and tenure, the SBIR program has not been comprehensively examined. There have been some previous studies focusing on specific aspects or components of the program—notably by the General Accounting Office and the Small Business Administration.[18] There are, as well, a limited number of internal assessments of

---

[11] NSF, for example, has what is called a Phase II-B program that allocates additional funding to help potentially promising technology develop further and attract private matching funds.

[12] See Reid Cramer, "Patterns of Firm Participation in the Small Business Innovation Research Program in Southwestern and Mountain States," in National Research Council, *The Small Business Innovation Research Program, An Assessment of the Department of Defense Fast Track Initiative*, op. cit. In this report, we use the term "product" to refer to goods and services produced by the SBIR firm.

[13] See National Research Council, *The Government Role in Civilian Technology: Building a New Alliance,* Washington, D.C.: National Academy Press, 1992, pp. 29.

[14] For fiscal year 2003, this has resulted in a program budget of approximately $1.6 billion across all federal agencies, with the Department of Defense having the largest SBIR program at $834 million, followed by the National Institutes of Health (NIH) at $525 million. The DoD SBIR program, is made up of 10 participating components: (see Figure 1): Army, Navy, Air Force, Missile Defense Agency (MDA), Defense Advanced Research Projects Agency (DARPA), Chemical Biological Defense (CBD), Special Operations Command (SOCOM), Defense Threat Reduction Agency (DTRA), National Imagery and Mapping Agency (NIMA), and the Office of Secretary of Defense (OSD). NIH counts 23 institutes and agencies making SBIR awards.

[15] See Robert Archibald and David Finifter, "Evaluation of the Department of Defense Small Business Innovation Research Program and the Fast Track Initiative: A Balanced Approach," op. cit. pp. 211-250.

[16] A GAO report had found that agencies had not adopted a uniform method for weighing commercial potential in SBIR applications. See U.S. General Accounting Office, 1999, *Federal Research: Evaluations of Small Business Innovation Research Can Be Strengthened,* AO/RCED-99-114, Washington, D.C.: United States General Accounting Office.

[17] The current assessment is congruent with the Government Performance and Results Act (GPRA) of 1993: http://govinfo.library.unt.edu/npr/library/misc/s20.html. As characterized by the GAO, GPRA seeks to shift the focus of government decision-making and accountability away from a preoccupation with the activities that are undertaken - such as grants dispensed or inspections made - to a focus on the results of those activities. See http://www.gao.gov/new.items/gpra/gpra.htm

[18] An important step in the evaluation of SBIR will be to identify existing evaluations of SBIR. See for example, GAO, "Federal Research: Small Business Innovation Research shows success but can be strengthened. Washington, D.C.: U.S. General Accounting Office, 1992; and GAO, "Evaluation of Small Business Innovation can be Strengthened," Washington, D.C.: U.S. General Accounting Office, 1999. There is also a 1999 unpublished SBA study on the commercialization of SBIR surveys Phase II awards from 1983 to 1993 among non-DoD agencies.

agency programs.[19] The academic literature on SBIR is also limited.[20] Annex E provides a bibliography of SBIR as well as more general references of interest.

Against this background, the National Academies' Committee for Government-Industry Partnerships for the Development of New Technologies—under the leadership of its chairman, Gordon Moore—undertook a review of the SBIR program, its operation, and current challenges. The Committee convened government policy makers, academic researchers, and representatives of small business on February 28, 1998 for the first comprehensive discussion of the SBIR program's history and rationale, review existing research, and identify areas for further research and program improvements.[21]

The Moore Committee reported that:

- SBIR enjoyed strong support both within and outside the Beltway.
- At the same time, the size and significance of SBIR underscored the need for more research on how well it is working and how its operations might be optimized.
- There should be additional clarification about the primary emphasis on commercialization within SBIR, and about how commercialization is defined.
- There should also be clarification on how to evaluate SBIR as a single program that is applied by different agencies in different ways.[22]

Subsequently, at the request of the DoD, the Moore Committee was asked to review the operation of the SBIR program at Defense, and in particular the role played by the Fast Track Initiative. This resulted in the largest and most thorough review of an SBIR program to date. The review involved substantial original field research, with 55 case studies, as well as a large survey of award recipients. It found that the SBIR program at Defense was contributing to the achievement of mission goals—funding valuable innovative projects—and that a significant portion of these projects would not have been undertaken in the absence of the SBIR funding. The Moore Committee's assessment also found that the Fast Track Program increases the efficiency of the DoD SBIR program by encouraging the commercialization of new technologies and the entry of new firms to the program.

More broadly, the Moore Committee found that SBIR facilitates the development and utilization of human capital and technological knowledge. Case studies have shown that the knowledge and human capital generated by the SBIR program has economic value, and can be applied by other firms. And through the certification function, it noted, SBIR awards encourage further private sector investment in the firm's technology.

Based on this and other assessments of public private partnerships, the Moore Committee's *Summary Report* on U.S. Government-Industry Partnerships recommended that "regular and rigorous program-based evaluations and feedback is essential for effective partnerships and should be a standard feature," adding that "greater policy attention and resources to the systematic evaluation of U.S. and foreign partnerships should be encouraged."[23]

Preparing the Current Assessment of SBIR

As noted, the legislation mandating the current assessment of the nation's SBIR program focuses on the five agencies that account for 96 percent of program expenditures (although the National Research Council is seeking to learn of the views and practices of other agencies administering the program as well.) The mandated agencies, in order of program size, are the Department of Defense, the National Institutes of Health, the National Aeronautics and Space Administration, the Department of Energy, and the National Science Foundation.

Following the passage of H.R. 5667 in December 2000, extensive discussions were held between the NRC and the responsible agencies on the scope and nature of the mandated study. Agreement on the terms of the study, formalized in a Memorandum of Understanding, was reached in December 2001 (See Annex B), and the funding necessary for the Academies to begin the study was received in September 2002. The study was officially launched on 1 October 2002.

The study will be conducted within the framework provided by the legislation and the NRC's contracts with the five agencies. These contracts identify the following principal tasks:

---

[19] Agency reports include an unpublished 1997 DoD study on the commercialization of DoD SBIR. Following the authorizing legislation for the NRC study, NIH launched a major review of the achievements of its SBIR program. NASA has also completed several reports on its SBIR program. See Annex C for a list of agency reports.

[20] See the attached bibliography.

[21] See National Research Council, *Small Business Innovation Research: Challenges and Opportunities,* C. Wessner, ed., Washington, D.C.: National Academy Press, 1999.

[22] Ibid.

[23] See National Research Council, *Government-Industry Partnerships for the Development of New Technologies, Summary Report,* C. Wessner, ed., Washington, D.C.: National Academies Press, 2002.

- Collection and analysis of agency databases and studies,
- Survey of firms and agencies,
- Conduct of case studies organized around a common template, and;
- Review and analysis of survey and case study results and program accomplishments.

As per the Memorandum of Understanding between the NRC and the agencies, the study is structured in two-phases. Phase I of the study, beginning on October 2002, focuses on identifying data collection needs and the development of a research methodology. Phase II of the study, anticipated to start in 2004, will implement the research methodology developed in Phase I of the study.

This document outlines the methodological approach being developed under Phase I of the study. It introduces many of the methodological questions to be encountered during Phase II of the NRC study. Finally, it outlines strategies for resolving these questions, recognizing that some issues can only be resolved in the context of the study itself.

Given that agencies covered in this study differ in their objectives and goals, the assessment will necessarily be agency-specific.[24] As appropriate, the Committee will draw useful inter-agency comparisons and multiyear comparisons. In this regard, a table with the agencies in one dimension and all of the identified SBIR objectives in the other may be a useful expository tool. The study will build on the methodological models developed for the 1999 NRC study of the DoD's Fast Track initiative, as appropriate, clearly recognizing that the broader and different scope of the current study will require some adjustments.[25] Additional areas of interest, as recognized by the Committee, may also be pursued as time and resources permit.

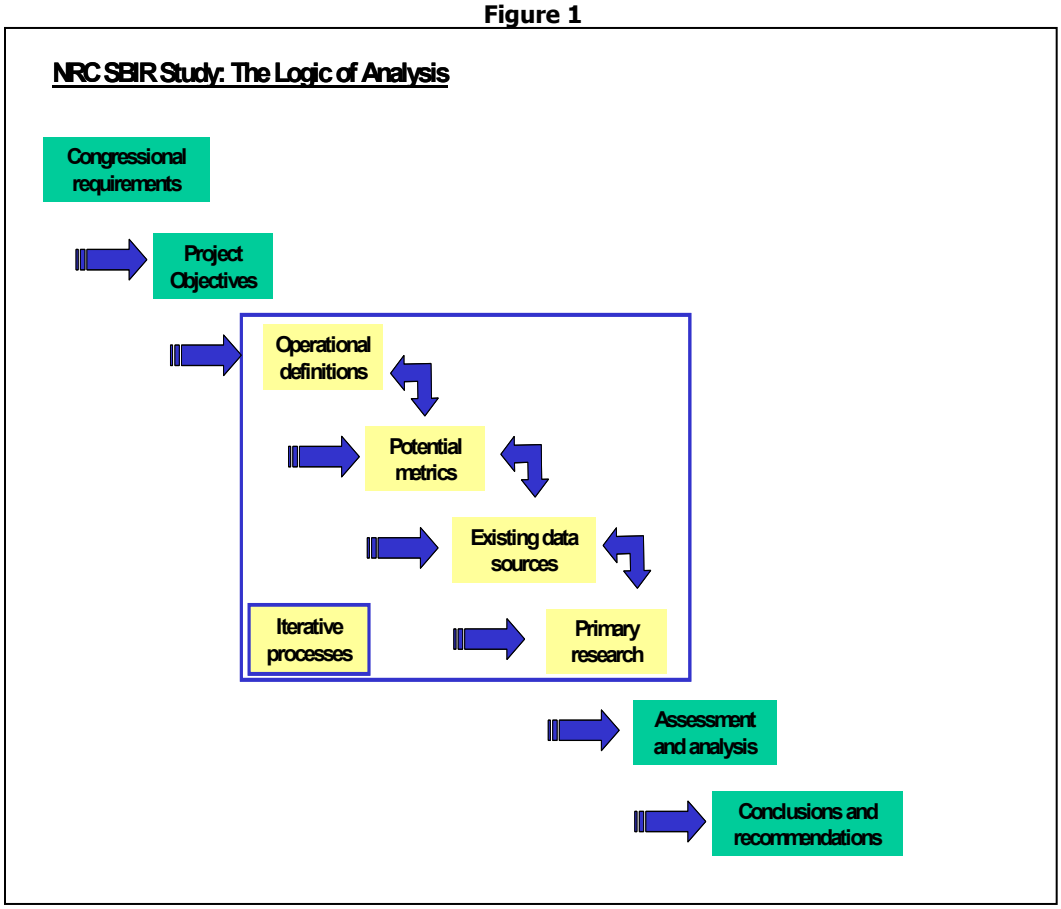
[24] Particularly, with respect to DoD, methodological comparability will be sought to enable multiyear comparisons. Where possible and appropriate, tracking of progress of previously surveyed/interviewed firms will be considered as well.

[25] In particular, the objective of the Fast Track study was to compare Fast Track awards and non-Fast Track awards *within the DoD SBIR program*, in order to determine the efficacy of Fast Track. See National Research Council, The *Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative*, C. Wessner, ed., National Academy Press, Washington, D.C., 2000.

2. An Overview of the Study Process

Following its approval of the broad study parameters of the study in October 2002, the Committee set out an overall roadmap to guide the research process. Tasks included are the development a set of operational definitions, the identification of detailed metrics, the review existing data sources, and the development of primary research methodologies. Closely interrelated, these tasks will be addressed iteratively. (These iterative tasks are represented in the box within Figure 1.) Following completion of field research, the Committee will conduct its analysis and assessment and will issue its findings and recommendations.

Figure 1



The elements of this multi-step process are detailed below:

1. **Agree on initial guidelines.** These initial guidelines are based on the legislation, the Memorandum of Understanding, and contracts.
2. **Clarify objectives.** What central questions must the study answer? What other interesting but optional questions should be addressed? What questions will specifically not be considered? This is discussed further in Section 3 of this chapter.
3. **Develop operational definitions:** For example, while Congress has mandated that the study address the extent to which SBIR supports the agencies' missions, the Committee needs to develop operational definitions of "support" and "agency mission," in collaboration with agency managers responsible for program operations. This is a necessary step before developing the relevant metrics. This is discussed further in Section 4 of this chapter.
4. **Identify metrics for addressing study objectives.** The Committee will determine extent of commercialization fostered by SBIR—measured in terms of products procured by agencies, commercial sales, licensing revenue, or other metrics. This is discussed further in Section 5 of this chapter.
5. **Identify data sources**. Implementation of agreed metrics requires data. A wide mix of data sources will be used, so the availability of existing data and the feasibility of collecting needed data by different methods will also condition the selection of metrics, and the choice of study methods. The existence or absence of specific methodologies and data sets will undoubtedly lead to the modification, adoption, or elimination of specific metrics and methods. This is discussed further in Section 6 of this chapter.
6. **Develop primary research methodologies.** The study's primary research components will include interviews, surveys, and case studies to supplement existing data. Control groups and counterfactual approaches will be used where feasible and appropriate to isolate the effects of the SBIR program. Other evaluation methods may also be used on a limited basis as needed to address questions not effectively addressed by the principal methods. This is discussed further in Section 7 of this report.
7. **Complete Phase I**. Phase I of the NRC study will be formally completed once a set of methodologies is developed and documented, is approved by the Committee, and passes successfully through the Academy's peer review process.
8. **Implement the research** program (NRC Study Phase II). The variety of tasks involved in implementing the research program is previewed in Annex I of this report.
9. **Prepare agency-specific reports.** Results from the research program will be presented in five agency-specific reports—one for each of the agencies. Where appropriate, agency-specific findings and recommendations will be formulated by the relevant study subcommittee for review and approval by the full Committee.
10. **Prepare overview report.** A separate summary report, buttressed by the relevant commissioned work and bringing together the findings of the individual agency reports, along with general recommendations, will be produced for distribution. This final report will also draw out, as appropriate, the contrasts and similarities among the agencies in the way they administer SBIR. It will follow the approval procedure outlined above.
11. **Organize public meetings to review and discuss findings.** Following report review, findings and recommendations will be presented publicly for information, review, and comment.
12. **Submit reports to Congress.**
13. **Disseminate findings broadly.**

3. Clarifying Study Objectives

Three primary documents condition and define the objectives for this study: These are the *Legislation—H.R. 5667* [Annex A], the *NAS contracts accepted by the five agencies* [Annex B], and the NAS-Agencies *Memorandum of Understanding* [Annex C]. Based on these three documents, the team's first task is to develop a comprehensive and agreed set of practical objectives that can be reviewed and ultimately approved by the Committee.

The Legislation charges the NRC to "conduct a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet Federal research and development needs." H.R. 5667 includes a range of questions [see Annex A]. According to the legislation, the study should:

a) review the quality of SBIR research**;**

b) review the SBIR program's value to the agency's mission;

c) assess the extent to which SBIR projects achieve some measure of commercialization;

d) evaluate economic and non-economic benefits;

e) analyze trends in agency R&D support for small business since 1983;

f) analyze—for SBIR Phase II awardees—the incidence of follow-on contracts (procurement or non-SBIR Federal R&D)

g) perform additional analysis as required to consider specific recommendations on:

- measuring outcomes for agency strategy and performance;
- possibly opening Phase II SBIR competitions to all qualifying small businesses (not just SBIR Phase I winners);
- recouping SBIR funds when companies are sold to foreign purchasers and large companies;
- increasing Federal procurement of technologies produced by small business;
- improving the SBIR program.

Items under (g) are questions raised by the Congress that will be considered along with other areas of possible recommendation once the data analysis is complete.

The NAS proposal accepted by the agencies on a contractual basis adds a specific focus on commercialization following awards, and "broader policy issues associated with public-private collaborations for technology development and government support for high technology innovation, including bench-marking of foreign programs to encourage small business development." The proposal includes SBIR's contribution to economic growth and technology development in the context of the economic and non-economic benefits listed in the legislation.

SBIR does seek to meet a number of distinctly different objectives with a single program, and there is no clear guidance from Congress about their relative importance. The methodology developed to date assumes that each of the key objectives must be assessed separately, that it will be possible to draw some conclusions about each of the primary objectives, and that it will be possible to draw some comparisons between those assessments. Balancing these different objectives by weighing the Committee assessment is a matter for Congress to decide.

At the core of the study is the need to determine how far the SBIR program has evolved from merely requiring more mission agency R&D to be purchased from small firms to an investment in new product innovation that might or might not be purchased later by the agency.

4. Developing Operational Definitions and Concepts

The study will identify core operational terms and concepts in advance of full development of the methodology. The following represents an initial identification of some terms and concepts:

The quality of SBIR research

Quality is a relative concept by definition, so an assessment of SBIR research quality must compare it to the quality of other research.[26] Quality is also subjective, so the realization of value may depend on its perceived utility. The principal comparison here will be with other extra-mural research funded by the same agencies. The question of whether comparisons should focus only on R&D by other small businesses is yet to be addressed; this decision may be made on an agency-by-agency basis.[27]

SBIR's value to agency missions

Given that agency missions and their associated sub-unit objectives differ substantially among, (and even within) agencies, the issue of SBIR's value to agency missions will be addressed largely in the context of individual agency analysis. While a more generic set of answers would be helpful, it will be important to emphasize the challenges posed by multiple agencies with multiple missions, executed by multiple subunits. For example, some agencies, such as DoD and NASA, are "procurement agencies," seeking tools for the nation's military, while others, such as NSF and NIH, are not. These different goals may change the agency's vision of SBIR's role quite fundamentally.
Generic mission elements include:

- **Technology needs** (i.e., agency-identified technology gaps, such as a missing vaccine delivery system identified as a priority by NIH[28]);
- **Procurement needs** (i.e., technologies that the agency needs for its own internal use, e.g., optical advances for smart weapons at DoD).
- **Expansion or commercialization of knowledge in agency's field of stewardship** (e.g., funding in relatively broad sub-fields of information technology at NSF);[29]
- **Technology transfer** (i.e., promoting the adoption of agency-developed technology by others). Technology may become available to the sponsoring agency and others through a variety of paths. These include
    - Procurement from supply chain providers,
    - Purchase by the agency on the open market via successful commercialization by the SBIR firm (e.g., purchase of DoD-R&D-supported advanced sonar equipment),
    - Use by others of the technology whose development is sponsored by the agency and made available through such means as licensing, partnership arrangements, or by purchase on the open market. (e.g., a power plant may adopt technology available on the market and fostered by DoE's SBIR, or a public health clinic may adopt a new vaccine delivery system available on the market and fostered by NIH's SBIR).

To address agency-specific missions (e.g., national defense at DoD, health at NIH, energy at DoE), the Committee will closely consult with agency staff to develop operational definitions of success--in some cases at the level of sub-units (e.g., individual NIH institutes and centers.) Some overlay will likely occur (e.g., defense-health needs.)
Finally, agencies will undoubtedly have their own conceptions of how their SBIR program is judged in relation to their missions, and it is possible (perhaps likely) that some of these views will not fit well in the areas listed. The Committee is sensitive to these distinctions and differences, and will articulate these concepts at an early stage.

---

[26] See K. Buchholz. "Criteria for the analysis of scientific quality," *Scientometrics* 32 (2), 1995:195-218.
[27] See M. Brown, T.R. Curlee and S.R. Elliott, "Evaluating Technology Innovation Programs: The Use of Comparison Groups to Identify Impacts," Research Policy, 24, 1995.
[28] See for example, "Micromachined Ultrasound Ejector Arrays For Aerosol-Based Pulmonary Vaccine Delivery." Response to SBIR Proposal PHS 2001 NIP Topic 009, Technologies to Overcome the Drawbacks of Needles and Syringes Contract No: 200-2001-00112
[29] See, for example, Maryann Feldman and Maryellen Kelley, "Leveraging Research and Development: The Impact of the Advanced Technology Program," in National Research Council, *The Advanced Technology Program,* C. Wessner, ed. Washington, D.C.: National Academy Press, 2001, for a potential model of how an agency can use SBIR to help foster specific areas of technical expertise. The paper, however, does not address the extent to which this is a conscious goal of DoD.

The extent of commercialization

SBIR is charged with supporting the commercialization of technologies developed with federal government support. In many agencies, this requirement is articulated as a focus on the "commercialization" of SBIR supported research.[30] At the simplest level, commercialization means, "reaching the market," which some agency managers interpret as "first sale": the first sale of a product in the market place, whether to public or private sector clients.[31] This definition is certainly practical and defensible. However, it risks missing significant components of commercialization that do not result in a discrete sale. At the same time, it also fails to provide any guidance on how to evaluate the *scale* of commercialization, which is critical to assessing the degree to which SBIR programs successfully encourage commercialization: the sale of a single widget is not the same as playing a critical role in the original development of Qualcomm's cell-phone technology.

Thus, the Committee's assessment of commercialization will require working operational definitions for a number of components. These include:

- Sales—what constitutes a sale?
- Application—how is the product used? For example, products like software are re-used repeatedly.
- Measuring scale—over what interval is the impact to be measured. (e.g., Qualcomm's SBIR grant was by all accounts very important for the company. The question arises as to how long the dollar value of Qualcomm's wireless related sales, stemming from its original SBIR grant, should be counted.)[32]
- Licensing—how should commercial sales generated by third party licensees of the original technology be counted. Is the licensing revenue from the licensee to be counted, or the sales of that technology by the licensee— (or both)?
- Complex sales—technologies are often sold as bundles with other technologies (auto engines with mufflers for example). Given this, how is the share of the total sales value attributable to the technology that received SBIR funding to be defined?
- Lags—some technologies reach market rapidly, but others can take 10 years or more. What is an appropriate discount rate and timeframe to measure award impact?

Metrics for assessing commercialization can be elusive. Notably, one cannot easily calculate the full value of developed "enabling technology" that can be used across industries. Also elusive is the value of material that enables a commercial service. In such cases, a qualitative approach to "commercialization" will need to be employed.

While the theoretical concept of additionality will be of some relevance to these questions, practicalities must govern, and the availability of data will substantially shape the Committee's approach in this area. This is particularly the case where useful data must be gathered from thousands of companies, often at very considerable expense in dollars and time. [33]

The NRC study will resolve these very practical questions by the early stages of the study's second phase. The Committee plans to adapt, where appropriate, definitions and approaches used in the Fast Track study for the current study.[34]

Broad economic effects

SBIR programs may generate a wide range of economic effects. While some of these may be best considered in a national context, others fall more directly on participating firms and on the agencies themselves. The Committee will consider these possible benefits and costs in terms of the level of incidence.

---

[30] A key objective of the 1982 Small Business Innovation Development Act is to increase private sector commercialization derived from federal research and development. The role of SBIR in stimulating commercialization was cited as a justification in the reauthorization of the Act in 1992: that SBIR "has effectively stimulated the commercialization of technology development through federal research and development, benefiting both the public and private sectors of the Nation."

[31] For analysis of observed variations in timelines for commercialization, see NISTIR 6917 "Different Timelines for Different Technologies: Evidence from the Advanced Technology Program" at http://www.atp.nist.gov/eao/ir-6917/chapt5.htm

[32] For a profile of Qualcomm, see http://www.inknowvation.com/cgi-bin/db4/Qualcomm_Profile.html

[33] Buisseret, T.J., Cameron, H., and Georghiou, L. (1995) "What difference does it make? Additionality in the public support of R&D in large firms", *International Journal of Technology Management, Vol.10*, Nos. 4/5/6 pp. 587-600. See also, Luke Georghiou, "Impact and Additionality of Innovation Policy," Paper presented at the Six Countries Programme on Innovation, Spring 2002, Brussels.

[34] See National Research Council, SBIR: *An Assessment of the Department of Defense Fast Track Initiative*, 2000, op. cit.

Participating firms

Economic effects on firms include some or all of the following elements:

- **Revenue** from *sale or adoption* of SBIR-developed products, services, or processes (this tracks quite closely but not 100 percent with commercialization)
- **Changes in the firm's access to capital**, including ways in which SBIR awards have helped (or hindered) recipient companies access capital markets
- **Change in firm viability and sustainability,** including how the SBIR program helped bridge the gaps between these interrelated stages of the innovation process;[35]
    - Conception
    - Innovation
    - Product development
    - Entry into market
- **Changes in the propensity to partner and the nature of the partnerships**
    - The impact of SBIR on the frequency with which companies develop partnerships
    - The nature of the partnerships—are they public or private partners?
- **Enhanced firm growth, productivity, profitability**
    - Change in employment and capitalization[36]
    - Change in firm productivity
    - Change in profits
- **Intellectual property** developed by the firm
    - Work in this section will follow closely on the Fast Track study model, seeking to identify ways in which the recipient firms were affected in the areas listed.[37]

The agencies

Effects on the agencies include the following:

- **Effects on mission support**
- **Effects on agency research efficiency,** including whether --
    - SBIR has helped to generate technologies that agencies might not otherwise have developed in the same timeframe without the program
    - SBIR is an effective way for agencies to fund competitive research, presumably compared to non-SBIR research funding for small scale requirements
    - There are significant benefits to agency missions from the specific effort of SBIR to capture research by small firms. Benchmark numbers for small business contributions to agency research programs before SBIR (pre-1983), and outside SBIR (other programs?) may be needed.

  Research efficiency implies a review of the returns to the agency from SBIR investment vs. other research investment. It is important to acknowledge, however, that this analysis will likely not be based on hard rate of return analysis, because the data necessary for such analysis is unlikely to be available at the agency level.
- Effects on agency procurement efficiency

[35] Though commonly conceived as a linear process, innovation is characterized by significant complexity. For a discussion of this complexity, see, National Research Council, *The Small Business Innovation Research Program: Program Diversity and Assessment Challenges,* C. Wessner, ed. Washington, D.C.: National Academies Press, 2004.
[36] The employment effects of research are most often indirect—through the application or commercialization of the research.
[37] Ibid.

Effects on society

- **Social returns** refer to the returns to society at large, including private returns and spillover effects. Using the Link/Scott approach from Fast Track as a model is expected to help us conceptualize our approach to this broad effect.[38] Other approaches may also be useful.
- **Small business support** refers to the positive social externalities associated with a vibrant small business sector, including community cohesiveness and improvements to life made possible new products. Measuring the impact of program support for small business is a major objective,[39] given that support encourages the commercialization of public investment in R&D, the achievement of national missions, and the encouragement of small firm growth.
- **Training in both business development and in technology and innovation** The Audtresch/ J. Weigand/ C. Weigand Fast Track paper provides a good methodological basis for addressing "training."[40]

Non-economic benefits

While it is possible to view almost all non-economic effects through the lens of economic analysis, pushing all effects to economic measurement is usually not feasible and may not be appropriate. Certain effects have been specifically defined as positive outcomes by Congress, regardless of whether they have any measurable impact on economic well-being. This section addresses non-economic benefits, which will in turn have non-economic metrics attached to them, discussed later in this paper.

Knowledge benefits

The missions of several agencies explicitly state the requirement of advancing knowledge in the relevant field. For the SBIR program, this requirement can be viewed from two distinct but complementary perspectives:

- **Intellectual property,**[41] which is governed by a set of legal definitions, and is susceptible to close measurement via analysis of patent filings and other largely quantitative assessment strategies.[42] Intellectual property rights are generally used to convert knowledge to property for commercial benefit of the owner. At the same time, mechanisms of intellectual property can help to disseminate knowledge to others. A patent, for example, gives the holder exclusive rights, but provides information to others. Intellectual property also includes "trade secrets." In many cases, the "know how" that firms keep proprietary may be the most important intellectual property produced by the research. These may be less susceptible to measurement.
- **Non-property knowledge** is much less well defined but nonetheless of great importance. Non-property knowledge ranges from formal activities (e.g., papers published in refereed journals, and seminars) to very informal activities (e.g., discussions among researchers and worker mobility). Many relevant concepts are discussed in the literature on human capital. Non-property knowledge is related to education and training and encompasses network capital and tacit expertise that an engineer or scientist may possess.

---

[38] See Link, A. N. and Scott, J. T. *Public Accountability: Evaluating Technology-Based Institutions*, Boston: Kluwer Academic Publishers, 1998. Link and Scott use published agency data and interviews to determine key indicators, including private hurdle rates, additional anticipated development time after Phase II, additional cost, life of the commercialized technology, and proportion of value appropriated by firm. These allow estimates of social and private returns. Link and Scott indicate that the rates of return on the SBIR Phase II investment for Fast Track were 84 percent for society and 25 percent for private investors.

[39] See also section 4.5 below.

[40] See David Audretsch, Jeurgen Weigand and Claudia Weigand, "The Impact of the SBIR on creating entrepreneurial behavior," *Economic Development Quarterly* Vol. 16, No. 1, February 2002, pp. 32-38. Audretsch/Weigand/Weigand identify interesting spillover effects of SBIR grants on non-recipient scientists and engineers, in terms of career paths, entrepreneurial activities and their timing, etc.

[41] Intellectual property is divided into two categories: *Industrial property*, which includes inventions (patents), trademarks, industrial designs, and geographic indications of source; and *Copyright*, which includes literary and artistic works such as novels, poems and plays, films, musical works, artistic works such as drawings, paintings, photographs and sculptures, and architectural designs. Rights related to copyright include those of performing artists in their performances, producers of phonograms in their recordings, and those of broadcasters in their radio and television programs. See http://www.wipo.org/about-ip/en/

[42] For a summary of such measures, see Table 1 in European Commission, Directorate General Enterprises "Enterprises and SME" Programme, "European Trend Chart on Innovation," June 2000. Accessed at http://trendchart.cordis.lu/Reports/Documents/Innovation_and_IPR_June2000.pdf

Other potential non-economic benefits

- Environmental impacts
- Safety
- Quality of life

Trends in agency funding for small business

For this study, "small business funding" will be defined as synonymous with SBIR. A definition of "small" is needed. The SBIR definition (fewer than 500 employees) is quite broad.[43] Dividing firm participants into size subcategories may be advantageous. We plan a breakdown of small firms by size, taking into account existing SBA classifications and based on natural divisions as emerge from the data.

The agencies have considerable discretion in defining which agency expenditures and disbursements they consider to be R&D, and thus subject to the percentage requirements of the SBIR set aside. Small firms also receive R&D funding directly from the agencies outside the SBIR program, and receive subcontracts for R&D from primes or other subcontractors, whose original funding source was federal R&D. Since in some cases the prime or intermediate contractor may also be a small business, there is an opportunity for double counting as well as for undercounting. It is important to keep in mind that the congressional intent was to increase the amount of federal R&D funding ultimately reaching small businesses.

Small businesses, in many cases, cannot take on more R&D funding, as they do not have the expert staff, or the culture to do R&D. Thus, there might conceivably be a sort of saturation effect. The issue of absorptive capacity also occurs in the case of fast moving high tech firms, which may not willing to risk the overhead and delay involved in seeking federal funds at all. In the present study, saturation effects can be examined in part by investigating the relationship between the growth of grant-program funding and the growth of grant-program applications. Insights into the impacts of expansions in grant funding on small-business response capacity and on research quality may be gained by analyzing ATP's experience between 1993 and 1994, based on changes in reviewer technical scores and small business application rates as the program was expanded dramatically between 1993 and 1994.

Best practices and procedures in operating SBIR programs

Issues related to administrative process, both within agencies and across agencies, will be defined over the course of the first phase of the NRC study. Areas to be addressed may include:

- Outreach
- Topic development
- Application procedures and timelines
- Project monitoring
- Agency management funding
- Project funding limitations
- Bridge funding
- Post SBIR Phase II support

[43] According to the Small Business Administration, a small business is a concern that is organized for profit, with a place of business in the United States, and which operates primarily within the United States or makes a significant contribution to the U.S. economy through payment of taxes or use of American products, materials, or labor. Further, the concern cannot be dominant in its field, on a national basis. Finally, the concern must meet the numerical small business size standard for its industry. SBA has established a size standard for most industries in the U.S. economy. The most common size standards are 500 employees for most manufacturing and mining industries, 100 employees for all wholesale trade industries, $6 million for most retail and service industries, $28.5 million for most general & heavy construction industries, $12 million for all special trade contractors, and $0.75 million for most agricultural industries.

5. Potential Metrics for Addressing Study Objectives

In keeping with the definitions and concepts in the previous section, the NRC study will identify the desired measures for expressing results related to each of the objectives defined in section 3, Clarifying Study Objectives. It is important to note that the metrics ultimately used in the study will be selected partly based on their theoretical importance in answering critical questions, and partly based on practicalities.
Here we list a set of draft metrics of clear utility to the study; not all will ultimately be adopted, and, as the research progresses; undoubtedly others will be developed as additional elements emerge as the study moves forward.

Research quality[44]

- Internal measures of research quality—These will be based on comparative survey results from agency managers with respect to the quality of SBIR-funded research versus the quality of other agency research. It is important here to recognize that standards and reviewer biases in the selection for SBIR awards in the selection of other awards may vary.
- External measures of research quality
    - Peer-reviewed publications
    - Citations
    - Technology awards from organizations outside the SBIR agency
    - Patents
    - Patent Citations

Agency mission

Agency missions vary; for example procurement will not be relevant to NSF and NIH (and some of DoE) SBIR programs. The value of SBIR to the agency mission can best be addressed through surveys at the sub-unit manager level, similar to the approach demonstrated by Archibald and Finifter's (2000) Fast Track study, which provides a useful model in this area.[45] These surveys will seek to address:

- The alignment between agency SBIR objectives and agency mission
- Agency-specific metrics (to be determined)
- Procurement:
    - The rate at which agency procurement from small firms has changed since inception of SBIR;
    - The change in the time elapsed between a proposal arriving on an agency's desk and the contract arriving at the small business;
    - The rate at which SBIR firm involvement in procurement has changed over time;
    - Comparison of SBIR-related procurement with other procurement emerging from extra-mural agency R&D;
    - Technology procurement in the agency as a whole;
- Agency success metrics – how does the agency assess and reward management performance? Issues include
    - Time elapsed between a proposal arriving on an agency's desk and the contract arriving at the small business.

[44] See also parameters of non-economic benefits, especially Knowledge Benefits, p. 11.
[45] See National Research Council, *The Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative*, op. cit., pp. 211-250.

- Minimization of lags in converting from SBIR Phase I to Phase II

Parallel data collection across the five agency SBIR programs is to compile year-by-year program demographics for approximately the last decade. Data compilation requests will include the number of applications, number of awards, ratio of awards to applications, and total dollars awarded for each phase of the multi-phase program. It will cover the geographical distribution of applicants, awards, and success rates; statistics on applications and awards by women-owned and minority-owned companies; statistics on commercialization strategies and outcomes; results of agency-initiated data collection and analysis; and uniform data from a set of case studies for each agency.

The Committee plans to draw on the following data collection instruments:

- Phase I recipient survey
- Phase II recipient survey
- SBIR program manager survey
- COTAR (technical point of contact) survey
- case data from selected cases

Data collected from these surveys and case studies will be added to existing public sources of data that will be used in the study, such as:

- all agency data covering award applications, awards, outcomes, and program management
- patent and citation data
- venture capital data
- census data

Additional data may be collected as a follow-up based on an analysis of response.

The study will examine the agency rates of transition between phases, pending receipt of the agency databases for applications and awards of Phase I and Phase II.

The Phase II survey will gather information on all Phase III activity including commercial sales, sales to the federal government, export sales, follow-on federal R&D contracts, further investment in the technology by various sources, marketing activities, and identification of commercial products or federal programs that incorporate the products. SBIR Program manager surveys and interviews will address federal efforts to exploit the results of phase II SBIR into phase III federal programs.

Commercialization

First order metrics for commercialization revolve around these basic areas:

- Sales (firm revenues)
  - Direct sales in the open market as a percentage of total sales
  - Indirect sales (e.g. bundled with other products and services) as a percent of total sales
- Licensing or sale of technology
  - Contracts relating to products
  - Contracts relating to the means of production or delivery—processes
- SBIR-related products, services, and processes procured by government agencies.
- Spin-off of firms

The issue of commercial success goes beyond whether project awards go to firms that then succeed in the market. It is possible that these firms may well have succeeded anyway, or they may simply have displaced other firms that would have succeeded had their rival not received a subsidy. The issue is whether SBIR increases the number of small businesses that succeed in the market. If the data permit, the study team may try to emulate the research of Feldman and Kelley to test the hypothesis that the SBIR increases/does not increase the number of small businesses that pursue their research projects or achieve other goals.[46]

Broad economic benefits

For firms

- Support for firm development, which may include:

[46] Maryann P. Feldman and Maryellen R. Kelley, "Leveraging Research and Development: The impact of the Advanced Technology Program." National Research Council, *The Advanced Technology Program, Assessing Outcomes*, 2001 op. cit.

- Creation of a firm (i.e., has SBIR led to the creation of a firm that otherwise would not have been founded)
- Survival
- Growth in size (employment, revenues)
- Merger activity
- Reputation
- Increase in stock value/IPO, etc.[47]
- Formation of collaborative arrangements to pursue commercialization, including pre-competitive R&D or a place in the supply chain
- Investment in plant (production capacity)
- Other pre-revenues activities aimed at commercialization, such as entry into regulatory pipeline and development of prototypes

- Access to capital
  - Private capital
    - From angel investors
    - From venture capitalists
    - Banks and commercial lenders
    - Capital contributions from other firms
    - Stock issue of the SBIR-recipient firm, e.g., initial public offerings (IPO)
  - Subsequent (non-SBIR) funding procurement from government agencies

For agencies (Aside from mission support and procurement)

- Enhanced research efficiency
  - Outcomes from SBIR vs. non-SBIR research
  - Agency manager attitudes toward SBIR

For society at large

Social returns include private returns, agency returns, and spillover effects from research, development, and commercialization of new products, processes, and services associated with SBIR projects. It is difficult, if not impossible, to capture social returns fully, but an attempt will be made to capture at least part of the effects beyond those identified above including the following:

- Evidence of spillover effects
- Small business support:
  - Small business share of agency R&D funding
  - Survival rates for SBIR supported firms
  - Growth and success measures for SBIR vs. non-SBIR firms
- Training:
  - SBIR impact on entrepreneurial activity among scientists and engineers
  - Management advice from Venture Capital firms
  - Other training effects.

[47] The web site *inknowvation.com* has a data set on publicly traded SBIR firms.

Non-economic benefits

Knowledge benefits

- Intellectual property
  - Patents filed and granted
  - Patent citations
  - Litigation
- Non-intellectual property
  - Journal articles and citations
  - Human capital measures

Other non-economic benefits

Given the complexity of the NRC study, the Committee is unlikely to devote substantial resources to this area. However, some evidence about other non-economic benefits e.g., environmental or safety impacts may emerge from the case studies and interviews.

Trends in agency funding for small business

- Absolute SBIR funding levels
- SBIR vs. other agency extra mural research funding received by small businesses
- Agency funding for small business relative to overall sources of funding in the US economy

Best practices in SBIR funding

It will be important to analyze the categories below with respect to the size of the firm.

- Recipient views on process
- Management views on process
- Flexibility of process, e.g., award size
- Timeliness of application decision process
- Management actions on troubled projects

Possible independent variables: demographic characteristics

For all of the outcome metrics listed above, it will be important to capture a range of demographic variables that could become independent variables in empirical analyses.

Bias

What is the best way of assessing SBIR? One approach—utilized by many agencies when examining their SBIR programs—has been to highlight successful firms. Another approach has been to survey firms that have been funded under the SBIR program, asking such questions as whether the technologies funded were ever commercialized, the extent to which their development would have occurred without the public award, and how firms assessed their experiences with the program more generally. It is important to recognize and account for the biases that arise with these and other approaches. Some possible sources of bias are noted below[48]:

- Response bias—1: Many awardees may have a stake in the programs that have funded them, and consequently feel inclined to give favorable answers (i.e., that they have received benefits from the program and that commercialization would not have taken place without the awards). This may be a

[48] See Joshua Lerner and Colin Kegler, "Evaluating the Small Business Innovation Research Program: A Literature Review, *SBIR: An Assessment of the Department of Defense Fast Track Initiative*, C. Wessner, ed., op. cit.

particular problem in the case of the SBIR initiative, since many small high-technology company executives have organized to lobby for its renewal.

- Response bias—2: Some firms may be unwilling to acknowledge that they received important benefits from participating in public programs, lest they attract unwelcome attention.
- Measurement bias: It may simply be very difficult to identify the marginal contribution of an SBIR award, which may be one of many sources of financing that a firm employed to develop a given technology.
- Selection bias. This source of bias concerns whether SBIR awards firms that already have the characteristics needed for a higher growth rate and survival, although the extent of this bias is likely overdrawn since an important role of SBIR is to telegraph information about firms to markets operating under conditions of imperfect information.[49]
- Management bias: information from agency managers, who must defend their SBIR management before the Congress, may be subject to bias in different ways.
- Size bias: The relationship between firm size and innovative activity is not clear from the academic literature.[50] It is possible that some indexes will show large firms as more successful (publications and total patents for example) while others will show small firms as more successful (patents per employee for example.)

A complement of approaches will be developed to address the issue of bias. In addition to a survey of program managers, we intend to interview firms as well as agency officials, employ a range of metrics, and use a variety of methodologies.

The Committee is aware of the multiple challenges in reviewing "the value to the Federal research agencies of the research projects being conducted under the SBIR program..." [H.R. 5667, sec. 108]. These challenges stem from the fact that

- the agencies differ significantly by mission, R&D management structures (e.g., degree of centralization), and manner in which SBIR is employed (e.g., administration as grants vs. contracts); and
- different individuals within agencies have different perspectives regarding both the goals and the merits of SBIR-funded research.

The Committee proposes multiple approaches to assessing the contributions of the program to agency mission, in light of the complicating factors mentioned above:

- A planned survey of all individuals within studied agencies having SBIR program management responsibilities (that is, going beyond the single "Program Manager" in a given agency). The survey will be designed and implemented with the objective of minimizing framing bias. We will reduce sampling bias by soliciting responses from R&D managers without direct SBIR responsibilities as well as those who have both. Important areas of inquiry include study of the process by which topics are defined, solicitations developed, projects scored, and award selections made.
- Systematic gathering and critical analysis of the agencies' own data concerning take-up of the products of SBIR funded research.
- Study of the role of multiple-award-winning firms in performing agency relevant research;

---

[49] See Adam Jaffee, "Building Program Evaluation into the Design of Public Research Support Programs," *Oxford Review of Economic Policy,* forthcoming.

[50] Many empirical studies suggest that small firms are more innovative than large firms or, at minimum, that the difference between large and small firm innovative activity is statistically insignificant. See Zoltan Acs and David B. Audretsch (1991), *Innovation and Small Firms* (Cambridge: MIT Press); Ricardo J. Caballero and Adam B. Jaffe (1993),"How high are the giants' shoulders: an empirical assessment of knowledge spillovers and creative destruction in a model of economic growth," in O.J. Blanchard and S. Fischer (eds.) *NBER Macroeconomic Annual 1993*, (Cambridge, MA: MIT Press); and Jaffe and Trajtenberg (2002), *Patents, Citations, and Innovations: A Window on the Knowledge Economy* (Cambridge: MIT Press). Concerns relating to size-dependant bias can be addressed by employing James Heckman's well-known techniques for controlling for the effects of sample selection bias. John Scott has recently employed such methods in a survey he conducted on environmental research. See John Scott, T., *Environmental Research and Development: US Industrial Research, the Clean Air Act and Environmental Damage* (Cheltenham, UK; Northampton, MA, USA: Edward Elgar Publishing, 2003).
It will be interesting to see if including such controls (for firm size) in our econometric analysis confirms or rejects the hypothesis that there will be a size dependant bias as a result of the selection of indicators in which large firms will score more broadly than small ones. Another pragmatic step we will take to address this issue is to make sure that any metrics we use are normalized for firm size (e.g., patents per employee)

- A possible study comparing funded and nearly funded projects at NIH (possibly extended to other agencies).

6. Existing Data Sources

Specific data requirements are driven by a study's methodology, and their definition would normally follow that discussion. As noted earlier, however, the status of prior agency studies and agency databases will affect the methodologies selected and hence data collection needs. The Committee will make an initial effort to identify and review existing data sources. These will be extended and undoubtedly modified during the early stages of Phase II of the NRC study.

In general, existing data will be extracted in the main from the following sources:

- Agency SBIR databases
- Published agency reports
- Internal agency analysis
- SBA and GAO reports
- Previously conducted recipient surveys
- Academic literature
- Prior NRC studies

These existing data sources are briefly discussed below.

Existing agency and SBA reports

The agencies appear to have produced few major reports on their own SBIR programs, aside from annual reports to SBA. In addition to Fast Track, DoD has unpublished studies; NASA recently completed some analysis; NSF also has some internal assessments. These agency reports must be assessed for accuracy and comprehensiveness, as an early-stage priority under Phase II of the NRC study.[51] Annex E provides a list of these agency studies

Existing agency SBIR databases

All five agencies maintain databases of awards and awardees. This information typically contains basic information about the awardee (e.g., company name, Principal Investigator, contact address), information about the award (amount, date, award number), and in many cases, additional detailed project information (e.g., proposal summary, commercialization prospects.)[52]

In general, the agency databases offer reasonably strong input data – award amounts, dates, Principal Investigator information etc. – and relatively weak output data – commercial impact etc. The agency databases may have information on modifications that have added funds, but do not typically contain sufficient information about the *use* of funds (The abstract, which may be useful for case study decisions, does not lend itself to statistical use since the sample size is one for each unique abstract.)[53]

Thus, the agency databases will be most useful as sources two critical sets of information:

- Basic information about awards, including some demographic data about awardees;
- Contact information for awardees, useful as the survey distribution lists are developed.

More technically, issues related to agency databases may include:

- ***Completeness of the agency's data***
  - Do the data cover all of the applications received by the agency?
  - Are all grants accounted for? Is the contact data up to date (i.e., what percentage respond to a contact effort based on this information)?
  - What year was the database started?
  - Does it maintain information about non-awardees?
  - What percent of SBIR Phase I awards get converted to Phase II awards

[51] See Annex D for a list of these reports.
[52] See NIH/NSF background papers for specifics.
[53] It would not be cost effective to try to group abstracts in any fashion.

- How many SBIR Phase II contracts lead to Phase III

- ***Accuracy of the data The*** biggest challenge here will be the transient nature of the firms and the information.
  - PI's come and go; firms shrink and grow; firms are acquired; firms may close down, move, or change names;
  - Answers often depend on whom you ask;
  - Firms that are very successful may have new management in place as a result of venture capital activity or other financial arrangements, or due to firm acquisition by another organization;
  - There is often a long gestation between award of the SBIR Phase II and achievement of significant revenues. Often other SBIR grants and other R&D may have occurred in the interval. There may not be anyone still at the firm knowledgeable of the link between the product and the SBIR;
  - The most serious analytical issue may be the dependency on self-reporting, as the agencies generally know little about commercialization except that which is self-reported by the firm.
- ***Depth of the data*** – Does the data reach firm level variables, award data, projects, and outcomes? Conversely, what primary gaps in the data should be filled by primary research? The Committee will also need to assess data collected by agencies beyond that required by SBA, to see if there are opportunities and/or gaps.
- ***The expanded role of DoD data*** Recent DoD collections include information on projects in the earlier studies, as well as in the next Fast Track: about one-third of the DoD collection is on projects awarded by other agencies. Note that information from the various data collection has not been cross-referenced and analyzed. It will take extensive effort to properly identify each project in each collection (as the collections for example lack common unique identifiers)
- ***The form of the data*** – is the agency data in paper form or is it computerized?

Relevant Features of Existing Survey Data

Four substantial surveys have addressed commercial and other outcomes from SBIR: GAO (1992), DoD (1997), SBA (1999), and DoD Fast Track.[54] In many areas, these surveys ask similar or identical questions, creating extensive databases of results relevant to many of the metrics being considered for use in this study.

The Fast Track surveys each addressed a single SBIR Phase II award, and collected some information on the firm. 80 to 90 percent of the questions were about the specific award. Some firms have only one award. Some have over 100. GAO (1992), SBA (1999) and DoD (1997) each surveyed 100 percent of the SBIR Phase II awards made from 1983 through an end date that was four years prior to the date of the survey: i.e., GAO (1992) surveyed, in 1991, all SBIR Phase II project awards from 1983 through 1987.[55] These studies provide coverage for the early years of the program.

The existing survey results showed the distribution of commercialization to be quite skewed. For example, 868 of the 1310 reporting projects in the SBA survey had no sales. Fifty five had over $5 million in sales, one of which was over $240M, two were slightly over $100M, and five were between $46 M and $60M. Those 55 projects represent 1.5 percent of the number surveyed, 4.2 percent of the responses, but 76 percent of the total sales. This means that in collecting commercialization data, firm selection becomes critically important. Surveying a high percentage of the

[54] See U.S. General Accounting Office, "Federal Research: Small Business Innovation Research shows success but can be strengthened." Washington, D.C.: U.S. General Accounting Office, 1992. The DoD study on the commercialization of DoD SBIR was based on a survey of Phase II awards from 1984–1992. It involved an 80 in-person and 69 telephone interviews with SBIR firms, interviews with DoD program managers and laboratory officials. This study, completed in October 1997, is unpublished. The SBA study on the commercialization of SBIR was based on a 100 percent survey of Phase II awards from 1983 to 1993 of non-DoD agencies, and 43 in-person interviews with SBIR firms. This study, completed in July 1999 is unpublished. The DoD Fast Track study was conducted by the National Research Council. See National Research Council, *The Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative*, 2000, op. cit.

[55] See GAO (1992) op. cit. An unpublished study by the SBA was completed in 1999, and an unpublished study by DoD was completed in 1997. See footnote 27 for description.

awards (using a long survey) has the related problems of imposing a substantial burden, and risks causing multiple award winners not to respond.[56]

A note on the SBA Tech-Net database: SBA maintains a database of information derived from the annual reports made on SBIR by the agencies.[57] Mandatory collected data includes award year and amount, agency topic number, awarding agency, phase, title, and agency tracking number. (Tracking numbers were not mandatory through 1998.)

However, this database is far from complete for our purposes:

- ***Principal Investigator (PI) Information*** Today, reporting the PI name is mandatory, but although there are fields for title, email address, and phone, these are not mandatory entries for the agencies to report. As recently as 1998, agencies did not have to report the name of the PI.
- ***Company information*** There are fields for the name, title, phone, and email of a company contact official, but these fields are not mandatory for the agencies to report.
- ***Award information*** Agency award contract or grant number, solicitation number, year of solicitation and number of employees have fields, but they are not mandatory.
- ***Technical project information.*** There are large fields for technical abstract, project anticipated results, and project comments, but they are not mandatory.
- ***Women and minorities*** Although information is mandatory on minority or women owned, it was not complete in the SBA data for the years before 1993.[58]
- ***Other data.*** Other data, such as award date for SBIR Phase I and Phase II, completion date for each phase, additional (non SBIR Phase II) and subsequent funding provided by the agencies, agency POC for each SBIR Phase II, information on cost sharing (if applicable), etc. may be available in some agency data bases.

[56] All prior efforts addressed only phase II. NIH and perhaps other agencies have indicated that they would be interested in a survey of Phase I winners that did not submit or did not win Phase II award.

[57] Tech-Net is an electronic gateway of technology information and resources, maintained by SBA, for and about small high tech businesses. It provides a search engine for researchers, scientists, state, federal, and local government officials, can serve as a marketing tool for small firms, and can "link" investment opportunities for investors and other sources of capital. Visit SBA Tech-Net database at http://tech-net.sba.gov/index.html

[58] Agencies have often reported information that is not mandatory so some of the above is available for many projects. For example, the SBA database through 1993 had names for 78 percent of the PI. It had phone numbers for just over half of the named PI. Number of firm employees was entered in 5 percent of the entries.

7. Methodology Development: Primary Research

The wide scope of the current study and gaps in the existing data will necessitate a considerable amount of primary research. The approach adopted is to select the methodological elements best suited to complement and supplement existing information. The study objectives will be realized using the most efficient combination of methods.[59] These include analyzing existing studies and databases, interviewing program officials, surveying various program and technical managers and project participants, carrying out case studies, using control groups and counterfactual approaches to isolate the effects of the SBIR program, and other methods such as econometric, sociometric, and bibliometric analysis. These tools will be used on an as needed, limited basis to address questions for which they are best suited.[60]

A dictionary of variable names with definitions that are common across all of the instruments will be developed. This dictionary will form a part of the training materials used by interviewers, survey managers, and those populating variables with administrative data.

Surveys

Surveys are an important methodological element of the study.

Program staff will be interviewed, with these interviews focusing (at least initially) on process issues – mechanisms, selection procedures, etc. - and on the contribution of the program to the agency. This will include understanding the motivations and objectives of the program managers. What are their goals and incentives? How is their performance within the agency SBIR program judged? Development of a *core questionnaire* and also a *basic reporting template* may be appropriate even though interviews with more senior program managers are likely to be free ranging with many open-ended questions and also more agency specific than those with participants. A core template with five derivative templates (one for each of the five agencies identified in the legislation) seems a promising approach. Higher-level research officials, such as deputy institute directors, may be interviewed about the SBIR in comparison with other research support by the agency.

SBIR award recipients will also be surveyed. The key issue here will be to identify the correct respondent, one who both knows the answers and is willing to fill out the instrument. The survey will begin by contacting those already in the database of firm information, which covers all applicants for SBIR Phase I or Phase II grants.[61] The database includes the name of the SBIR Point of Contact (POC) for that firm (along with phone, address, and email). In fact, the database covers many firms that have also received awards from NSF, NASA, and DoE. Most NIH awardees do not submit proposals to these agencies and, therefore, are not covered. Surveys will be field-tested ensure that they are effective and encourage compliance.

The first step will be to develop a short survey to cover those firms lacking a point of contact (POC). This survey will ask for information about the POC and solicit information on a very small set of firm-related questions. This will facilitate development of a comprehensive database of POC's.

Subsequent recipient surveys will be directed to these POC's, although it is likely that certain information will require responses at the corporate level of the firm, and at the level of the primary investigator (PI).

The following questionnaires and surveys will likely be administered:

- **Survey of program managers**, focusing on major strategic questions and overall program issues and concerns;
- **Survey of technical managers** focusing on operations and issues of program implementation;
- **Survey of SBIR Phase II participants,** focusing both on outcomes from SBIR grants (especially commercial outcomes) and on program management issues from the recipient perspective. This survey is likely to have both a general and an agency-specific component. It is also likely to have a section focused on company impacts (as opposed to project impacts);
- **Survey of SBIR Phase I participants**, focusing on initial selection and support issues;
- **Additional limited surveys** focusing on particular aspects of the program, possibly at specific agencies, can be initiated, with limiting parameters to be specified.

---

[59] For a review of methodologies for evaluating technology programs, see D. Campbell, *Research Design for Program Evaluation,* Beverly Hills: Sage, 1984. See also L. Georghiou and D. Roessner, "Evaluating Technology Programs," *Research Policy*, 29, 2000.

[60] See additional discussion related to the counterfactual issue in Section 7 of this chapter, pp. 32-33.

[61] Available from BRTRC, the consulting/survey firm with whom NRC worked in the 1999 Fast Track study.

Each of the survey instruments will have a stated purpose and each will be "mapable" to the objectives of the study to which they relate.[62] All surveys will be pre-tested. These surveys are discussed in more detail below.

Program manager survey

The program manager survey will focus on strategic management issues and on manager views of the program. It will be designed to capture senior agency views on the operations of the SBIR program focused on concerns such as funding amounts and flexibility, outreach, topic development, top-level agency support for SBIR, and evaluation strategies.

The survey may be administered through face-to-face interviews with senior managers, by telephone, by mail, via electronic questionnaire, or through some combination or these approaches. All senior program managers at the agency and all program managers at the sub-unit level (e.g., NIH institutes, DoD agencies) are to be covered. Altogether, there are approximately 45 program managers at this level in the five study agencies.

Technical manager survey

While program managers should have a strategic view of the SBIR program at their agency, the program is to a considerable extent operated by other managers. The responsibilities of these technical managers (or TMs) are focused on the development of appropriate topics, appointment of selection panels, process management (e.g., ensuring that reviews are received on time and that the selection and management process meets approved timelines), and contacts with the grant recipients themselves.

The Committee plans to conduct informal interviews with selected TMs. In addition, a survey instrument is currently being designed which will be sent to each TM in each agency. This instrument will address technical management issues, and will focus on the relationship between SBIR projects and non-SBIR components of each agency's research and development program. TMs, for example, may play a pivotal role in the subsequent take-up of SBIR-funded research within DoD, and the survey is aimed at enhancing assessment of that possibility.

The survey will therefore be delivered to all TMs in the five agencies. Approximately 200-300 potential survey recipients are anticipated.

SBIR Phase I recipient survey

In order to identify characteristics of firms and projects that received SBIR Phase I awards only, the Committee anticipates the implementation of a survey of SBIR Phase I recipients. The objective of this survey is to enhance understanding about project outcomes, and to identify possible weaknesses in the SBIR Phase I—Phase II transition that may have excluded worthy projects from SBIR Phase II funding. (It should be understood that the Committee has no preconceptions on this issue—only that this is an important transition point and winnowing mechanism in SBIR, and should therefore be reviewed.)

As there have been more than 40,000 SBIR Phase I grants made, it is not feasible to cover all SBIR Phase I winners. Therefore, the Committee will developed an initial set of selection criteria, aimed at ensuring that outcomes are assessed for a range of potential independent variables. These will include:

- Size of firm
- Geographic location
- Women and minority ownership
- Agency
- Multiple vs. single award winners
- Industry sector

SBIR Phase II recipient surveys

The SBIR Phase II recipient survey will be a central component of the research methodology. It will address commercial outcomes, process issues, and post-SBIR concerns about subsequent support for successful companies.

Surveys must provide data that will allow the Committee to address the various questions defined in sections 3 and 4. Specifically, survey methodologies will need to differentiate between:

- Funded and unfunded applications

[62] "Mapability" means that questions on the survey instrument must map, individually or by groups, to the objectives of the study. A survey is a methodological tool for collecting information to meet a study's objective.

- Women led/minority led businesses
- Different geographical regions or perhaps clusters of zip codes
- SBIR Phase I vs. Phase II awards
- Firms by size: single-person companies vs. micro corporations vs. relatively large established companies (100+ employees?). [63]
- Firms by total revenues and by revenues attributable to the SBIR-related commercialization
- Firms by employment effects
- Recipients of single vs. multiple awards
- Other criteria, including the procedural efficiency of converting from Phase I to Phase II

The Committee is also interested in finding relevant points of comparison between research quality and research value. However, such comparisons are complicated because SBIR and non-SBIR funding is differentiated not only by the size of the firm but also by the kind of research, by funding rationale, and by time horizon. For example, NSF views SBIR as a tool for funding research that leads to commercialization, while the remaining 97.5 percent of NSF funding is for non-commercial research. Here, a comparison would be inappropriate. In addition, non-SBIR grants operate under different timeframes and are usually at a different phase of the R&D cycle, requiring different resource commitments.

To address this point, the Committee will consider if the Phase II survey should be expanded to identify awards that have received some form of quality recognition from and outside agency. For example, if the only competitors for such recognition are other SBIR projects, (as is the case with the Tibbetts Award) this may identify the best SBIR projects but say little about comparisons to non-SBIR projects.

All of these data will be collected on an agency-by-agency basis, to ensure sufficient data for the statistical analysis of each agency. The result will be a survey matrix, with an x-axis showing potential explanatory variables such as multiple- vs. single-award winners, and the y-axis showing the individual agencies.[64] (Each cell of the matrix is important to the extent that the specified data help to address study objectives. Detailed articulation between objectives and survey instruments will be an early stage task for SBIR Phase II. See Annex F for a prototype of this matrix.

Background

Award numbers. Although data inconsistencies mean that the number of SBIR Phase II awards from 1992 – 2000 is not known exactly, it is estimated that this number is at about 10,800. Based on the three published reports, about 7 percent of these SBIR Phase II awards are from the smaller agencies. Thus, it is estimated that about 10,000 awards have been made by the five study agencies. There are no good data concerning the distribution by firm (some firms have received more than 100 awards, many others just one).

Existing Commercialization Data DoD has data by project for 10,372 SBIR Phase II projects. (This includes projects from 1983). Since 1999, firms who have submitted SBIR or STTR proposals to DoD have had to enter firm information and information on sales and investments for all of the SBIR Phase II awards they have received, regardless of awarding agency.

The DoD commercialization database contains information on approximately 75 percent of DoD Phase II awards from 1992 to 2000, 67 percent of NASA and DoE awards, 54 percent of NSF awards, and 16 percent of NIH/HHS awards. DoE has provided commercialization data by product, which cannot be directly associated to projects as this may lead to a double counting of awards to firms. NASA does have data by project, although this does not appear to correspond directly to DoD data.

[63] Responses to questions about size are often faulty. Some proposal writers enter the size of their division of the company, rather than whole company. Some pull a number out of the air based on the last estimate they heard. A company may apparently vary substantially in size on several proposals that were awarded the same year (even proposals submitted within days of each other.) However, by grouping the sizes in broad groups most of this type of variation can be avoided. One should keep in mind that companies may be very small, for early awards, grow, while continuing to submit, eventually becoming no longer eligible (over 500) then shrink and start submitting again. What is relevant is the size at the time of the award.

[64] The matrix is provided in Annex G.

Sampling Approaches and Issues

The question of sampling is of central importance here, and a more extended discussion of the issues raised can be found in Annex G.

The Committee proposes to use an array of sampling techniques, to ensure that sufficient projects are surveyed to address a wide range of both outcomes and potential explanatory variables, and also to address the problem of skew noted earlier.

- **Random Sample.** After integrating the 10,000 awards into a single database, a random sample of approximately 20 percent will be sampled for each year; e.g., 20 percent of the 1992 awards. Generating the total sample one year at a time will allow improved access to changes in the program over time, as otherwise the increased number of awards made in recent years could dominate the sample.
- **Random sample by agency.** Surveyed awards will then be grouped by agency; additional respondents will be randomly selected as required to ensure that at least 20 percent of each agency's awards were included in the sample.
- **Top Performers.** In addition to the random sample, the problem of skew will be dealt with by ensuring that all projects meeting a specific commercialization threshold will be surveyed—most likely $5 million in sales or $5 million in additional investment (derived from the commercialization database). Estimates from current DoD commercialization data indicate that the "top performer" part of the survey would cover approximately 385 projects.
- **Firm surveys:** 100 percent of the projects that went to firms with only one or two awards will be polled—these are estimated at approximately 30 percent of the 10,000 SBIR Phase II awards, based on data from 1983 to 1993. These are the hardest firms to find: address information is highly perishable, so response rates are much lower.
- **Coding** The project database will track which survey corresponds with each response. For example, it is possible for a randomly sampled project from a firm that had only two awards to be a top performer. Thus, the response could be coded as a random sample for the program, a random sample for the awarding agency, a top performer, and as part of the sample of single or double winners. In addition, the database will code the response for the array of potential explanatory or demographic variables listed earlier.
- **Total number of surveys:** With the random sample set at 20 percent, the approach described above will generate approximately 5500 project surveys, and approximately 3000 firm surveys (assuming that each firm receiving at least one project survey also received a firm survey). Although this approach samples more than 50 percent of the awards, multiple award winners would be asked to respond to surveys covering about 20 percent of their projects.

Projected response rates. The response rate is expected to be highly variable. It will depends partly on the quality of the address information, which is itself a function of the effort expended on address collection and verification before surveys are administered, and partly on the extent of follow up of non-respondents. The latter is especially important: one agency manager noted that his survey had a final response rate of 70-80 percent, but that the initial rate before follow-up phone calls was approximately 15 percent.

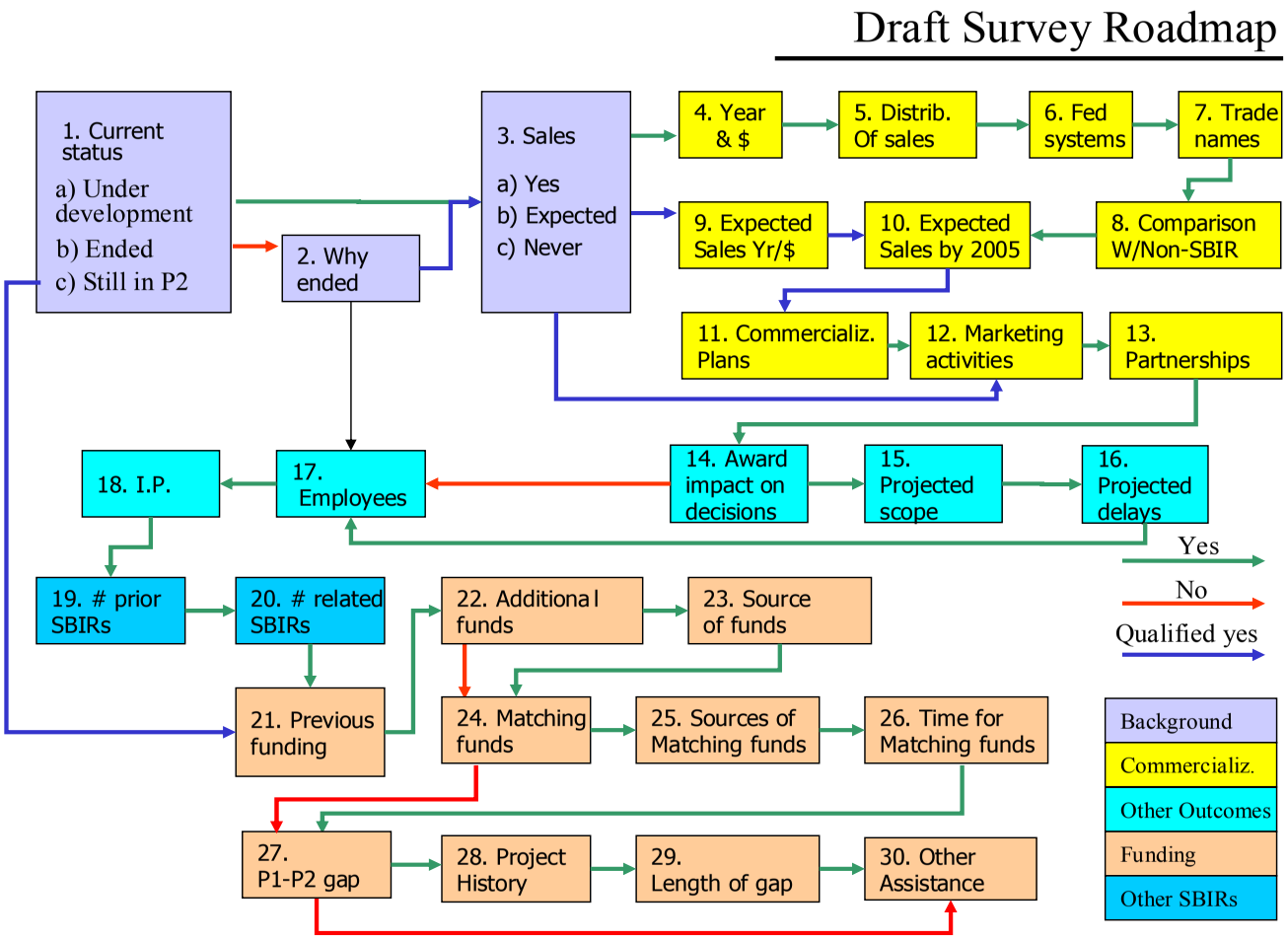
As noted in Siegel, Waldman, and Youngdahl (1997), response rates to technology surveys are notoriously low, averaging somewhere in the teens. Thus, a 20 percent response rate for a technology survey can be considered high, especially if it involves sampling small firms, and there is potential attrition in the sample through exits or mergers and acquisitions.

The NRC surveys are expected to exceed this benchmark for two reasons.

- Experience: The NRC has assembled expertise with an excellent track record of effective sampling of firms. Previous survey work for the Department of Defense SBIR Fast Track survey yielded a response rate of 68 percent.
- Stewardship: Substantial time and effort will be devoted to following up the survey with phone calls to non-respondents and those that provide incomplete information.

While the NRC study expects a significant response rate, based on the same techniques as have proved successful in the past, it is inherently difficult to predict the precise size of the actual result.

Draft SBIR Phase II Survey Roadmap



Starting date and coverage

Surveys administered in 2004 will cover SBIR awards through 2000. 1992 is a realistic starting date for the coverage, allowing inclusion of the same projects as DoD for 1991 and 1992, and the same as SBA for 1991, 1992, and 1993. This would add to the longitudinal capacities of the study.

Projects awarded earlier than 1992 suffer from potentially irredeemable data loss: firms and PI's are no longer in place, and data collected at the time was very limited.

Delivery modalities

Possible delivery modalities for surveys will include:

- Online
- By phone
- By mail
- In person (interviews or focus groups)

Clearly, there are many advantages to online surveys (such as cost, speed, possibly response rates), and such surveys can now be created at minimal cost using third party services. Response rates become clear fairly quickly, and can rapidly indicate needed follow up for non-respondents. Clarifications of inconsistent responses are also easier using online collection. Finally, online surveys allow dynamic branching of question sets, with some respondents answering selected sub-sets of questions but not others, depending on prior responses.

There are also some potential advantages to traditional paper surveys. Paper surveys may be easier to circulate, allowing those responsible at a firm to answer relevant parts of the questionnaire. Firms with multiple SBIR grants also often seek to exercise some quality control over their responses; after assigning surveys to different people, answers may be centrally reviewed for consistency.

It may be appropriate to consider a phased approach to the survey work, with more expensive approaches (e.g. phone solicitation) supplementing email, specifically aiming to ensure appropriate coverage of the various groups outlined above.

Case study method

Case studies will be another central component of the study. Second- and third-level benefits in particular will be addressed primarily through focused case studies, as will information about the procurement needs of Federal agencies.[69]

Research objectives addressed primarily through case studies may include:

- generating detailed data not accessible through surveys
- pursuing lines of inquiry suggested by surveys
- identifying anecdotes that illuminate findings that are more general.

Common threads in the case studies are expected to reveal some of the general characteristics of the program, and may help the Committee to understand some of the data resulting from the surveys and agency databases. A common template or set of templates will be developed for the consistent collection of information; however, interviewers will be accorded sufficient freedom to develop the cases in a way that best suits each case and also to collect additional data relevant to their current lines of inquiry and to agency specific concerns. The templates will be mapable to the objectives of the study. Each case study template will be pre-tested.

Case study questions will focus fruitfully on the firm, in addition to the project. This would allow a different perspective, focusing on questions such as: Why did the firm participate? What types of firm were they? What were their business strategy and plans? Did they seek strategic alliances, partnerships, or investment to commercialize when in the SBIR cycle? Why? and How? How long did it generally take to produce sales from SBIR? What difficulties did they experience in commercializing SBIR? What impact did SBIR have on company formation and development? Additional questions will focus on the nature of the competitive landscape. Who are the customers and suppliers? How has the marketplace changed and what value does the innovated product introduce to the market?

[69] See R. Yin, Case Study Research: Design and Methods. Thousand Oaks, CA: Sage, 1995.

Case selection criteria: who participates?

Case studies will be directed to company officers and individual research scientists, and to appropriate individuals within the funding agency, and possibly in other agencies.

The range of selection criteria will be relevant. (e.g., agency, size of firm, multiple awards, etc.). It is not likely that a sufficient number of case studies can be conducted to generate statistically valid results for all relevant issues: not all "cells" in the research matrix will be fully populated. However, it may also be possible to undertake a sufficient number of cases to generate statistically valid results for a limited set of questions. The interview data mentioned above can be used to supplement case studies, or a small subset of case study questions could be generated for responses from prior interviewees.

Process characteristics – ensuring comparability across case study teams

It will be important to ensure that the case studies are at least minimally comparable with information collected and the reports generated. By developing n integrated case-study guide and data collection templates the Committee can synthesize information needed for the final report.[70] Specific tasks to facilitate the case-study component of the study include the following:

- The Committee will develop a common ***case-study guide*** for use in the case study process. The guide will outline the case-study approach to be followed, and provide a loosely structured framework for conducting and reporting the cases. It will provide a set of core questions to be used in all the case studies, and will provide formatting and stylistic guidance for writing up the cases.
- The Committee will develop a data collection template with a core data section that applies to all the case studies, and a specific section for each set of case studies aimed at addressing a separate issue. (See Annex F.) The template will be exact with respect to the metrics to be collected. The template will map to an EXCEL spreadsheet that will be used to facilitate working with the case-study data across cases.
- As the case studies relevant to the same agency will be conducted by multiple field researchers reporting to the Committee, attention will be given throughout the process to calibrate these individuals in their interviewing styles and to take into account any remaining differences before drawing conclusions from the case studies.

Use of counterfactual and control group studies

Determining "additionality" entails finding out if a program made a difference that accounts for all or part of an observed change. [71] As a "best practice" principle, additionality means that it is not sufficient to observe that an SBIR

[70] For an illustration of a large set of case studies written by different researchers and using a common data template to ensure consistent collection of data across projects for combination and analysis, see Advanced Technology Program, *Performance of 50 Completed ATP Projects*, Status Report-Number 2, NIST SP 950-2 (Gaithersburg, MD: National Institute of Standards and Technology, 2001).

[71] As noted, the SBIR program has not been extensively researched, particularly in light of the program's size and 20 year history. Early examples of evaluations of the SBIR program include Myers, Stern, and Rorke, 1983; Price Waterhouse, 1985; and the U.S. General Accounting Office, 1987, 1989, 1992. One early assessment by Scott Wallsten of the subset of SBIR awardees that were publicly traded determined that SBIR grants do not contribute additional funding but instead replace firm-financed R&D spending "dollar for dollar." See Wallsten, S. J. 1998, Rethinking the Small Business Innovation Research Program," in Branscomb and Keller, Eds., *Investing In Innovation*, MIT Press, Cambridge. While Wallsten's paper has the virtue of being one of the first attempts to assess the impact of SBIR, Josh Lerner questions whether employing a regression framework to assess the marginal impact of public funding on private research spending is the most appropriate tool in assessing public efforts to assist small high technology firms. He points out that "it may well be rational for a firm not to increase its rate of spending, but rather to use the funds to prolong the time before it needs to seek additional capital." Lerner suggests that "to interpret such a short run reduction in other research spending as a negative signal is very problematic." See Lerner, "Public Venture Capital: Rationales and Evaluation" in *The Small Business Innovation Research Program: Challenges and Opportunities,* op. cit., p. 125. See also Lerner, "Angel financing and public policy: An overview, *Journal of Banking and* Finance, vol. 22, no. 6-8, p. 773-784. and Lerner, "The government as venture capitalist: The long-run impact of the SBIR program," *Journal of Business,* July, v. 72, 3, pp. 285-97. More broadly, recent research has shown evidence of additionality. For examples, Saul Lach has showed that government R&D subsidies in Israel induced "additionality" in R&D activity for small firms." See Saul Lach, "Do R&D subsidies stimulate or displace private R&D? Evidence from Israel, *Journal of Industrial Economics* December 2002, pp. 369-390. Similarly, a study by Feldman and Kelley on the ATP program found that the recipients of awards attracted additional funding, thus meeting the test of additionality, a phenomena they describe as a "halo effect." See Maryann P. Feldman; Maryellen R. Kelley, "Leveraging Research and Development: Assessing the Impact of the U.S. Advanced Technology Program," *Small Business Economics* Vol. 20, No. 2, 2003. More generally, in a major review of the econometric evidence, David, Hall, and Toole, found the evidence for the "crowding out," of private capital to be at best problematic. See Paul David, Bronwyn Hall, and Andrew Toole, "Is public R&D a complement or substitute for private R&D? A review of the econometric evidence," *Research Policy* 29(4-5): 497-530 (2000). The broader point is that these analyses

award was made and later the awardee commercialized a new product. Rather, a goal of the study will be to determine if the commercialization or its timing or some other associated attribute of importance was likely *caused* by the SBIR award. Evaluation is directed at ruling out alternative, competing explanations of an observed change.[72] Additionality tests are usually applied by contrasting the changes that occurred in a "program group" with what, hypothetically, they would have done without the program, or, better, what a comparable group that did not participate in the program actually did relative to the program group. In selecting comparison groups, it is important to ensure that they do not differ in important ways other than participation. Additionality tests can be strengthened by using statistical tools and econometric techniques to help rule out other causes.

The comparison of what program participants would have done differently without the program is usually ascertained by interviews or surveys, using what are called "counterfactual questions." Counterfactual questions, for example, have been used in a variety of ATP surveys.[73] They have also been used in ATP case studies to help estimate project impacts.[74]

Use of a control group will entail the comparison of a program group with a comparable group that did not participate in the program. Although identifying appropriate control groups will be challenging and can be controversial, the approach is worth considering. Good examples of the use of control groups in evaluation are also available from ATP studies, where they have been used in conjunction with surveys and supporting econometric analysis. [75]

Use of other evaluation methods

Special studies may be required that use methods other than surveys and case studies—such as bibliometric or sociometric analysis. Such needs will be determined as the study progresses.

---

underscore the challenge of assessing the impact of public support for private R&D and the need to address the challenges in a comprehensive fashion.

[72] For a further discussion, see R. Ruegg and I. Feller, A Toolkit for Evaluating Public R&D Investments: Models, Methods, and Findings from ATP's First Decade, NIST GCR 02-842 (Gaithersburg, MD: National Institute of Standards and Technology, May 2003).

[73] See, for example, J. Powell and K. Lellock, Development, Commercialization, and Diffusion of Enabling Technologies: Progress Report, NISTIR 6491 (Gaithersburg, MD: National Institute of Standards and Technology, April 2000).

[74] See A. N. Link, *Advanced Technology Program; Early Stage Impacts of the Printed Wiring Board Research Joint Venture, Assessed at Project End*, NIST GCR 97-722 (Gaithersburg, MD: National Institute of Standards and Technology, 1997); and Sheila A. Martin, Daniel L. Winfield, Anne E. Kenyon, John R. Farris, Mohan V. Baal, and Tayler H. Bingham, *A Framework for Estimating the National Economic Benefits of ATP Funding of Medical Technologies*, GCR 97-737 (Gaithersburg, MD: National Institute of Standards and Technology, 1998).

[75] See, for example, Maryann Feldman and Maryellen Kelley, Winning an Award from the Advanced Technology Program: Pursuing R&D Strategies in the Public Interest and Benefiting from a Halo Effect, NISTIR 6577 (Gaithersburg, MD: National Institute of Standards and Technology, 2001).

Annex A: SBIR Legislation
H.R.5667
Small Business Reauthorization Act of 2000 (Introduced in the House)

SEC. 108. NATIONAL RESEARCH COUNCIL REPORTS.

(a) STUDY AND RECOMMENDATIONS- The head of each agency with a budget of more than $50,000,000 for its SBIR program for fiscal year 1999, in consultation with the Small Business Administration, shall, not later than 6 months after the date of the enactment of this Act, cooperatively enter into an agreement with the National Academy of Sciences for the National Research Council to--

(1) conduct a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet Federal research and development needs, including--

(A) a review of the value to the Federal research agencies of the research projects being conducted under the SBIR program, and of the quality of research being conducted by small businesses participating under the program, including a comparison of the value of projects conducted under the SBIR program to those funded by other Federal research and development expenditures;

(B) to the extent practicable, an evaluation of the economic benefits achieved by the SBIR program, including the economic rate of return, and a comparison of the economic benefits, including the economic rate of return, achieved by the SBIR program with the economic benefits, including the economic rate of return, of other Federal research and development expenditures;

(C) an evaluation of the non-economic benefits achieved by the SBIR program over the life of the program;

(D) a comparison of the allocation for fiscal year 2000 of Federal research and development funds to small businesses with such allocation for fiscal year 1983, and an analysis of the factors that have contributed to such allocation; and

(E) an analysis of whether Federal agencies, in fulfilling their procurement needs, are making sufficient effort to use small businesses that have completed a second phase award under the SBIR program; and

(2) make recommendations with respect to--

(A) measures of outcomes for strategic plans submitted under section 306 of title 5, United States Code, and performance plans submitted under section 1115 of title 31, United States Code, of each Federal agency participating in the SBIR program;

(B) whether companies who can demonstrate project feasibility, but who have not received a first phase award, should be eligible for second phase awards, and the potential impact of such awards on the competitive selection process of the program;

(C) whether the Federal Government should be permitted to recoup some or all of its expenses if a controlling interest in a company receiving an SBIR award is sold to a foreign company or to a company that is not a small business concern;

(D) how to increase the use by the Federal Government in its programs and procurements of technology-oriented small businesses; and

(E) improvements to the SBIR program, if any are considered appropriate.

(b) PARTICIPATION BY SMALL BUSINESS-

(1) IN GENERAL- In a manner consistent with law and with National Research Council study guidelines and procedures, knowledgeable individuals from the small business community with experience in the SBIR program shall be included--

(A) in any panel established by the National Research Council for the purpose of performing the study conducted under this section; and

(B) among those who are asked by the National Research Council to peer review the study.

(2) CONSULTATION- To ensure that the concerns of small business are appropriately considered under this subsection, the National Research Council shall consult with and consider the views of the Office of Technology and the Office of Advocacy of the Small Business Administration and other interested parties, including entities, organizations, and individuals actively engaged in enhancing or developing the technological capabilities of small business concerns.

(c) PROGRESS REPORTS- The National Research Council shall provide semiannual progress reports on the study conducted under this section to the Committee on Science and the Committee on Small Business of the House of Representatives, and to the Committee on Small Business of the Senate.
(d) REPORT- The National Research Council shall transmit to the heads of agencies entering into an agreement under this section and to the Committee on Science and the Committee on Small Business of the House of Representatives, and to the Committee on Small Business of the Senate--

(1) not later than 3 years after the date of the enactment of this Act, a report including the results of the study conducted under subsection (a)(1) and recommendations made under subsection (a)(2); and

(2) not later than 6 years after that date of the enactment, an update of such report.

Annex B: Sample Proposal

NATIONAL RESEARCH COUNCIL

Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Research Program

Proposal to the National Institutes of Health (Sample)

I. Overview

A. Summary

The Small Business Innovation Research program (SBIR) is one of the largest government-industry partnerships in the United States. At approximately $1.2 billion annually, it will continue to expand with increases in federal funding for research. In anticipation of this expansion, the relevant Congressional Committees believe that the SBIR program would benefit from an objective review of the program's operation.

As part of the recent renewal of the SBIR program, the Congress mandated (H.R. 5667: Section 108) that the National Research Council (NRC) undertake a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet federal research and development needs at the five agencies which have SBIR programs larger than $50 million annually. The National Institutes of Health's (NIH) SBIR program is included within these legislated parameters. The NRC is tasked with carrying out this study and must contract with the relevant agencies no later than 20 June 2001.

To comply with this legislation, the NRC hereby proposes a study of the SBIR program at the NIH, for an initial period of three years.[76] This study is to be carried out in close cooperation with NIH officials and program managers. Results of the study will be integrated, as appropriate, into a broader report on the contributions of the SBIR program as a whole to federal research and development needs.

B. Statement of Task

The program for the NIH, currently funded at approximately $410 million annually, is one of the larger components of the SBIR program. Moreover, as the importance of the NIH's SBIR program continues to expand, it can help the NIH maximize the return on its R&D budget.

The study will:

- Satisfy the Congressional mandate for an objective, external assessment of the program;
- Provide an empirical analysis of the operations of the SBIR program, including both quality of research and commercialization of awards, for NIH officials and program managers;
- Address research questions relevant to the program's operation and evaluation that emerge in the course of the study of the NIH SBIR program;
- Contribute to a comprehensive assessment of the program and to Congressional understanding of its accomplishments, challenges, and ongoing contributions.

This study will review the NIH program with regard to parameters such as the quality of the research projects being conducted under the SBIR program, the commercialization of the research, and the program's contribution to accomplishing the NIH missions. To the extent possible, the evaluation will

[76] The legislation calls for a six-year study. In agreement with the NIH, the NRC proposes an initial three-year effort to be followed by a review and agreement as to the requirements for the second phase of the analysis.

include estimates of the benefits, both economic and non-economic, achieved by the SBIR program, as well as broader policy issues associated with public-private collaborations for technology development and government support for high technology innovation, including benchmarking of foreign programs to encourage small business development. Where appropriate, operational improvements to the program will be considered.

The project will assess the contributions of the SBIR program with regard to economic growth, technology development and commercialization, and contributions by small business awardees to the accomplishment of agency missions, while seeking to identify best practice for the operation of the SBIR program. The project will encourage cross-fertilization among program managers, agency officials, and participants by convening national experts from industry, academia, and the public sector to review and discuss research findings.

II. Background

A. NRC and Technology Policy

Since 1991, the National Research Council has undertaken a program of activities to improve policy makers' understandings of the interconnections of science, technology, and economic policy and their importance for the American economy and its international competitive position. The NRC's activities have corresponded with increased policy recognition of the importance of technology to economic growth. New economic growth theory emphasizes the role of technology creation, which is believed to be characterized by significant growth externalities. In addition, many economists have recognized the limitations of traditional trade theory, particularly with respect to the reality of imperfect international competition.

Recent economic analysis suggests that high-technology is often characterized by increasing rather than decreasing returns, justifying to some the proposition that governments can capture permanent advantage in key industries by providing relatively small, but potentially decisive support to bring national industries up the learning curve and down the cost curve. There is also growing attention given to the potential of science-based economic growth derived from clusters of universities, laboratories, leading corporations, and dynamic small businesses. Recognition of these linkages and the corresponding ability of governments to shift comparative advantage in favor of the national economy provides the intellectual underpinning for government support for high-technology industry and especially small business.

B. Policy Context

The creation of new high technology business is a central concern of policymakers around the world. Starting in the late 1970s and accelerating in the 1980s, a growing body of empirical evidence began to indicate an increasing role for small business in job creation and innovation.[77] A recent report by the Organization for Economic Cooperation and Development (OECD) confirms policymakers' perceptions that small and medium-sized enterprises are major sources of economic vitality, flexibility, and employment.[78] In the United States, programs to support high technology business were launched during a time of increasing concern over the ability of U.S. companies to commercialize R&D results.

A prominent element in the diagnosis of America's economic ills during this period involved the country's failure to successfully commercialize new technologies developed by researchers. A recent report by the National Research Council recalls how the "gloomy picture of U.S. industrial competitiveness" in the 1980s was frequently cast in terms of American industry's failure "to translate its research prowess into commercial advantage."[79] One of the strategies adopted by the United States in response to its loss, or

[77] Zoltan J. Acs and David B. Audretsch, *Innovation and Small Business*. Cambridge, MA: MIT Press, 1991. For specifics on job growth, see Steven J. Davis, John Haltiwanger, and Scott Schuh, "Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts," *Business Economics*, vol. 29, no. 3, 1994, pp. 113-22.

[78] Small business is especially important as a source of new employment, accounting for a disproportionate share of job creation. See OECD, *Small Business Job Creation and Growth: Facts, Obstacles, and Best Practices*. OECD, Paris, 1997.

[79] David C. Mowery, "America's Industrial Resurgence (?): An Overview," in David C. Mowery, ed., *U.S. Industry in 2000: Studies in Competitive Performance*. Washington, D.C.: National Academy Press, 1999, p. 1. This volume examines 11 economic sectors, contrasting the improved performance of many industries in the late 1990s with the apparent decline that was subject to much scrutiny in the 1980s. Among the studies highlighting poor economic performance in the 1980s include Dertouzos, et. al., *Made in America: The MIT Commission on Industrial Productivity*, Cambridge, MA: The MIT Press, 1989 and Eckstein, et al., *DRI Report on U.S. Manufacturing Industries,* New York: McGraw Hill, 1984.

perceived loss, in competitiveness in some sectors was to encourage greater cooperation among companies and between industry and government. The rapid growth of small firms into large, sometimes very large firms is one of the defining features of the late eighties and the nineties. These new firms have been instrumental in bringing new products and processes to the market.

As the allocation and relative shares of the U.S. research and development budgets continue to evolve, small business is recognized as a major source of economic growth and technological innovation. Improved understanding of the policy questions associated with programs to encourage the commercialization of research by small business is therefore important. Indeed, the interrelationship among universities, industry, and government is a central element of the national innovation system, and one in which the SBIR program plays an increasingly salient role. From an international perspective, understanding the benefits and challenges of this type of program is also valuable insofar as they have been, and remain, a central element in the national development strategies of both industrial and industrializing countries. Recent data collected by the OECD suggests that worldwide government expenditure on support for high-technology industry and small business continues to rise. The proliferation of these programs provides a rich base of experience and underscores the current policy relevance of national programs to encourage small business development.

C. Recent National Research Council Contributions

The NRC has demonstrated its capability in the area of research and technological innovation by small companies through its major study on *Government-Industry Partnerships for the Development of New Technologies.* This multiyear, multifaceted study reviews the drivers of industry-university-government cooperation for technology development, current partnership practices and challenges, sectoral differences, means of evaluation, and the experience of foreign-based partnerships. Under this project, the NRC conducted an overview of the SBIR program[80] and initiated the first large-scale, independent assessment of the SBIR program at the Department of Defense.[81]

The extensive research carried out by the National Research Council's team of nationally recognized scholars has achieved substantial progress in terms of research techniques, understanding of SBIR program objectives, and the development of promising lines of inquiry for additional research. One of the major recommendations of the recent Academy analysis was the need for additional research.[82] The Congressional mandate, joined with the NRC's established methodology and the tacit knowledge acquired by the research team, offer a unique opportunity for an informed assessment of the NIH SBIR program.

D. Steering Committee Oversight

Drawing on the considerable public and corporate interest in these issues, the NRC will assemble a multidisciplinary Steering Committee to oversee the project and the review of the NIH's SBIR program. The Committee will include industry leaders, expert academics, successful entrepreneurs with experience in the SBIR program, and experienced public policy makers with extensive knowledge of the SBIR program as well as issues associated with R&D and business development.

To address the broad range of issues taken up by the project, the Committee will convene a series of fact-finding workshops, symposia, and conferences, and commission analyses of existing partnerships to establish the basis for a consensus report by the Academies. In light of the interest in the issues under review by the project, the Committee will issue intermediate reports as required to highlight important issues for the program and enable the Committee to respond to research questions as they emerge.

III. Goals, Methodology, and Deliverables

A. Overall Goals of the Study

[80] See National Research Council, *The Small Business Innovation Research Program: Challenges and Opportunities*. Washington, D.C.: National Academy Press, 1999.
[81] National Research Council, *The Small Business Innovation Research Program: An Assessment of the Department of Defense Fast Track Initiative.* Washington, D.C.: National Academy Press, October 2000.
[82] Ibid

A major advantage of this project is that although it will be carried out as a separate activity, the analysis will be conducted in the context of a multiyear, multifaceted assessment of the SBIR program in the five agencies accounting for 96 percent of program expenditure, as called for in H.R. 5667. Combined with the Academies' current work on government-industry partnerships, this brings substantial benefits in terms of the expertise, experience base, and related work already undertaken. The two publications by the NRC on the SBIR program, cited above, illustrate this advantage. For the study as a whole, the overall goals are to develop:

1. **Improved understanding of the conditions associated with successful and unsuccessful outcomes for the SBIR program. This includes but is not limited to mission-related R&D including procurement, small business development and growth, and the commercialization of new products and processes;**

2. **Best practice principles of operation, based on U.S. and foreign experience, for the SBIR program to support high technology small business and entrepreneurship.**

The SBIR program continues to grow as the federal R&D budget rises. This expansion highlights the need for better understanding by public policymakers and private participants alike of the rationale for public contributions and the conditions most likely to ensure successful programs. In the context of these goals, the study will seek to provide an objective review of:

1. **The operations and effectiveness of the SBIR program with regard to:**
   - agency missions;
   - support for R&D and innovation;
   - commercialization of new products and processes;
   - small business development and job growth;

2. **General issues of importance**, such as the rationale and national benefits to be derived from government support to small business to help bring new technologies to market; the principles which should guide such cooperation, demarcating the role and contribution of the public authorities, including the government's role in supporting university-industry research; the current practices and policies of foreign governments designed to encourage the development of small business both as a point of reference and comparison; and the relationship of different types of cooperative programs which affect the operations and prospects of small firms, including the rationale for strategic alliances among firms and universities in sectors supported by publicly funded programs.

B. Project Methodology for the NIH SBIR Assessment

Accordingly, the NRC proposes to the NIH the following research strategy, to be carried out in close consultation with responsible program managers, for a review of the NIH's Small Business Innovation Research program. The NRC research team, in cooperation with leading economists, relevant program officials, responsible NIH managers, and small business representatives, will develop the following:

1. **Definition of Success:** An operational definition(s) of SBIR success for the NIH, taking into account the diverse goals of the NIH mission;

2. **Survey Instrument:** A survey instrument to be applied to a significant sample of SBIR award recipients. The survey instrument will be designed to gather information on firm development, technological progress, and the operations of the SBIR program;

3. **Case Study Template:** A series of questions for use in conducting case studies of NIH SBIR award recipients to provide greater detail and depth on selected SBIR award recipients. The case studies will focus on the award process, intermediate achievements, indicators of project success, and long-term impact, including, *inter alia*, measures such as papers, patents, products, sales, and acquisitions of awardees;

4. **Survey and Case Development, Execution, and Evaluation:** A group of leading academics in small business development and innovation policy will be commissioned to conduct original field research and analyze that research. In order to examine the NIH SBIR program from multiple perspectives, the project will include a triangulation of case studies, surveys, and empirical

analysis. Where required, an original survey of a wide selection of firms which have participated in the NIH SBIR program will be undertaken.[83] There is virtually no academic literature on the NIH SBIR program. The National Academies' study will be one of the first independent, external reviews of the program as a whole.

C. Tasks:

In carrying out this study, the NRC will:

- **Assemble A Research Team:** Assemble a research team of qualified academics to assist the NRC in carrying out its research;
- **Develop Metrics:** Convene a small workshop(s), which will include the NRC research team and relevant NIH program managers, to develop operational definitions of program success and appropriate metrics, and review emerging issues for the program in light of new the NIH missions or needs;
- **Prepare A Methodology for the NIH:** Drawing on the experience of the NIH program managers, the NRC will prepare a methodology for assessment of the NIH SBIR program using input from the NRC research team and discussion at the workshop(s), which will include a case study template, a survey instrument, and appropriate focus areas;
- **Identify Case Categories:** Identify appropriate categories of firms for case studies involving both promising technologies and/or research results;
- **Conduct Case Studies:** Carry out, via the research team, case studies of a significant subset of the NIH SBIR awardees, employing the case study template developed in cooperation with the NIH;
- **Survey:** Conduct a survey of a significant subset of NIH SBIR awardees employing the survey instrument developed by the research team in cooperation with the NIH.
- **Organize Symposium:** Organize a substantial symposium to discuss new orientations/initiatives for the NIH program and to review publicly the results of the research;

D. Deliverables

Under the study, the NRC would commit to:

- Prepare annual progress reports;
- When the initial phase of research is completed, prepare a report based on the research, providing an overview of the current NIH SBIR program and identifying accomplishments, emerging challenges, and possible policy solutions;
- Prepare a Summary Report including the NIH-specific research to submit to Congress.

IV. NRC Dissemination

The process of holding a number of high profile events, bringing together national experts from industry, academia, and the public sector, should itself contribute to an improvement of the quality of the national debate on these subjects. The policy recommendations, with supporting evidence and analysis, will be addressed to SBIR program managers and agency leadership, members of Congress and the Executive Branch, industry leaders, and major associations as well as relevant international organizations.

An important and distinctive element of the work of the Academy is its well-developed dissemination process designed to maximize the policy impact of the findings and recommendations of its projects. Normally, the process includes several phases. The NRC's publishing arm, National Academy Press, produces high quality final publications with a wide audience. At the moment of publication, the Academy staff also produce a series of accompanying press reports

[83] In cooperation with the NRC, BRTRC, Inc. conducted a similar survey for the National Research Council's review of the Department of Defense SBIR Fast Track initiative, a study conducted in 1998-1999. That survey had an unusually high response rate compared to similar surveys, and provided a wealth of new data on the program. BRTRC is a highly qualified consulting firm located in the D.C. area, and has done extensive work on the SBIR program over the last several years, on contracts with the Department of Defense, the Small Business Administration, and the National Academies.

and other dissemination materials. When the project report is released, a formal press conference, attended by national and international publications, and discussion seminars may be organized by the Academy.

The National Research Council also undertakes a concerted effort to disseminate the project's findings and conclusions. Opinion articles will be prepared for newspapers and influential journals, presentations and discussion will be organized at the Academy and other academic and policy forums as well as briefings, speaking engagements for key participants, and testimony before appropriate legislative bodies. Reports resulting from this effort shall be prepared in sufficient quantity to ensure their distribution to the sponsor and to other relevant parties, in accordance with Academy policy. Reports may be made available to the public without restrictions.

V. Public Information

A. *FEDERAL ADVISORY COMMITTEE ACT*

The Academy has developed interim policies and procedures to implement the Federal Advisory Committee Act, 5 U.S.C. § 1 et seq. (FACA), as amended by the Federal Advisory Committee Act Amendments of 1997, H.R. 2977, signed into law on December 17, 1997 (FACA Amendments). The FACA Amendments exempted the Academy from most of the requirements of FACA, but added a new Section 15 that includes certain requirements regarding public access and conflicts of interest that are applicable to agreements under which the Academy, using a committee, provides advice or recommendations to a Federal agency. In accordance with Section 15 of FACA, the Academy shall deliver along with its final report to the NIH, a certification by the Responsible Staff Officer that the policies and procedures of the National Academy of Sciences that implement Section 15 of FACA have been complied with in connection with the performance of the contract /grant/cooperative agreement.

B. *Public Information About the Project*

The NRC will post on its web site (http://national-academies.org) a brief description of the project, as well as committee appointments with short biographies of the members, meeting notices, and other pertinent information, to afford the public greater knowledge of our activities, and an opportunity to make comments.

The website will also include an ongoing record of compliance to the requirements of Section 15 of the Federal Advisory Committee Act of 1997, and a certification of compliance will be provided when the study is completed.

Annex C

MEMORANDUM OF UNDERSTANDING
between the
NATIONAL RESEARCH COUNCIL
and the
DEPARTMENT OF DEFENSE
NATIONAL INSTITUTES OF HEALTH
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
DEPARTMENT OF ENERGY
NATIONAL SCIENCE FOUNDATION

Summary

This memorandum summarizes the understanding reached at the December 7 meeting, convened by Science Committee staff, between the agencies and the NRC on issues relating to the contract, funding, and execution of the NRC study of the SBIR program.

Background

On November 19 and December 7, 2001, representatives of five agencies carrying out SBIR programs, the SBA, and the House and Senate staff met to work out all remaining issues in negotiations between the agencies and the National Academy of Sciences to carry out the statutory review of the SBIR program that is described in Section 108 of HR 5667 of the 106th Congress and required under Public Law 106-554, hereafter referred to as "the study". Under this law, the head of each agency with a budget of more than $50,000,000 for its SBIR program for fiscal year 1999, (NSF, NIH, DOE, NASA, and DOD) in consultation with the Small Business Administration, shall, not later than 6 months after the date of enactment of PL 106-554, cooperatively enter into an agreement with the National Academy of Sciences for the National Research Council to conduct a comprehensive study of how the SBIR program has stimulated technological innovation and used small businesses to meet Federal research and development needs. Section 108 also enumerates a series of questions to be answered and issues to be examined as part of the study. The meetings were successful and there is now broad agreement on a cooperative approach to the study.

Areas of Agreement

Substantial areas of agreement among the parties to the discussion included:

- A shared desire to carry out the required study.
- A shared desire to work in a consultative and cooperative way through the conduct of the study.
- An understanding that the scope and duration of the study are defined in the statute.
- A recognition of the need to preserve the National Academies' independence in the conduct of the study, while ensuring that the study be as broadly inclusive as possible of all SBIR constituencies and demographics. The study shall in all regards be conducted in accordance with standard Academy procedures[1], including compliance with Section 15 of the Federal Advisory Committee Act[2]. Further, to

[1] SEARCH FOR COMMITTEE NOMINEES: POLICY of the NAS--The fundamental consideration in appointing committees of the NRC is that the resulting group be wholly qualified and appropriately balanced to perform its assigned task with distinction.

Every nomination submitted to the Chair, NRC for approval should be the result of a careful choice among alternatives. Suggestions should be sought from several sources whenever possible, including Liaisons for the relevant sections of the NAS and NAE. The objective is to draw nominees from the broad community of qualified individuals, including those who may be less prominent or "visible" than their peers by reason of their race, sex, or age.

Those who have helped formulate the charge to a committee and have given thought to its task are usually involved in selecting the first nominees; members already serving are likely to have preferences concerning additions or replacements. However, while suggestions from those sources are appropriate, consultation should also be sought within the major unit in which the committee is organized, with other major units having related activities or pertinent information resources, and with networks of sources outside the NRC.

Policy: It is the policy of the NRC that those responsible for preparing nominations for NRC committee service should strive to ensure that the search for suitable nominees is a broad one. Special effort should be devoted to the identification of qualified women, members of ethnic or racial minorities, younger individuals (35 years old and younger), and members of the NAS, NAE, and IOM.

With reference to women and minorities, recent editions of the following biographical directories are available in the Academy Library:

Who's Who of American Women
Who's Who Among Black Americans
Black Engineers in the United States

With reference to members of the Academies and the Institute, Section Liaisons should be contacted sufficiently in advance of the need that they can have time to consult with their sections. See "Section Liaison Process" in the Guide to Project Management.

[2] PL 105-153, December 17, 1997, 111 Stat 2689—Section 15 of the Federal Advisory Committee Act of 1997 was amended to read as follows:

"REQUIREMENTS RELATING TO THE NATIONAL ACADEMY OF SCIENCES AND THE NATIONAL

ACADEMY OF PUBLIC ADMINISTRATION

"SEC. 15. (a) IN GENERAL.--An agency may not use any advice or recommendation provided by the National Academy of Sciences or National Academy of Public Administration that was developed by use of a committee created by that academy under an agreement with an agency, unless--
"(1) the committee was not subject to any actual management or control by an agency or an officer of the Federal Government;
"(2) in the case of a committee created after the date of the enactment of the Federal Advisory Committee Act Amendments of 1997, the membership of the committee was appointed in accordance with the requirements described in subsection (b)(1); and
"(3) in developing the advice or recommendation, the academy complied with--
"(A) subsection (b)(2) through (6), in the case of any advice or recommendation provided by the National Academy of Sciences; or
"(B) subsection (b)(2) and (5), in the case of any advice or recommendation provided by the National Academy of Public Administration.
"(b) REQUIREMENTS.--The requirements referred to in subsection (a) are as follows:
"(1) The Academy shall determine and provide public notice of the names and brief biographies of individuals that the Academy appoints or intends to appoint to serve on the committee. The Academy shall determine and provide a reasonable opportunity for the public to comment on such appointments before they are made or, if the Academy determines such prior comment is not practicable, in the period immediately following the appointments. The Academy shall make its best efforts to ensure that (A) no individual appointed to serve on the committee has a conflict of interest that is relevant to the functions to be performed, unless such conflict is promptly and publicly disclosed and the Academy determines that the conflict is unavoidable, (B) the committee membership is fairly balanced as determined by the Academy to be appropriate for the functions to be performed, and (C) the final report of the Academy will be the result of the Academy's independent judgment. The Academy shall require that individuals that the Academy appoints or intends to appoint to serve on the committee inform the Academy of the individual's conflicts of interest that are relevant to the functions to be performed.
"(2) The Academy shall determine and provide public notice of committee meetings that will be open to the public.
"(3) The Academy shall ensure that meetings of the committee to gather data from individuals who are not officials, agents, or employees of the Academy are open to the public, unless the Academy determines that a meeting would disclose matters described in section 552(b) of title 5, United States Code. The Academy shall make available to the public, at reasonable charge if appropriate, written materials presented to the committee by individuals who are not officials, agents, or employees of the Academy, unless the Academy determines that making material available would disclose matters described in that section.
"(4) The Academy shall make available to the public as soon as practicable, at reasonable charge if appropriate, a brief summary of any committee meeting that is not a data gathering meeting, unless the Academy determines that the summary would disclose matters described in section 552(b) of title 5, United States Code. The summary shall identify the committee members present, the topics discussed, materials made available to the committee, and such other matters that the Academy determines should be included.
"(5) The Academy shall make available to the public its final report, at reasonable charge if appropriate, unless the Academy

ensure that the concerns of small business are appropriately represented, the statute requires the National Research Council to "consult with and consider the views of the Office of Technology and the Office of Advocacy of the Small Business Administration and other interested parties, including entities, organizations and individuals actively engaged in enhancing or developing the technological capabilities of small business concerns." Also, in recognition of a need to seek out representatives of under-served populations for advice and as potential panelists and peer reviewers, the Academy shall look to socially and economically disadvantaged small business concerns, as defined in section 637(a)(4) of title 15 of the United States Code[3], small businesses that are at least 51 percent owned and controlled by women, and researchers at

---

determines that the report would disclose matters described in section 552(b) of title 5, United States Code. If the Academy determines that the report would disclose matters described in that section, the Academy shall make public an abbreviated version of the report that does not disclose those matters.
"(6) After publication of the final report, the Academy shall make publicly available the names of the principal reviewers who reviewed the report in draft form and who are not officials, agents, or employees of the Academy.
"(c) REGULATIONS.--The Administrator of General Services may issue regulations implementing this section.".

(c) EFFECTIVE DATE AND APPLICATION.--
(1) IN GENERAL.--Except as provided in paragraph (2), this section and the amendments made by this section shall take effect on the date of the enactment of this Act.
(2) RETROACTIVE EFFECT.--Subsection (a) and the amendments made by subsection (a) shall be effective as of October 6, 1972, except that they shall not apply with respect to or otherwise affect any particular advice or recommendations that are subject to any judicial action filed before the date of the enactment of this Act.

[3] 15 U.S.C 637 –

(4)(A) For purposes of this section, the term "socially and economically disadvantaged small business concern" means any small business concern which meets the requirements of subparagraph (B)

and -

(i) which is at least 51 per centum unconditionally owned by -

(I) one or more socially and economically disadvantaged individuals,

(II) an economically disadvantaged Indian tribe (or a wholly owned business entity of such tribe), or

(III) an economically disadvantaged Native Hawaiian organization, or

(ii) in the case of any publicly owned business, at least 51 per centum of the stock of which is unconditionally owned by -

(I) one or more socially and economically disadvantaged individuals,

(II) an economically disadvantaged Indian tribe (or a wholly owned business entity of such tribe), or

(III) an economically disadvantaged Native Hawaiian organization.

(B) A small business concern meets the requirements of this subparagraph if the management and daily business operations of such small business concern are controlled by one or more -

(i) socially and economically disadvantaged individuals described in subparagraph (A)(i)(I) or subparagraph (A)(ii)(I),

(ii) members of an economically disadvantaged Indian tribe described in subparagraph (A)(i)(II) or subparagraph (A)(ii)(II), or

(iii) Native Hawaiian organizations described in subparagraph (A)(i)(III) or subparagraph (A)(ii)(III).

(C) Each Program Participant shall certify, on an annual basis, that it meets the requirements of this paragraph regarding ownership and control.

Historically Black Colleges and Universities and other minority institutions.
- The division of the study into two major phases as elaborated in Appendix A, with an external peer review directed according to standard Academy procedures of the methodology proposed at the end of Phase I to be carried out before Phase II is undertaken.
- Specifics related to the contracts and funding of the study are as elaborated below.

Contracts and Funding for the Congressional Study:

The NRC and the agencies agreed on all of the following points:
- The agencies will provide up-front funds to cover the first half of the funding for the entire two-phased study. That is, half the total cost will be used to cover Phase I activities and substantial bridging to Phase II.
- Pending budget authority, funding for completion of Phase II activities will be released in its entirety, within 60 days following completion of Phase I and the external peer review (described above) of the Phase I results and the Phase II plan/activities. Agencies fully intend to commit funds for the balance of the study, however, that release of funding depends on agency budget authority. There will be no gap as the study moves from Phase I to Phase II.
- New proposals will not be prepared. The NRC will submit a revised budget to each agency for the study.
- The contracts for the study with the individual agencies are to be finalized 30 days after signature of this document, pending receipt of agencies' budgets and the specific receipt of funds from which this study will be supported.
- Each agency is to take responsibility for the transfer of funds to the NRC under its contract.

(5) Socially disadvantaged individuals are those who have been subjected to racial or ethnic prejudice or cultural bias because of their identity as a member of a group without regard to their individual qualities.

(6)(A) Economically disadvantaged individuals are those socially disadvantaged individuals whose ability to compete in the free enterprise system has been impaired due to diminished capital and credit opportunities as compared to others in the same business area who are not socially disadvantaged.

Appendix A: A Two-Phase NRC Study of the SBIR Program

PHASE I [Time estimates]	**DEVELOP & REVIEW TOOLS AND METRICS**
Launch NRC Study [Months 1-4]	Conclude contracts Secure Academy GBEC Approval Select Steering Committee Identify members and agree on initial contracts for Research Team Secure approval of Steering Committee
Convene Initial Symposium & Working Groups [Months 5-8]	Host Initial Symposium to launch project and help identify issues, commonalities, and unique features of agency programs. Convene a series of meetings between the research group, agency representatives, and program officers, and other interested parties to review the study's overall methodology, to address unique agency objectives, practices and metrics, and to address the specific issues identified in the legislation.
Develop Strategy and Research Tools [Months 9-12]	Develop survey evaluation framework including sampling strategy, appropriate survey instruments including target populations (e.g. small business awardees, agency employees, etc.), case study templates, and an analysis plan.
Review [Months 13-16]	Consult with small business representatives. Review instruments with agency representatives and research team. Finalize methodologies with research team and Steering Committee. Submit overall methodology and survey evaluation framework for the external peer review. Complete peer review of overall methodology and evaluation framework.
Phase II	**RESEARCH, REFINE, REVIEW, AND REPORT**
Field Research & Empirical Analysis [Months 17-27]	Organize tasking of research team Commission Research Facilitate and follow-up on field interviews and surveys Commission independent empirical analyses to review results
Produce, Review, Publish & Publicize Field Research [Months 28-36]	Evaluate and cross-check survey results and commissioned work Discuss results with agencies for comment Convene symposium (s) based on study outcomes.

Annex D
Additional Research Areas of Committee Interest

To complement and further illuminate the core issues identified in the Methodology Report, the Committee has identified several special topics of interest. Such special topics may include:

- **Aligning SBIR cycle time and research cycle time**
  - Can SBIR cycle time and research time be better aligned?
    - For example, the SBIR cycle time may not suit electronics research, because of its short cycle time, but may be more compatible with biotech research.
    - For example, NIH stated that they need longer periods for their SBIR Programs--and, in fact, are using them.
  - How can the SBIR program cycles be better structured to facilitate electronics and software research?
  - What degree of flexibility on cycle time is available and how it is provided?
    - What are the advantages of this flexibility?
    - Could we suggest legislative changes to provide it?

- **Facilitating transition between Phase I and II and Phase II and III**
  - What incentives can be created to encourage the Phase II to Phase III transition?
    - For example, a commonly identified weakness in the SBIR is the transition from Phase II to "Phase III," i.e., the picking up of the project after it has been successfully demonstrated.
  - How can we get the program people involved in the Phase III effort?
  - How are similar transitions handled between DARPA and the Service's programs?

- **The role of state governments**
  - How can we study the impact state government perspectives and contributions?
  - What associations validly represent the states' interest in this type of activity and what are their views?
  - What similarities can we make among states' that are particularly active in SBIR, e.g., Massachusetts, Maryland?

- **The role of intellectual property and patent rights**

- **The effect of coupling SBIR with STTR**

- **The effect of Joint ventures and teaming**
  - What benefits can be realized from "teaming" on SBIR Programs?
  - What if any anti-trust concerns that have to be considered in this light?

- **The effect of other legislation on SBIR**
  - What other legislative acts inter-relate with the SBIR Program?
  - Do these interrelationships have a positive or negative impact?
    - For example, the Bayh-Dole Act.

- **The SBIR "mills" phenomenon**
  - How prevalent is this phenomenon
  - Types/motivators of mills
  - How concentrated are they by agency?
  - What is the nature of the awards?
  - What are characteristics of mills that deal with one agency vs. those that deal with multiple agencies?

- **The University Connection**
  - How tightly are firms that are participating in SBIR linked to universities?

- What is the nature of this connection?
- What spillovers can occur in this context?
- What is the PI's relationship to the university?
- How is issue of intellectual property handled? E.g., licensing agreements
- How near/far is the firm located from the university?

- **Administrative best practices in SBIR**

- **The SBIR role in overcoming barriers to finance**
  - Does SBIR crowd out private investment?
  - Does SBIR work as a signal to markets?

Annex E

Bibliography

Acs, Z. and D. Audretsch. 1991. *Innovation and Small Firms*. Cambridge, MA: MIT Press.

Alic, John A., Lewis Branscomb, Harvey Brooks, Ashton B. Carter, and Gerald L. Epstein. 1992. *Beyond Spinoff: Military and Commercial Technologies in a Changing World.* Boston: Harvard Business School Press.

Arrow, Kenneth. 1962. "Economic welfare and the allocation of resources for invention." Pp. 609–625 in *The Rate and Direction of Inventive Activity: Economic and Social Factors.* Princeton, NJ: Princeton University Press.

Arrow, Kenneth. 1973. "The theory of discrimination." Pp. 3–31 in *Discrimination In Labor Markets,* Orley Ashenfelter and Albert Rees, eds. Princeton, NJ: Princeton University Press.

Audretsch, David B. 1995. *Innovation and Industry Evolution*. Cambridge, MA: MIT Press.

Audretsch, David B. and Maryann P. Feldman. 1996. "R&D spillovers and the geography of innovation and production." *American Economic Review* 86(3):630–640.

Audretsch, David B. and Paula E. Stephan. 1996. "Company-scientist locational links: The case of biotechnology." *American Economic Review* 86(3):641–642.

Audretsch, D. and R. Thurik. 1999. *Innovation, Industry Evolution, and Employment*. Cambridge, MA: MIT Press.

Barfield, C. and W. Schambra, eds., 1986. *The Politics of Industrial Policy.* Washington, D.C.: American Enterprise Institute for Public Policy Research.

Baron, Jonathan. 1998. "DoD SBIR/STTR Program Manager." Comments at the Methodology Workshop on the Assessment of Current SBIR Program Initiatives, Washington, D.C., October.

Barry, C. B.. 1994. "New directions in research on venture capital finance." *Financial Management* 23 (Autumn):3–15.

Bator, Francis. 1958. "The anatomy of market failure." *Quarterly Journal of Economics* 72:351–379.

Bingham, R. 1998. *Industrial Policy American Style: From Hamilton to HDTV*. New York: M.E. Sharpe.

Birch, D. 1981. "Who Creates Jobs." *The Public Interest* 65 (Fall):3–14.

Branscomb, Lewis M., Kenneth P. Morse, Michael J. Roberts, and Darin Boville. 2000. *Managing Technical Risk: Understanding Private Sector Decision Making on Early Stage Technology Based Projects.* Washington, D.C.: National Institute of Standards and Technology, Department of Commerce.

Branscomb, Lewis M. and Philip E. Auerswald. 2001. *Taking Technical Risks: How Innovators, Managers, and Investors Manage Risk in High-Tech Innovations*, Cambridge, MA: MIT Press.

Branscomb, Lewis M. and J. Keller, 1998. *Investing in Innovation: Creating a Research and Innovation Policy.* Cambridge, MA: MIT Press.

Brav, A. and P. A. Gompers, 1997. "Myth or reality?: Long-run underperformance of initial public offerings; Evidence from venture capital and nonventure capital-backed IPOs." *Journal of Finance* 52:1791-1821.

Brown, G. and J. Turner, 1999. "Reworking the Federal Role in Small Business Research." *Issues in Science and Technology* (Summer): 51-58.

Bush, Vannevar. 1946. *Science—the Endless Frontier.* Republished in 1960 by U.S. National Science Foundation, Washington, D.C.

Caballero, Ricardo J. and Adam B. Jaffe (1993),"How high are the giants' shoulders: an empirical assessment of knowledge spillovers and creative destruction in a model of economic growth," in O.J. Blanchard and S. Fischer (eds.) *NBER Macroeconomic Annual 1993*, Cambridge, MA: MIT Press.

Caves, Richard E. 1998. "Industrial organization and new findings on the turnover and mobility of firms." *Journal of Economic Literature* 36(4):1947–1982.

Clinton, William Jefferson. 1994. *Economic Report of the President*. Washington, D.C.: U.S. Government Printing Office.

Coburn, C. and D. Bergland, 1995. *Partnerships: A Compendium of State and Federal Cooperative Technology Programs*. Columbus, OH: Battelle.

Cohen, L. R. and R. G. Noll, 1991. *The Technology Pork Barrel.* Washington, D.C.: The Brookings Institution.

Cooper, R. S. Purpose and performance of the Small Business Innovation Research (SBIR) program, *Small Business Economics* 20, pp. 137-151.

Council of Economic Advisers, 1995. *Supporting Research and Development to Promote Economic Growth: The Federal Government's Role.* Washington, D.C..

David, P., B. Hall, and A. Toole, "Is public R&D a complement or substitute for private R&D? A review of the econometric evidence," *Research Policy* 29(4-5):497-530 (2000).

Davis, S.J., J. Haltiwanger, and S. Schuh. 1994. "Small Business and Job Creation: Dissecting the Myth and Reassessing the Facts," *Business Economics* 29(3):113–22.

Dertouzos, M. 1989. *Made in America: The MIT Commission on Industrial Productivity*, Cambridge, MA: The MIT Press.

Eckstein, 1984. *DRI Report on U.S. Manufacturing Industries,* New York: McGraw Hill.

Eisinger, P. K., 1988. *The Rise of the Entrepreneurial State: State and Local Economic Development Policy in the United State*. Madison, WI: University of Wisconsin Press.

Feldman, Maryann P. 1994a. "Knowledge complementarity and innovation." *Small Business Economics* 6(5):363–372.

Feldman, Maryann P. 1994b. *The Geography of Knowledge.* Boston: Kluwer Academic.

Feldman, Maryann P. and Maryellen R. Kelley, 2003. "Leveraging Research and Development: Assessing the Impact of the U.S. Advanced Technology Program," *Small Business Economics* Vol. 20, No. 2.

Fenn, G. W., N. Liang, and S. Prowse, 1995. *The Economics of the Private Equity Market.* Washington, D.C.: Board of Governors of the Federal Reserve System.

Flamm, K., 1988. *Creating the Computer*. Washington, D.C.: The Brookings Institution.

Freear, J. and W. E. Wetzel, Jr. 1990. "Who bankrolls high-tech entrepreneurs?" *Journal of Business Venturing* 5:77–89.

Freeman, Chris and Luc Soete. 1997. *The Economics of Industrial Innovation.* Cambridge, MA: MIT Press.

Galbraith, J. K. 1957. *The New Industrial State.* Boston: Houghton Mifflin.

Gans, J. S. and S. Stern, 2003. When does funding research by smaller firms bear fruit?: Evidence from the SBIR program. *Economic Innovation and New Technology*, Vol. 12 No. 4, pp. 361-384

Garcia-Quevedo, J. 2004. "Do public subsidies complement business R&D? A meta-analysis of the econometric evidence." *Kyklos,* Vol. 57.

Geroski, Paul A. 1995. "What do we know about entry?" *International Journal of Industrial Organization* 13(4):421–440.

Gompers, P. A., 1995. "Optimal investment, monitoring, and the staging of venture capital." *Journal of Finance* 50:1461–1489.

Gompers, P. A. and J. Lerner. 1996. "The use of covenants: An empirical analysis of venture partnership agreements." *Journal of Law and Economics* 39:463–498.

Gompers, P. A. and J. Lerner. 1999. "An analysis of compensation in the U.S. venture capital partnership." Journal *of Financial Economics* 51(1):3–7.

Gompers, P. A. and J. Lerner. 1998a. "Capital formation and investment in venture markets: A report to the NBER and the Advanced Technology Program." Unpublished working paper, Harvard University.

Gompers, P. A. and J. Lerner. 1998b. "What drives venture capital fund-raising?" Unpublished working paper, Harvard University.

Gompers, P. A. and J. Lerner. 1999. *The Venture Cycle*. Cambridge, MA: MIT Press.

Good, M. L. 1995. Prepared testimony before the Senate Commerce, Science, and Transportation Committee, Subcommittee on Science, Technology, and Space (Photocopy, U.S. Department of Commerce).

Graham, O. L. 1992. *Losing Time: The Industrial Policy Debate*. Cambridge, MA: Harvard University Press.

Greenwald, B. C., J. E. Stiglitz, and A. Weiss, 1984. "Information imperfections in the capital market and macroeconomic fluctuations." *American Economic Review Papers and Proceedings* 74:194–199.

Griliches, Z. 1990. *The Search for R&D Spillovers*. Cambridge, MA: Harvard University Press.

Hall, Bronwyn H. 1992. "Investment and research and development: Does the source of financing matter?" Working Paper No. 92-194, Department of Economics, University of California at Berkeley.

Hall, Bronwyn H. 1993. "Industrial research during the 1980s: Did the rate of return fall?" Brookings Papers: *Microeconomics* 2:289–343.

Hamberg, Dan. 1963. "Invention in the industrial research laboratory." *Journal of Political Economy* (April):95–115.

Hao, K. Y. and A. B. Jaffe, 1993. "Effect of liquidity on firms' R&D spending." *Economics of Innovation and New Technology* 2:275–282.

Hebert, Robert F. and Albert N. Link. 1989. "In search of the meaning of entrepreneurship." *Small Business Economics* 1(1):39–49.

Himmelberg, C. P. and B. C. Petersen, 1994. "R&D and internal finance: A panel study of small firms in high-tech industries." *Review of Economics and Statistics* 76:38–51.

Hubbard, R. G. 1998. "Capital-market imperfections and investment." *Journal of Economic Literature* 36:193–225.

Huntsman, B. and J. P. Hoban, Jr. 1980. "Investment in new enterprise: Some empirical observations on risk, return, and market structure." *Financial Management* 9 (Summer): 44–51.

Jaffe, A. B. 1996, "Economic analysis of research spillovers—Implications for the Advanced Technology Program." Washington, D.C.: Advanced Technology Program, National Institute of Standards and Technology, U.S. Department of Commerce.

Jaffe, A. B. 1998. "The importance of 'spillovers' in the policy mission of the Advanced Technology Program." Journal *of Technology Transfer* (Summer).

Jaffe, A. B. and M. Trajtenberg. 2002. *Patents, Citations, and Innovations: A Window on the Knowledge Economy*. Cambridge, MA: MIT Press.

Jewkes, J., D. Sawers, and R. Stillerman. 1958. *The Sources of Invention*. New York: St. Martin's Press.

Kleinman, D. L.. 1995. *Politics on the Endless Frontier: Postwar Research Policy in the United States*. Durham, NC: Duke University Press.

Kortum, Samuel, and Josh Lerner. 1998. "Does Venture Capital Spur Innovation?" NBER Working Papers 6846, National Bureau of Economic Research, Inc.

Krugman, P. 1990. *Rethinking International Trade*. Cambridge, MA: MIT Press.

Krugman, P. 1991. *Geography and Trade.* Cambridge, MA: MIT Press.

Lach, S. "Do R&D subsidies stimulate or displace private R&D? Evidence from Israel, *Journal of Industrial Economics* December 2002, pp. 369-390

Langlois, Richard N. and Paul L. Robertson 1996. "Stop Crying over Spilt Knowledge: A Critical Look at the Theory of Spillovers and Technical Change." Paper prepared for the MERIT Conference on Innovation, Evolution, and Technology. Maastricht, Netherlands, August 25-27.

Lebow, I. 1995. *Information Highways and Byways: From the Telegraph to the 21st Century*. New York: Institute of Electrical and Electronic Engineering.

Lerner, J. 1994. "The syndication of venture capital investments." *Financial Management* 23 (Autumn):16–27.

Lerner, J. 1995. "Venture capital and the oversight of private firms." *Journal of Finance* 50:301–318.

Lerner, J. 1996. "The government as venture capitalist: The long-run effects of the SBIR program" (Working paper no. 5753, National Bureau of Economic Research).

Lerner, J. 1998. "Angel financing and public policy: An overview" *Journal of Banking and Finance* 22(6–8):773–784.

Lerner, J. 1999. "The government as venture capitalist: The long-run effects of the SBIR program." *Journal of Business* 72(3):285–297.

Lerner, J. 1999. "Public venture capital: Rationales and evaluation," in *SBIR: Challenges and Opportunities.* Washington, D.C.: National Academy Press.

Levy, D. M. and N. Terleckyk, 1983. "Effects of government R&D on private R&D investment and productivity: A macroeconomic analysis" *Bell Journal of Economics* 14: 551–561.

Liles, P. 1977. *Sustaining the Venture Capital Firm*. Cambridge, MA: Management Analysis Center.

Link, Albert N. 1998. "Public/Private Partnerships as a Tool to Support Industrial R&D: Experiences in the United States." Paper prepared for the working group on Innovation and Technology Policy of the OECD Committee for Science and Technology Policy, Paris.

Link, Albert N. and John T. Scott. 1998a. *Overcoming Market Failure: A Case Study of the ATP Focused Program on Technologies for the Integration of Manufacturing Applications (TIMA)*. Draft final report submitted to the Advanced Technology Program. Gaithersburg, MD: National Institute of Technology. October.

Link, Albert N. and John T. Scott. 1998b. "Assessing the infrastructural needs of a technology-based service sector: A new approach to technology policy planning." *STI Review* 22: 171–207.

Link, Albert N. and John T. Scott. 1998c. *Public Accountability: Evaluating Technology-Based Institutions.* Norwell, Mass.: Kluwer Academic.

Link, Albert N. and John Rees. 1990. "Firm size, university based research and the returns to R&D." *Small Business Economic*s 2(1):25–32.

Malone, T. 1995. *The Microprocessor: A Biography.* Hamburg, Germany: Springer Verlag/Telos.

Mansfield, E., J. Rapoport, A. Romeo, S. Wagner, and G. Beardsley, 1977. "Social and private rates of return from industrial innovations" *Quarterly Journal of Economics* 91: 221–240.

Mansfield, E. 1985. "How Fast Does New Industrial Technology Leak Out?" *Journal of Industrial Economics*. 34(2).

Mansfield, E. 1996. *Estimating Social and Private Returns from Innovations Based on the Advanced Technology Program: Problems and Opportunities*. Unpublished report.

Martin, Justin. 2002. "David Birch." *Fortune Small Business,* December 1.

McCraw, T. 1986. Mercantilism and the market: antecedents of American industrial policy, in Barfield, C., and Schambra, W., eds., *The Politics of Industrial Policy.* Washington, D.C.: American Enterprise Institute for Public Policy Research.

Mervis, Jeffrey D. 1996. "A $1 Billion 'Tax' on R&D Funds." *Science* 272:942–944.

Mowery, D. 1998. "Collaborative R&D: how effective is it," *Issues in Science and Technology,* (Fal): 37-44.

Mowery, D. and N. Rosenberg. 1989. *Technology and the Pursuit of Economic Growth*. New York: Cambridge University Press.

Mowery, D. and N. Rosenberg. 1998. *Paths of Innovation: Technological Change in 20th Century America.* New York: Cambridge University Press.

Myers, S., R. L. Stern, and M. L. Rorke. 1983. A Study of the Small Business Innovation Research Program. Lake Forest, Illinois: Mohawk Research Corporation.

Myers, S. C. and N. Majluf. 1984. "Corporate financing and investment decisions when firms have information that investors do not have," *Journal of Financial Economics* 13:187–221.

National Research Council. 1986. *The Positive Sum Strategy*: *Harnessing Technology for Economic Growth*. Washington, D.C.: National Academy Press.

National Research Council. 1987. *Semiconductor Industry and the National Laboratories: Part of a National Strategy.* Washington, D.C.: National Academy Press.

National Research Council. 1991. *Mathematical Sciences, Technology, and Economic Competitiveness*. James, G. Glimm, ed. Washington, D.C.: National Academy Press.

National Research Council. 1995. *Allocating Federal Funds for R&D*. Washington, D.C.: National Academy Press.

National Research Council. 1996. *Conflict and Cooperation in National Competition for High-Technology Industry*. Washington, D.C.: National Academy Press.

National Research Council. 1997. *Review of the Research Program of the Partnership for a New Generation of Vehicles: Third Report.* Washington, D.C.: National Academy Press.

National Research Council. 1999. *The Advanced Technology Program: Challenges and Opportunities.* Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 1999. *Funding a Revolution: Government Support for Computing Research*. Washington, D.C.: National Academy Press.

National Research Council. 1999. *Industry-Laboratory Partnerships: A Review of the Sandia Science and Technology Park Initiative.* Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 1999. *New Vistas in Transatlantic Science and Technology Cooperation.* Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 1999. *The Small Business Innovation Research Program: Challenges and Opportunities.* Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 2000. *The Small Business Innovation Research Program: A Review of the Department of Defense Fast Track Initiative.* Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 2000. *U.S. Industry in 2000: Studies in Competitive Performance*. David C. Mowery, ed. Washington, D.C.: National Academy Press.

National Research Council. 2001. *The Advanced Technology Program: Assessing Outcomes.* Charles W. Wessner, ed. Washington D.C.: National Academy Press.

National Research Council. 2001. *Attracting Science and Mathematics PhDs to Secondary School Education*. Washington, D.C.: National Academy Press.

National Research Council. 2001. *Building a Workforce for the Information Economy.* Washington, D.C.: National Academy Press.

National Research Council. 2001. *Capitalizing on New Needs and New Opportunities: Government-Industry Partnerships in Biotechnology and Information Technologies*. Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 2001. *A Review of the New Initiatives at the NASA Ames Research Center*. Charles W. Wessner, ed. Washington, D.C.: National Academy Press.

National Research Council. 2001. *Trends in Federal Support of Research and Graduate Education.* Washington, D.C.: National Academy Press.

National Research Council, 2001. *Energy Research at DOE: Was It Worth It? Energy Efficiency and Fossil Energy Research 1978 to 2000*, Washington, D.C.: National Academy Press.

National Research Council. 2002. *Government-Industry Partnerships for the Development of New Technologies: Summary Report.* Charles W. Wessner, ed. Washington, D.C.: National Academies Press.

National Research Council. 2002. *Measuring and Sustaining the New Economy*. Dale W. Jorgenson and Charles W. Wessner, eds. Washington, D.C.: National Academy Press.

Nelson, R. R. 1982. Government and Technological Progress. New York: Pergamon.

Nelson, R. R. 1986. "Institutions supporting technical advances in industry." American Economic Review, Papers and Proceedings 76(2): 188.

Nelson, R. R., ed. 1993. National Innovation System: A Comparative Study. New York: Oxford University Press.

Office of the President. 1990. *U.S. Technology Policy.* Washington, D.C.: Executive Office of the President.

Office of Management and Budget. 1996. *Economic analysis of federal regulations under Executive Order 12866.* Mimeo.

Organisation for Economic Co-operation and Development. 1982. *Innovation in Small and Medium Firms.* Paris: OECD.

Organisation for Economic Co-operation and Development, 1997. *Small Business Job Creation and Growth: Facts, Obstacles, and Best Practices*. Paris: OECD.

Organisation for Economic Co-operation and Development. 1998. *Technology, Productivity and Job Creation: Toward Best Policy Practice.* Paris: OECD.

Organisation for Economic Co-operation and Development, 1995. *Venture capital in OECD countries*. Paris: OECD.

Perret, G. 1989. A Country Made by War: From the Revolution to Vietnam—The Story of America's Rise to Power. New York: Random House.

Powell, Walter W. and Peter Brantley. 1992. "Competitive cooperation in biotechnology: Learning through networks?" Pp. 366–394 in: N. Nohria and R. G. Eccles (eds.), *Networks and Organizations: Structure, Form and Action*. Boston: Harvard Business School Press.

Price Waterhouse. 1985. Survey of small high-tech businesses shows Federal SBIR awards spurring job growth, commercial sales. Washington, D.C.:Small Business High Technology Institute.

Roberts, Edward B. 1968. "Entrepreneurship and technology." *Research Management* (July):249–266.

Romer, P. 1990. "Endogenous technological change." Journal of Political Economy 98:71–102.

Rosenbloom, R. and Spencer, W. 1996. *Engines of Innovation: U.S. Industrial Research at the End of an Era*. Boston: Harvard Business Press.

Rubenstein, A. H. 1958. Problems Financing New Research-Based Enterprises in New England. Boston Mass.: Federal Reserve Bank.

Sahlman, W. A. 1990. "The structure and governance of venture capital organizations." *Journal of Financial Economics* 27:473–521.

Saxenian, Annalee. 1994. *Regional advantage: Culture and competition in Silicon Valley and Route 128*. Cambridge, MA: Harvard University Press.

Scherer, F. M. 1970. *Industrial Market Structure and Economic Performance.* New York: Rand McNally College Publishing.

Scott, John T. 2003, *Environmental Research and Development: US Industrial Research, the Clean Air Act and Environmental Damage,* Cheltenham, UK; Northampton, MA, USA: Edward Elgar Publishing.

Siegel, Donald S., David Waldman, and William Youngdahl. 1997. "The Adoption of Advanced Manufacturing Technologies: Human Resource Management Implications," *IEEE Transactions on Engineering Management,* Vol. 44, No. 3, August 1997, pp. 288-298.

Small Business Administration. 1994. *Small Business Innovation Development Act: Tenth-Year Results.* Washington, D.C.: U.S. Government Printing Office (and earlier years).

Small Business Administration. 1992. *Results of Three-Year Commercialization Study of the SBIR program*. Washington, D.C.: U.S. Government Printing Office**.**

Stiglitz, J. E. and A. Weiss. 1981. "Credit rationing in markets with incomplete information." *American Economic Review* 71:393–409.

Schumpeter, J. 1950. *Capitalism, Socialism, and Democracy*. New York: Harper and Row.

Scott, John T. 1998. "Financing and leveraging public/private partnerships: The hurdle-lowering auction." *STI Review* 23:67–84.

Sohl, Jeffrey. 1999. *Venture Capital,* Vol. 1, No. 2.

Sohl, Jeffery, John Freear, and W.E. Wetzel Jr. 2002. **"**Angles on Angels: Financing Technology-Based Ventures - An Historical Perspective**."** *Venture Capital: An International Journal of Entrepreneurial Finance,* Vol. 4, No. 4.

Stiglitz, J. E. and A. Weiss. 1981. "Credit rationing in markets with incomplete information." *American Economic Review* 71:393–409.

Stowsky, J. 1996. "Politics and Policy: The Technology Reinvestment Program and the Dilemmas of Dual Use." Mimeo: University of California.

Tassey, Gregory. 1997. *The Economics of R&D Policy.* Westport, CT: Quorum Books.

Tirman, John. 1984. *The Militarization of High Technology.* Cambridge, MA: Ballinger.

Tyson, Laura, Tea Petrin, and Halsey Rogers. 1994. "Promoting entrepreneurship in Eastern Europe." *Small Business Economics* 6:165–184.

U.S. Congress, House. 1992. *SBIR and Commercialization: Hearing Before the Subcommittee on Technology and Competitiveness of the House Committee on Science, Space, and Technology, on the Small Business Innovation Research [SBIR] Program* (testimony of James A. Block, President of Creare Inc.), pp. 356–361.

U.S. Congress, Senate Committee on Small Business. 1981. Small Business Research Act of 1981. S.R. 194, 97th Congress.

U.S. Congress, Senate Committee on Small Business. 1981. Senate Report 97–194*. Small Business Research Act of 1981.* September 25, 1981. Washington, D.C.: U.S. Government Printing Office.

U.S. Congress, Senate Committee on Small Business. 1999. Senate Report 106–330, *Small Business Innovation Research (SBIR) Program*. August 4, 1999. Washington, D.C.: U.S. Government Printing Office.

U.S. Congressional Budget Office. 1985. Federal financial support for high-technology industries. Washington, D.C.: U.S. Congressional Budget Office.

U.S. General Accounting Office. 1987. Federal research: Small Business Innovation Research participants give program high marks. Washington, D.C.: U.S. General Accounting Office.

U.S. General Accounting Office. 1989. Federal research: Assessment of Small Business Innovation Research program. Washington, D.C.: U.S. General Accounting Office.

U.S. General Accounting Office. 1997. *Federal Research: DoD's Small Business Innovation Research Program*. RCED–97–122, Washington, D.C.: U.S. General Accounting Office.

U.S. General Accounting Office. 1999. *Federal Research: Evaluations of Small Business Innovation Research Can Be Strengthened.* RCED–99–198, Washington, D.C.: U.S. General Accounting Office.

U. S. General Accounting Office. 1998. *Federal Research: Observations on the Small Business Innovation Research Program*. RCED–98–132. Washington, D.C.: U.S. General Accounting Office.

U.S. General Accounting Office. 1992. *Small Business Innovation Research Shows Success But Can Be Strengthened.* RCED–92–32. Washington, D.C.: U.S General Accounting Office.

U.S. Small Business Administration. 1994. Small Business Innovation Development Act: Tenth-year results. Washington, D.C.: U.S. Government Printing Office.

Small Business Administration. 2003. "Small Business by the Numbers." SBA Office of Advocacy, May.

Venture Economics. 1988. *Exiting venture capital investments*. Wellesley, MA: Venture Economics.

Venture Economics. 1996. "Special Report: Rose-colored asset class." *Venture Capital Journal* 36 (July) 32–34 (and earlier years).

VentureOne. 1997. National Venture Capital Association 1996 annual report. San Francisco: VentureOne.

Wallsten, S. J. 2000. The effects of government-industry R&D programs on private R&D: the case of the Small Business Innovation Research Program, *Rand Journal of Economics*, Vol. 31, No. 1.

Wallsten, S. J. 1998, "Rethinking the Small Business Innovation Research Program," in Branscomb and Keller, Eds., *Investing In Innovation*, MIT Press, Cambridge

Wallsten, S. J. 1996. The Small Business Innovation Research Program: Encouraging Technological Innovation and Commercialization in Small Firms. (Unpublished working paper, Stanford University).

ANNEX F: Research Matrix

SBIR Review Objectives

	Assessment of the program				Consideration of operational improvements to the program			
	quality of research	*commercialization of SBIR funded research / economic and non-economic benefits*	*small business innovation / growth (incl. minority owned)*	*use of small business research to advance agency missions*	*program design*	*service to participants*	*efficiency of SBIR program administration*	*program evaluation*
Questions	*** How does the quality of SBIR funded research compare that of other government funded R&D?**	*** What is the overall economic impact of SBIR funded research? * What fraction of that impact is attributable to SBIR funding?**	*** How to broaden participation and replenishing contractors? * Possibility of link SBIR with state/regional programs?**	*** How to increase agency uptake while continuing to support high-risk research?**	*** Time and award limits? * Review process and criteria? * Intra- and inter-agency interface? * New funding model to build collaborative networks?**	*** How can SBIR better serve technology entrepreneurs? * Lessons from angels? Corporate R&D?**	*** How to leverage economies of scale in program administration while allowing each agency full management autonomy?**	*** How to evaluate SBIR success: Appropriate measures? Impact of skew in returns?**
Measures	**peer review scores, publication counts, citation analyses**	**sales; follow-up funding (e.g. angel, VC, corporate); drug development progress; IPOs**	**patent counts and other IP / employment or job growth, number of new technology firms**	**agency procurement of products resulting from SBIR work**	**?**	**?**	**speed of response to applicants; administrative cost per dollar awarded**	**[all]**

Key research issues / challenges	*** Difficulty both of measuring quality and of identifying proper reference group**	*** Skew of returns: estimates of returns invariably dominated by a few big "winners"` * Significant inter-agency and inter-industry differences**	*** Measures of actual success failure (both project and firm level) * Relationship of Federal and state programs in this context**	**Major inter-agencies differences in use of SBIR to meet agency missions**	**Documenting / addressing the problem of "backwater" status of SBIR programs within agencies**	*** Response time * Ease of application * Outreach activities**	*** Shift from paper to electronic program management * Possibility of using some funds for program administration**	*** Appropriate implementation of GPRA in this context?**
Desired outcomes	* SBIR is working better* Projects are being tracked* Measures exist of long-term impacts							

	Assessment of the program				Consideration of operational improvements to the program			
	quality of research	*commercialization of SBIR funded research / economic and non-economic benefits*	*small business innovation / growth (incl. minority owned)*	*use of small business research to advance agency missions*	*program design*	*service to participants*	*efficiency of SBIR program administration*	*program evaluation*
Phase I survey			**X**		**X**	X		X
Phase II survey		X	**X**		**X**	X		X
survey of "program managers"		X		**X**	**X**		**X**	X
case studies	X	X	X	X		X		X
agency program studies	X			X	X	X	**X**	X
proposed study of repeat winners	X	X	X	**X**		X	X	X
proposed bibliometric analysis comparing SBIR firms with (similar) non-SBIR firms	**X**		X					X

Annex G: Issues Related to Sampling

BACKGROUND:

Number of Phase II (1992 – 2000): Until we receive and integrate all databases, we do not know this. Combining data from the SBA web site (1997-2000) and SBA published reports for 1992,1993, and 1994 and extrapolating from DoD data for 1995 and 1996, I estimate this number to be about 10,800. Based on the three published reports, about 7 percent of these Phase II are from the smaller agencies. Thus if we consider only the big five 10,000 is a good approximation.

Number of Awards per Firm: Until we receive and integrate all databases, we do not know how many firms have only one phase II award, or two or three etc. Thus I must estimate how many surveys will be generated by the following approach.

Existing Commercialization Data: DoD has data by project for 10,372 Phase II projects. (This includes projects from 1983 to 1991 and 2001). Since 1999, firms who have submitted SBIR or STRR proposals to DoD have had to enter firm information and information on sales and investments for all of the Phase II awards that they received, regardless of awarding agency. As a percent of Phase II awarded by Agency from 1992 to 2000, we have data on approximately 75 percent of DoD, 67 percent of NASA and DOE, 54 percent of NSF and 16 percent of NIH/HHS Phase II awards. DOE has provided commercialization data by product, which cannot be directly associated to projects due to double counting. NASA has collected data by project, which could very useful to our examination of NASA.

Proposed New Commercialization Database: We may set up a database comparable to the DoD one, to collect initial data from firms not in the DoD Commercialization Database. The Commercialization Data includes substantial information about the firm, which will not then have to be collected on the firm survey. It provides a broad overview of all projects. This allows us to sample survey rather than 100 percent survey, yet still have info on a high percentage of projects and firms. It also reduces the chance we will miss any high performing projects when we sample.

Addresses: the use of a commercialization database insures we have a point of contact, phone number and email address, which is important if not essential to executing a good on line survey.

SAMPLING APPROACH:

I propose several different samples described below.

Random Sample. After integrating the 10,000 awards in a single database, I will generate a random sample of some percent of the awards (for example 20 percent) for each of the years; e.g., 20 percent of the 1992 awards, etc. Generating the total sample one year at a time will provide a balance sample.

Random sample by agency. I would then group by agency and randomly select a few more as required to insure each agency had at least 20 percent surveyed.

Top Performers. From the Commercialization database, we would identify the top projects in sales and investment. (Since the current DoD Commercialization data include 10,372 projects, it gives us an approximation of how many projects this would entail.) If we select all projects that had at least $5,000,000 in sales or at least $5,000,000 in investment this would entail about 385 projects.

100 percent for Firms with a Small Number of Projects. I would like to survey 100 percent of the projects that went to firms with only one or two awards (perhaps three). I would estimate about a third of the 10,000 awards went to firms with 2 or less awards. (Based on data from 1983 to 1993, which show 2/3 of all Phase II awards went to firms with four or less awards and a roughly exponential distribution where firms with a single award were most common, followed by firms with two etc.) These are the hardest firms to find; address information is perishable, thus response rate is much lower. We usually have good address info for multiple winners, thus a much higher level of response.

Coding: The database will track which sample(s) each survey belongs to. It would be possible for a random sampled project to be a top performer from a firm, which had only two awards. Thus it could be coded as random sample for the program, random sample for the awarding agency, top performer and 100 percent of single or double winners. The database itself can group surveys that came from multiple winners once we establish how many awards we use as a cutoff for that designation.

How many surveys: I estimate that if the random sample were 20 percent, this approach would generate about 5000 to 5500 project surveys and about 3000 firm surveys, assuming each firm that received at least one project survey also received a firm survey. Although we would be sampling over half of the awards, firms that had many awards would have surveys on slightly over 20 percent. The response rate depends on how much effort is spent before the survey in insuring good addresses (Do we create the new commercialization database?) and how much follow up and phone calls we make to people who do not respond. One agency mentioned that his survey had a 70-80 percent response rate, but until he began phone calls that rate was 15 percent.

Annex H: Committee and Research Team Bios

The National Academies

Capitalizing on Science, Technology, and Innovation: An Assessment of the Small Business Innovation Research Program

Steering Committee Background Information

Jacques Gansler: Chairman

Jacques Gansler, former Under Secretary of Defense for Acquisition, Technology, and Logistics, is the first to hold the University of Maryland's Roger C. Lipitz Chair in Public Policy and Private Enterprise. As the third ranking civilian at the Pentagon from 1997 to 2001, Dr. Gansler was responsible for all research and development activities, acquisition reform, logistics, advanced technology, environmental security, defense industry, and other programs. Before joining the Clinton Administration, Dr. Gansler held a variety of positions in government and the private sector, including those of Deputy Assistant Secretary of Defense (Material Acquisition), Assistant Director of Defense Research and Engineering (Electronics), Vice President of ITT, and engineering and management positions with Singer and Raytheon Corporations.

Throughout his career, Dr. Gansler has written, published, and taught on subjects related to his work. He is the author of *Defense Conversion: Transforming the Arsenal of Democracy*, MIT Press, 1995; *Affording Defense*, MIT Press, 1989, and *The Defense Industry*, MIT Press, 1990. He has published numerous articles in *Foreign Affairs, Harvard Business Review, International Security, Public Affairs*, and other journals as well as newspapers and through the proceedings of Congressional hearings.

David Audretsch

David B. Audretsch is the Ameritech Chair of Economic Development and the Director of the Institute for Development Strategies at Indiana University. He is also a Research Fellow of the Centre for Economic Policy Research (London). He was at the Wissenschaftszentrum Berlin fuer Sozialforschung in Berlin, Germany, a government funded research think tank, between 1984 and 1997, serving as its Acting Director from 1989 to 1991. In 1991, he became a Research Professor.

Dr. Audretsch's research has focused on the links between entrepreneurship, government policy, innovation, economic development, and global competitiveness. He has consulted with the World Bank, National Academy of Sciences, U.S. State Department, United States Federal Trade Commission, General Accounting Office and International Trade Commission as well as the United Nations, the Commission of the European Union, the European Parliament, the OECD, numerous private corporations, state governments, and a number of European Governments. He is a member of the Advisory Board to a number of international research and policy institutes, including the Zentrum fuer Europaeisch Wirtschaftsforschung (ZEW, Centre for Economic Research), Mannheim, Germany and the Hamburgisches Welt-Wirtschafts-Archiv (HWWA, Hamburg Institute of International Economics), and the American Institute for Contemporary German Studies (AICGS), Washington, D.C.

His research has been published in over one hundred scholarly articles in the leading academic journals. He has published 25 books including, *Innovation and Industry Evolution*, with MIT Press. He is founder and editor of the premier journal on small business and economic development*, Small Business Economics: An International Journal*.

He was awarded the 2001 International Award for Entrepreneurship and Small Business Research by the Swedish Foundation for Small Business Research.

Gene Banucci

Gene Banucci, a founder of Advanced Technology Materials, Inc., has served as Chief Executive Officer, Chairman of the Board, and as Director since 1986. At its inception, ATMI focused its core expertise on materials for Chemical Vapor Deposition (CVD) technology and has since developed a unique portfolio of leading-edge materials technologies for innovative packaging, productive delivery systems, accurate solid-state sensors, low-impact environmental equipment, and engineered services that are combined into materials solutions.

Before co-founding ATMI in 1986, Gene Banucci served as a Director for American Cyanamid's Chemical Research Division, where he directed more than 400 scientists and engineers in new product research and development for this $1 billion unit. He also created and directed Cyanamid's Discovery Research Department where he managed the creation of new specialty chemical and materials technologies, leading to new business ventures.

Dr. Banucci holds 21 issued U.S. patents and is an author of numerous published scientific articles. He is a founding member of the Connecticut Technology Council, a member of the Board of Directors of Precision Combustion, Inc., and a member of the Board of Trustees of Beloit College. He received his Ph.D. in Organic Chemistry from Wayne State University, and his B.A. in Chemistry from Beloit College.

Jon Baron

Jon Baron is the Executive Director of the Coalition for Evidence-Based Policy, a project launched under the sponsorship of the Council for Excellence in Government in September 2001 to promote government policymaking based on rigorous evidence of program effectiveness.

Before joining the Council, he served as the Executive Director of the Presidential Commission on Offsets in International Trade (2000-2001). In that position, he developed and built consensus for a major Commission report to Congress that was approved by the Director of the Office of Management and Budget, with the concurrence of all Commission members.

From 1995-2000, he was the Program Manager for the Defense Department's Small Business Innovation Research (SBIR) program, which provides over a half-billion dollars each year to small technology companies to develop new commercial/military technologies. In that position, he initiated and led major program reforms that greatly increased the effectiveness of the program in spawning successful new companies and technologies. The reforms received the Vice President's Hammer Award for reinventing government and were recognized by Harvard University's Innovations Awards Program as one of the top government innovations in the United States.

From May 1993 to May 1994, he was a special assistant for dual-use technology policy in the Office of the Secretary of Defense. From 1989-1994, he served as counsel to the House of Representatives Committee on Small Business, where among other activities he initiated, led, and worked successfully to secure enactment of legislation establishing the federal Small Business Technology Transfer (STTR) program. The program funds cooperative R&D projects involving universities and small technology companies, and was recently reauthorized by Congress and expanded to $130 million per year.

Mr. Baron holds a law degree from Yale Law School, a master's degree in public affairs from Princeton University, and a Bachelor of Arts degree in economics from Rice University.

Michael Borrus

Michael Borrus is a Managing Director of the Petkevich Group, an investment bank focused on the health-care and information technology industries. Before joining the Petkevich Group, Mr. Borrus was a Co-Director of the Berkeley Roundtable on the International Economy (BRIE) at the University of California at Berkeley and Adjunct Professor in the College of Engineering, where he taught Management and Technology.

He is the author of two books and over 60 chapters, articles and monographs on a variety of topics including high-technology competition, international trade and investment and the impact of new technologies on industry and society. For the last decade, he has served as consultant to a variety of governments and firms in the U.S., Asia and Europe on policy and business strategy for international competition in high-technology industries. Mr. Borrus is a graduate of Harvard Law School and a member of the California State Bar.

Gail Cassell

Gail Cassell is currently Vice President of Infectious Diseases, Eli Lilly and Company. She was previously the Charles H. McCauley Professor and Chairman of the Department of Microbiology at the University of Alabama Schools of Medicine and Dentistry at Birmingham, a department that ranked first in research funding from the National Institutes of Health under her leadership.

She is a current member of the Director's Advisory Committee of the National Centers for Disease Control and Prevention. She is a past President of the American Society for Microbiology, a former member of the National Institutes of Health Director's Advisory Committee, and a former member of the Advisory Council of the National Institute of Allergy and Infectious Diseases of NIH. Dr. Cassell served 8 years on the Bacteriology-Mycology 2 Study Section and as Chair for 3 years. She also was previously chair of the Board of Scientific Councilors of the Center for Infectious Diseases, Centers for Disease Control.

Dr. Cassell has been intimately involved in establishment of science policy and legislation related to biomedical research and public health. She is the chairman of the Public and Scientific Affairs Board of the American Society for Microbiology; a member of the Institute of Medicine; has served as an advisor on infectious diseases and indirect costs of research to the White House Office of Science and Technology Policy, and has been an invited participant in numerous Congressional hearings and briefings related to infectious diseases, antimicrobial resistance, and biomedical research. She has served on several editorial boards of scientific journals and has authored over 250 articles and book chapters. Dr. Cassell has received several national and international awards and an honorary degree for her research in infectious diseases.

Elizabeth Downing

Elizabeth Downing is President, CEO, and founder of 3D Technology Labs in Sunnyvale, California. She is a winner of Technology and Innovation awards from *Discover Magazine, Industry Week Magazine*, and Saatchi & Saatchi, and was recently featured, along with Hillary Rodham Clinton, Madeleine K. Albright, and Sandra Day O'Connor in *Feminine Fortunes – Women of the New Millennium.*

Dr. Downing is well known for her contributions to the field of volumetric visualization and display technology. She holds more than a dozen patents on optical and laser-based instrumentation, working not only to develop a paradigm shifting technology, but also to channel it into key initial markets where time-critical visualization of volumetric data can mean the difference between life and death. A mechanical engineer specializing in systems integration by training, Dr. Downing not only conceived of the basic concepts, but also has developed the material processing capabilities and integrated the optical systems to create the world's first 360-degree walk-around three-dimensional display. Founded in 1996 with the help of key technical and business experts, her company, 3D Technology Labs has meticulously pushed the performance envelope of a challenging new visualization frontier.

Since 1996, Dr. Downing has been invited to speak as an expert in her field by the National Academy of Sciences, the Optical Society of America, SIGGRAPH, and the U.S. Display Consortium. In addition, she continues to push the boundaries of field, and is the author of several scientific publications relating to three-dimensional display, nonlinear optics, non-oxide glasses and their applications.

Kenneth Flamm

Kenneth Flamm is the Dean Rusk Professor of International Affairs at the LBJ School at the University of Texas–Austin. Before this, he worked at the Brookings Institution in Washington, D.C, where he served eleven years as a Senior Fellow in the Foreign Policy Studies Program. He is a 1973 honors graduate of Stanford University and received a Ph.D. in economics from M.I.T. in 1979. From 1993 to 1995, Dr. Flamm served as Principal Deputy Assistant Secretary of Defense for Economic Security and Special Assistant to the Deputy Secretary of Defense for Dual Use Technology Policy. He was awarded the Department's Distinguished Public Service Medal by Defense Secretary William J. Perry in 1995.

Dr. Flamm has been a professor of economics at the Instituto Tecnológico de México in Mexico City, the University of Massachusetts, and George Washington University. He has also been an adviser to the Director General of Income Policy in the Mexican Ministry of Finance and a consultant to the Organization for Economic Cooperation and Development, the World Bank, the National Academy of Sciences, the Latin American Economic System, the U.S. Department of Defense, the U.S. Department of Justice, the U.S Agency for International Development, and the Office of Technology Assessment of the U.S. Congress. He has played an active role in the National Research Council's committee on Government-Industry Partnerships, under the direction of Gordon Moore, and played a key role in that study's review of the SBIR program at the Department of Defense**.**

Dr. Flamm has made major contributions to our understanding of the growth of the electronics industry, with a particular focus on the development of the computer and the U.S. semiconductor industry. He is currently working on an analytical study of the post-Cold War defense industrial base and has expert knowledge of international trade and high technology industry issues.

Christina Gabriel

Christina Gabriel is Vice Provost for Corporate Partnerships and Technology Development at Carnegie Mellon University. Dr. Gabriel came to Carnegie Mellon from CASurgica, Inc., a Carnegie Mellon spin-off company focusing on computer-assisted orthopedic surgery, where she was President and CEO. In earlier university positions, Dr. Gabriel has served as Director of Collaborative Initiatives at Carnegie Mellon as well as Vice President for Research and Technology Transfer at Case Western Reserve University in Cleveland, Ohio.

Dr. Gabriel spent five years with the National Science Foundation in Washington, D.C., and Arlington, VA, most recently serving as Deputy Assistant Director for Engineering, which is the chief operating officer of the Engineering Directorate, an organization of 140 staff members (half Ph.D.-level) which awards over $300 million to universities and small businesses for engineering research and education. In earlier assignments at NSF, Dr. Gabriel served as program director within several engineering research programs, as well as Coordinator for the $50 million university-industry collaborative Engineering Research Centers program**.**

Dr. Gabriel spent most of the year 1994 at the United States Senate Appropriations Committee, working as one of three majority professional staff members for the Subcommittee on VA, HUD and Independent Agencies, chaired by Senator Barbara Mikulski. This subcommittee was responsible for appropriating about $90 billion annually among 25 federal organizations. Dr. Gabriel was also a researcher for six years at AT&T Bell Laboratories in New Jersey and spent six months in 1990 as a visiting professor at the University of Tokyo in Japan. She received her masters and doctorate degrees in electrical engineering and computer science from the Massachusetts Institute of Technology and her undergraduate electrical engineering degree from the University of Pittsburgh. She was an AT&T Bell Laboratories GRPW Fellow and a National Merit Scholar (Richard King Mellon Foundation). Her research publications

focus on digital optical switching devices and systems exploiting ultra fast optical non-linearities in fibers and wave guides of glasses, polymers and semiconductors, and she holds three patents.

Trevor O. Jones

Trevor O. Jones is the Chairman and Founder of BIOMEC Inc., an entrepreneurial company founded in 1998 engaged in the development and commercialization of biomedical engineered devices and products.

After 7 years, Mr. Jones retired from the Board of Directors of Echlin, Inc. in June 1998 where he served in a number of capacities as Chairman, Vice Chairman, CEO and Chairman of its European Advisory Committee.

Mr. Jones was appointed Chairman of the Board of Libbey-Owens-Ford Co. in 1987, and assumed the additional positions of President and CEO in May 1993. Mr. Jones retired from LOF in 1994 but remained a member of the Board of Directors including Chairman of their Salary and Bonus Committee until 1997.

From 1978 to 1987, Mr. Jones was an officer of TRW, Inc. He joined TRW in 1978 as Vice President, Engineering, Automotive Worldwide Sector and in 1979 he formed TRW's Transportation Electronics Group and was appointed its Group Vice President and General Manager. His responsibilities included activities in the United States, United Kingdom and Japan. In 1985, his responsibilities were further expanded to include Sales, Marketing, Strategic Planning, and Business Development activities for the entire Automotive Sector.

From 1959 to 1978, Mr. Jones spent 19 years with General Motors. His last position there was Director of General Motors Proving Grounds, a post to which he was appointed in 1974.

From 1959 to 1970, Mr. Jones was involved in General Motors' aerospace activities at the Delco Electronics Division. During this period, he directed many major programs, including the B-52 bombing navigational system production program, advanced military avionic systems, and the Apollo lunar and command module computers. In 1969, he was selected to direct the application of aerospace technology to automotive safety and electronics systems.

He became the Director, Automotive Electronic Control Systems, a newly organized group at General Motors Technical Center in 1970 and was appointed Director, Advanced Project Engineering in 1972. In this capacity, he directed many major vehicle, engine and component development programs.

In 1982 he was elected a member of the National Academy of Engineering and was cited for "leadership in the application of electronics to the automobile to enhance its mechanical performance." He has been a member of a number of National Research Council (NRC) study committees, including "National Interests in an Age of Global Technology", "Safety Research for a Changing Highway Environment","Engineering as an International Enterprise", "Competitiveness of the US Automotive Industry" and "Time Horizons and Technology Investments". In 1993, Mr. Jones chaired the National Academy of Engineering Committee on the effects of products liability law on innovation.

From 1994 to 2000, Mr. Jones chaired the National Research Council's Standing Committee for the Partnership for a New Generation Vehicle, which is often referred to as the "80 mile per gallon super car". Mr. Jones continues to be active in fuel cell developments and is a member of UTC's Fuel Cell Advisory Committee and a member of the Executive Committee of the Ohio Fuel Cell Coalition.

He is a Fellow of the British Institute of Electrical Engineers and received its Hooper Memorial Prize in 1950. He is a Life Fellow of the American Institute of Electrical and Electronics Engineers, and has been cited for "leadership in the application of the electronics to the automobile." He is also a Fellow of the Society of Automotive Engineers and received SAE's Arch T. Colwell Award in 1974 and in 1975, Vincent Bendix Automotive Electronics Engineering Award in 1976, Buckendale Lecturer Award in 1986, and Edward N. Cole Automotive Engineering Award 1988.

He is a Fellow of the Royal Society for the Encouragement of Arts, Manufacturing and Commerce (FRSA), an Honorary Fellow, Institution of Mechanical Engineers, a Fellow of the Engineering Society of Detroit and a Life

Member of the Cleveland Engineering Society.

He received the U.S. Department of Transportation of Safety Award for Engineering Excellence in 1978, and in 1991, he received the H.H. Bliss Award from The Center for Study of Responsive Law; both awards recognized his pioneering contributions to inflatable occupant restraint systems development.

Mr. Jones holds many patents, has lectured and authored numerous papers on automotive electronics, occupant safety, fuel cells and international human resource management.

Mr. Jones was appointed to the National Motor Vehicle Safety Advisory Council by the Secretary of Transportation in 1971, and was appointed vice chairman of the council in 1972. In 1975, President Ford appointed him to a three-year term on the National Highway Safety Advisory Committee. In 1976, he was appointed the first non-governmental chairman of the committee.

In 1995, Mr. Jones was appointed to the Secretary of Defense's Defense Science Board's Committee for "Technology Investments for the 21st Century Military Superiority" and in 1996, to the Task Force on International Arms Development Cooperation.

Ohio's Governor Taft appointed Mr. Jones a Trustee of Cleveland State University in February 2001. Mr. Jones is also a member of the Visiting Committee for Biomedical Engineering at Case Western Reserve University and a member of its Medical School Technology Advisory Council. Mr. Jones is also a member of the Board of the Cleveland Orchestra and a member of the Development Committee of the Cleveland Clinic Foundation's Heart Center.

A native of Maidstone, England, Mr. Jones completed his formal engineering education in electrical engineering at Aston Technical College in 1952 and in mechanical engineering in Liverpool Technical College in 1957, prior to moving to the United States. He is a registered Professional Engineer in the State of Wisconsin and a Chartered Engineer in the United Kingdom.

Charles Kolb

Charles Kolb is the President and Chief Executive Officer of Aerodyne Research, Inc., (ARI) a position he has held since 1994. Since 1970, ARI has provided research and development services requiring expertise in the physical and engineering sciences to commercial and government clients working to solve national and international environmental problems. These include a wide range of topics such as global and regional environmental quality and the development of clean and efficient energy and new propulsion technologies.

Dr. Kolb has received numerous professional honors and has served in a broad range of professional and Academy related positions. He is currently a member of the Advisory Council for the Department of Civil and Environmental Engineering at Princeton University and has served as a committee member of the Richards Medal Committee for the American Chemical Society since 1998. He has contributed to a variety of National Academies' studies and is currently serving as Chairman on the National Research Council's Committee on Review and Evaluation of Chemical Events at Army Chemical Disposal Facilities.

Dr. Kolb holds an S.B. in Chemistry (Chemical Physics option) from the Massachusetts Institute of Technology, an M.S. in Physical Chemistry from Princeton University, and a Ph.D. in Physical Chemistry from Princeton University. His research interests include: atmospheric, combustion and materials chemistry as well as physics and chemistry of aircraft and rocket exhaust plumes. In addition to over 200 reports, non-refereed symposia papers, patents, book reviews, and policy papers, Dr. Kolb has published over 150 archival journal articles and book chapters.

Henry Linsert

Henry Linsert joined Martek as Chairman of the Board in 1988 and became its Chief Executive Officer in 1989. Martek Biosciences Corporation develops and sells products from microalgae. Microalgae are microplants. The Company is engaged in the commercial development of microalgae into a portfolio of high value products and product candidates consisting of Nutritional Products, Advanced Detection Systems and Other Products, primarily Algal Genomics. Nutritional products include nutritional oils for infant formula, dietary supplementation and other products. Advanced Detection Systems products include fluorescent dyes from various algae for use in scientific applications for detection of certain biological processes.

From 1987 to 1988, he was primarily engaged as President of American Technology Investments Corp. ("ATI"), a consulting company specializing in the development and financing of early stage companies in the Mid-Atlantic area. He was President and Chief Executive Officer of Suburban Capital Corporation, a venture capital subsidiary of Sovran Financial Corporation (now part of Bank of America), from 1983 to 1987. Before 1983, Mr. Linsert was Vice President of Inverness Capital Corporation, a small business investment company, and Vice President of First Virginia Bank. He also served as a Captain in the U.S. Marine Corps and as an artillery officer in Vietnam.

Mr. Linsert received an M.A. in economics from George Washington University and a B.A. from Duke University.

Clark McFadden

Clark McFadden, a partner at the law firm Dewey Ballantine, specializes in international corporate transactions, especially the formulation of joint ventures, consortia, and international investigations and enforcement proceedings. Mr. McFadden has had a broad background in foreign affairs and international trade, with experience with Congressional committees, the U.S. Department of Defense and the National Security Council.

In 1986, he was appointed General Counsel, President's Special Review Board, to investigate the National Security Council system ("Tower Commission"). In 1979, Mr. McFadden served as Special Counsel to the Senate Foreign Relations Committee on the Strategic Arms Limitation Treaty (SALT II). Previously, from 1973-1976, he worked as General Counsel, Senate Armed Services Committee and was responsible to the Committee for all legislative, investigatory, and oversight activities.

Mr. McFadden has a B.A. from Williams College (1968), M.B.A. from Harvard University (1972), and J.D. from Harvard Law School (1972).

Duncan T. Moore

Duncan Moore is the Rudolf and Hilda Kingslake Professor of Optical Engineering and Professor of Biomedical Engineering at the University of Rochester. He is also Special Assistant to the University President and Executive Director of the University, Industry and Government Partnership for Advanced Photonics. Previously, from 1995 until the end of 1997, he served as Dean of Engineering and Applied Sciences at the University.

In 1996, Dr. Moore also served as President of the Optical Society of America (OSA), a professional organization of 12,000 members worldwide. From January 2001 to the present, he has served as Senior Science Advisor at OSA.

The U.S. Senate confirmed Dr. Moore in the fall of 1997 for the position of Associate Director for Technology in The White House Office of Science and Technology Policy (OSTP). In this position, which ended December 2000, he worked with Dr. Neal Lane, President Clinton's Science Advisor, to advise the President on U.S. technology policy, including the Next Generation Internet, Clean Car Initiative, elder tech, crime tech, and NASA. From January through May 2001, Dr. Moore served as Special Advisor to the Acting Director of OSTP.

Dr. Moore has extensive experience in the academic, research, business, and governmental arenas of science and technology. He is an expert in gradient-index optics, computer-aided design, and the manufacture of optical systems. He has advised nearly 50 graduate thesis students. In addition, Dr. Moore began a one-year appointment as Science Advisor to Senator John D. Rockefeller IV of West Virginia in 1993. He also chaired the successful Hubble Independent Optical Review Panel organized in 1990 to determine the correct prescription of the Hubble Space Telescope. Dr. Moore is also the founder and former president of Gradient Lens Corporation of Rochester, NY, a company that manufactures the high-quality, low-cost Hawkeye boroscope.

Dr. Moore was elected to the National Academy of Engineering in February 1998. He has been the recipient of the Science and Technology Award of the Greater Rochester Metro Chamber of Commerce (1992), Distinguished Inventor of the Year Award of the Rochester Intellectual Property Law Association (1993), Gradient-Index Award of the Japanese Applied Physics Society (1993), and an Honorary Doctor of Science degree from the University of Maine (1995). In 1999, he received the National Engineering Award of the American Association of Engineering Societies and was recognized as the Engineer of the Year by the Rochester Engineering Society. Most recently, he was the recipient of the 2001 OSA Leadership Award.

Dr. Moore holds a Ph.D. in Optics (1974) from the University of Rochester. He had previously earned a master's degree in Optics at Rochester and a bachelor's degree in Physics from the University of Maine.

Kent Murphy

Dr. Kent Murphy is the Founder and CEO of Luna Innovations, a next-generation, employee-owned company. Luna has built a complete network for driving innovative technologies through the development cycle all the way to fully functioning separate subsidiary companies. Luna has 200+ working the technology sector in biotechnology, nanomaterials, optical fiber telecommunications and instrumentation, and control and predictive based maintenance as well as other key technologies of the future. Luna Innovations has licensed patents from Virginia universities, government labs, and large industrial partners, and is ranked second only to GM in industrial-funded research at Virginia Tech.

Murphy is a recipient of both the High Tech Entrepreneur Award for the New Century Technology Council and the Entrepreneur of the Year Award for Virginia Small Business Innovations Research. Murphy holds the B.S. Degree in Engineering Science and Mechanics and the Master of Science and Ph.D. in Electrical Engineering from Virginia Tech.

Linda Powers

Linda Powers has more than fifteen years of experience in the fields of corporate mergers and acquisitions (both hostile and friendly), restructurings, and highly leveraged, structured and specialty finance transactions. She is a co-founder and Managing Director of Toucan Capital Corporation.

Before co-founding Toucan Capital, Ms. Powers was Senior Vice President, Global Finance, at Enron Corporation. Before joining Enron, Ms. Powers served as the Deputy Assistant Secretary of Commerce in the Bush, Sr. Administration. In that capacity, she was responsible for a number of small business programs, mainly concerned with access to capital. She also assisted financial services, information services and related businesses in entering foreign markets, and was responsible for government-to-government negotiations to remove foreign market entry restrictions for U.S. firms. She was co-lead negotiator for the U.S. on the North American Free Trade Agreement, financial sector agreement, which opened banking, securities, insurance, pension fund and related opportunities in Canada and Mexico.

During the 1980s, Ms. Powers practiced law, specializing in corporate mergers, acquisitions and financings, and certain kinds of intellectual property transactions. While working for the headquarters of the European Union in Brussels, she was responsible for drafting the initial intellectual property rules that now govern know-how licensing in the European Union.

Ms. Powers has also taught International Business Transactions and European Business Law at Georgetown Law School for eight years, as an adjunct professor. She is a graduate, *magna cum laude*, of both Princeton University and Harvard Law School.

Patrick Windham

Until April 1997, Patrick Windham served as Senior Professional Staff Member for the Subcommittee on Science, Technology, and Space of the U.S. Senate's Committee on Commerce, Science, and Transportation. He helped the Senators oversee and draft legislation for several major civilian R&D agencies with responsibility for science, technology, and U.S. competitiveness; industry-government-university R&D partnerships; state economic development; federal laboratory technology transfer; high-performance computing; and computer encryption. From 1982 to 1984, he served as a legislative aide in the personal office of Senator Ernest Hollings. From 1976 to 1978, he worked as a Congressional fellow with the Senate Commerce Committee and then returned to California from 1978 to 1982 to pursue graduate studies in political science at the University of California at Berkeley.

Mr. Windham holds a Masters of Public Policy from the University of California at Berkeley and a B.A. from Stanford University. He is currently an independent, California-based consultant on science and technology policy issues.

Tyrone C. Taylor

Tyrone C. Taylor brings an exceptional combination of hands on experience in technology development and commercialization. He has held senior management positions in the federal government, worked extensively in the R&D community. He also is the founder and President of Capitol Advisors on Technology, a technology consulting firm that serves the Washington, D.C. area, and until recently Mr. Taylor was also the Senior Vice President of Unisphere. Capital Advisors represents industry, federal, and non-profit clients and assists them in all aspects of technology commercialization. Mr. Taylor is well known within the federal research and development (R&D) associations and small business community as an authoritative source with hands-on experience in launching new initiatives.

Reflecting his broad experience, he has been asked to serve on numerous technology advisory committees such as the National Science Foundation, National Defense Industrial Association, and the Minority Business Technology Transfer Consortium. Congressional science and technology committees have also called upon him to assess the impact of legislation affecting the technology commercialization community.

As an executive on loan, Mr. Taylor represented the entire Federal R&D community as the Washington, D.C. Representative for the Federal Laboratory Consortium for Technology Transfer, a Congressionally chartered organization. In this capacity, he provided leadership in developing legislation that governs the private and public sectors? ability to collaborate in R&D activities, manage intellectual property, and commercialize technologies. Recognized for his efforts by Congress, Mr. Taylor often addresses audiences throughout the United States and abroad on technology development, transfer, and commercialization issues.

Until recently Mr. Taylor served as the Senior Vice President for Marketing and Business Development for Unisphere, Inc., a technology assessment firm aimed at developing dual-use technologies for the defense and commercial marketplace. In this capacity, he aided in the expansion and growth of small businesses and their clients, helping to generate about $35 million in revenue and produce over $64 million in cost savings. Due to his broad technology background, he is able to interact effectively with all aspects of the technology commercialization field including inventors, attorneys, and acquisition managers as well as aspects of commercialization testing, engineering, and marketing. His technology management experience covers such areas as medical technologies, energy and environment, advanced materials, infrared imaging, and aerospace.

Before joining Unisphere, Mr. Taylor served in the Senior Executive Service in a variety of executive management positions at NASA. He brings extensive program/project experience having managed over $1 billion in contracts and grants for systems engineering, information systems, facilities management, and technical and administrative services as a member of the International Space Station program, which included Japan, Canada and the European

Space Agency and the Space Science management team.

Tyrone Taylor has a Masters in Business Administration from Southeastern University. He earned an A.B. in Business Administration from Wilmington College, and has served as Adjunct Professor for numerous technology transfer/commercialization courses. Other activities include serving on the board of Pediatric AIDS/HIV Care in Washington, D.C. and nurturing businesses in the assistive technology arena.

Charles Trimble

As President, Chief Executive Officer, and as one of the Company's founders, Charles Trimble guided Trimble Navigation to its dominant role in the GPS (Global Positioning System) information technology market. Before founding Trimble, Mr. Trimble was manager of Integrated Circuit Research and Development at Hewlett-Packard's Santa Clara Division. During his tenure at HP, he was recognized for developing commercial advances in efficient signal processing, high-speed analog-to-digital converters, and digital time measurement techniques to the picosecond level.

Mr. Trimble received his B.S. degree in Engineering Physics, with honors, in 1963, and his M.S. degree in Electrical Engineering, in 1964, from the California Institute of Technology. He was a member of the Vice President's Space Advisory Board's task group on the future of U.S. Space Industrial Base for the National Space Council. In September of 1994, Mr. Trimble was honored with the Piper General Aviation award from the American Institute of Aeronautics and Astronautics (AIAA) for pioneering the manufacture and application of affordable GPS.

SBIR Research Team Background Information

Zoltan Acs

Zoltan J. Acs is the Doris and Robert McCurdy distinguished Professor of Entrepreneurship and Innovation and director of the Entrepreneurship Program in the Robert G. Merrick School of Business, University of Baltimore. He has a Ph.D. in Economics from the New School University in New York City. His primary research focus is in the area of understanding the dynamics of small business growth and failure from a global perspective. He has published over 100 scholarly articles in leading journals. Dr. Acs is a leading advocate of the importance of entrepreneurship as an emerging engine of economic growth. He is the recipient of the 2001 Small Business and Entrepreneurship Research Award given by the Swedish Foundation for Small Business. His most recent publication is Innovation and the Growth of Cities, Edward Elgar 2002. He is also the founder and editor of Small Business Economics, the leading international journal in entrepreneurship and small business research.

Philip A. Auerswald

Philip Auerswald is an Assistant Professor at the School of Public Policy, George Mason University, and an Adjunct Lecturer and Assistant Director of the Science, Technology, and Public Policy Program at the Kennedy School of Government, Harvard University. He is co-author with Lewis Branscomb of Taking Technical Risk: How Innovators, Executives and Investors Manage High-Tech Risks, MIT Press, 2001.He is currently a member of the research team for a multi-year National Academies study of the Small Business Innovation Research (SBIR) program. He has been a consultant to the Department of Economic Development of the Commonwealth of Massachusetts and is principal author of Competitive Imperatives for the Commonwealth: A conceptual framework to guide the design of state economic strategy. He has published on topics pertaining to science and technology policy, entrepreneurship, and the economics of innovation. He is also co-editor with David Auerswald of The Kosovo Conflict: A Diplomatic History Through Documents, 2001 (foreword by Sen. Joseph Biden Jr.), and since has been Editor of the Foreign Policy Bulletin: The Documentary Record of United States Foreign Policy. He holds a Ph.D. in economics from the University of Washington and a B.A. (political science) from Yale University.

Grant Black

Grant Black is an economist at the Andrew Young School of Policy Studies, Georgia State University. He has contributed to research funded by the Alfred P. Sloan Foundation, the Andrew W. Mellon Foundation, the National Science Foundation, the South African Revenue Service, and the United States Agency for International Development. He has participated in national and international conferences on science and technology policy issues and is a regular participant in the Scientific Workforce Project sponsored by the National Bureau of Economic Research and Alfred P. Sloan Foundation.

Black's research interests focus on the economics of science, including the transfer of knowledge in the economy, the geographic dimension of innovation, and the education and careers of scientists. Recent research has examined the importance of the local knowledge infrastructure to small-firm innovation, patent activity in academe, the location decision of foreign-born doctorate recipients, industrial placements of new Ph.D.s, and patterns of research collaboration. Other research has focused on the impact of immigration on scientific labor markets; women and minorities in the sciences; and educational training and labor market outcomes in the emerging field of bioinformatics. Black is also knowledgeable about the Small Business Innovation Research Program, the largest federal R&D program targeting small high-tech businesses.

Black received a B.S. and M.A. in economics from the University of Missouri, St. Louis, and a Ph.D. in economics from Georgia State University. He has taught economics at the University of Missouri-St. Louis and Georgia State University, and was a visiting scholar at the University of Pretoria, South Africa, in spring 2002. His collaborative

work on foreign-born Ph.D. recipients has received considerable media attention. He is the author of *The Geography of Small Firm Innovation* forthcoming from Kluwer Academic Publishers (2003).

Pete Cahill

Peter J. Cahill is a Senior Principal Analyst and Program Manager at BRTRC, Inc. In this position he has performed extensive analysis of and provided support to the Small Business Innovation Research Program (SBIR). Following an in-depth survey and series of interviews of Department of Defense (DoD) agencies and SBIR awardees, he conducted a two-year survey and interview study of the entire federal SBIR program for the Small Business Administration (SBA). He developed and implemented a web-based system to measure past commercialization performance of SBIR firms as a part of the award evaluation process for DoD SBIR proposals. He conducted the survey and provided database support as a member of the research team that conducted the NRC study of the DoD SBIR Fast Track Initiative. Other recent projects have included research and analysis of a number of military systems, including bridging, mine clearing, and battle simulation models. Prior to joining BRTRC, Inc. in 1993, Mr. Cahill's U.S. Army assignments included professor of management engineering at the U.S. Military Academy at West Point, Deputy Commander of the U.S. Army Research Laboratory, and command and staff positions in construction, research, development, and engineering.

Robert Carpenter
University of Maryland, Baltimore County

Julie Ann Elston

Julie Ann Elston is a professor of economics in the College of Business Administration (CBA) at the University of Central Florida. She is currently teaching in the graduate and undergraduate programs on comparative markets and institutions, macroeconomics, and quantitative methods. Dr. Elston is a regular contributor to the field small firm studies, serving as Review Editor of Small Business Economics since 1998. She has worked as a consultant to a number of international governmental agencies firms including: National Oceanic and Atmospheric Administration (NOAA), Organization for Economic Cooperation and Development (OECD), the Deutsche Bundesbank (German Central Bank), and the National Academies of Science.

Dr. Elston graduated from the University of Washington's Department of Economics in June 1992. From 1992-1996 she was a Research Fellow at the Wissenschaftszentrum Berlin (WZB) in Germany. In 1995-1996 she was invited as a Visiting Scholar to the Hoover Institution, Stanford University, where she participated in the Comparative Institutional Analysis program sponsored by the Economics Department and the School of Business. 1996-97 she taught at the California Institute of Technology and has been on the economics faculty here at UCF since 1998. In 2001 Dr. Elston was selected as a Policy Fellow in the Robert Bosch Foundation Scholars Program in Comparative Public Policy and Institutions at the American Institute for Contemporary German Policy.

David H. Finifter

David H. Finifter is Dean of Research and Graduate Studies in Arts and Sciences and Professor of Economics and Public Policy at The College of William and Mary. He served as founding director of The Thomas Jefferson Program in Public Policy at William and Mary, a position he held from 1987 to 2000. He was also founding director of the Program's Center for Public Policy Research. His teaching and scholarly interests include the economics of higher education and public policy, human resource economics, science and technology policy, evaluation and benefit/cost analysis, labor economics, public health service delivery and finance, and microeconomics and econometrics applied to public policy analysis. Dr. Finifter has been on the faculty at The College of William and Mary since completing his Ph.D. in economics from the University of Pittsburgh. He also holds a B.S. degree from Loyola College of Maryland and an M.A. degree in economics from the University of Pittsburgh.

Dr. Finifter has published several articles and reports in the area of evaluation of human resources and public policy on issues including federally subsidized employment and training programs, and veterans' job training programs. He has also published research on workplace literacy and productivity. He has co-edited two books on higher education and public policy and a special edition of the *Quarterly Review of Economics and Business* on health care policy. He has served as a consultant to several federal government agencies, including the U.S. Department of Labor, the Veterans Administration, NASA, Sandia National Laboratories, and the Environmental Protection Agency. During 1978-79, he served as a Staff Associate in Employment Policy at the Brookings Institution and the U.S. Department of Labor. During the summer of 1995, he served as a faculty summer fellow, American Society for Engineering Education (ASEE) at NASA-Langley Research Center, and worked on technology transfer policy and performance measurement/metrics.

Dr. Finifter's research over the past few years has emphasized work in collaboration with Dr. Robert B. Archibald on the Small Business Innovation Research (SBIR) Program. They evaluated the SBIR Program at NASA-Langley Research Center and for the U.S. Department of Defense as part of the National Academy of Sciences team working on the SBIR Fast Track Program. Dr. Finifter also has a research interest in the future of graduate and professional education and the linkages to research funding.

Michael Fogarty
University of Portland

Robin Gaster

Dr. Robin Gaster has been president of North Atlantic Research Inc (a Washington-based consulting firm) since 1991. Before that he was a fellow at the Congressional Office of technology assessment, worked at the IMF, and was an associate professor at the University of Virginia.

Dr. Gaster has authored many reports and publications covering a wide arrange of topics broadly related to technology, trade, and e-commerce. His work has been published in Foreign Policy and The Atlantic, and his consulting clients include the European Commission, Deloitte and Touche, the Economist Intelligence Unit, the National Academy of Sciences, and the Electric Power Research Institute, as well as many corporate clients such as Philips, Olivetti, Mitsubishi Research, and Dataquest.

In addition, Dr. Gaster has founded several companies, covering local and online information services. He received a Ph.D. from U.C. Berkeley and a B.A. from Oxford University in the U.K.

Rosalie Ruegg

Rosalie Ruegg, managing director of TIA Consulting, Inc., specializes in the economic assessment of new technologies. Recent accomplishments include development of an evaluation toolkit for public R&D investments; a composite performance rating system for project and program portfolio analysis; a case-study guide for science managers; and a benchmarking report comparing evaluation practices in five science and technology programs in the U.S., and programs in Canada, Israel, and Finland. Clients include government agencies in the U.S. and abroad, universities, companies, and non-profit institutions.

Ruegg's prior positions include director of the Advanced Technology Program's Economic Assessment Office, senior economist in NIST's Center for Applied Mathematics, and financial economist for the Federal Reserve System's Board of Governors. She has more than 60 publications, including an economics textbook; has served on editorial boards, most recently as economics editor of Macmillan's *Encyclopedia of Energy*; and has served on advisory and steering committees, such Harvard University's advisory committee for a study of technical risk management, and the Department of Energy's steering committee for benefits estimation. A former member of the Federal Senior Executive Service, Ruegg received both the Department of Commerce's Gold and Silver Medal Awards, and also the Institute of Industrial Engineers' 2001 Wellington Award for contributions to the field of engineering economics.

Mrs. Ruegg's degrees in economics are from the Universities of North Carolina (B.A., Phi Beta Kappa, cum laude) and Maryland (M.A., Woodrow Wilson Fellow), and she holds an M.B.A. (specialty in finance) from The American

University. She received extensive executive training from The Federal Executive Institute, Georgetown University, and Harvard University.

Donald Siegel

Donald Siegel is Professor of Economics and Chair of the Department of Economics at Rensselaer Polytechnic Institute. He received his bachelor's, master's, and doctoral degrees from Columbia University. After receiving his Ph.D., he was a Alfred P. Sloan Foundation post-doctoral fellow at the National Bureau of Economic Research, under the supervision of Ernie Berndt at MIT and the late Zvi Griliches at Harvard. He then served as an assistant professor at SUNY-Stony Brook, a full professor at Arizona State University, and held a chair in industrial economics at the University of Nottingham in the U.K. He has also been a faculty research fellow of the NBER and an ASA/NSF Senior Research Fellow at the U.S. Bureau of Labor Statistics.

Professor Siegel is editor of the Journal of Technology Transfer, an international journal devoted to the managerial and policy implications of technology transfer. He is also an associate editor of the Journal of Productivity Analysis and recently co-edited a special issue of Small Business Economics on "Policies to Promote Innovation and Entrepreneurship in a Knowledge-Based Economy: Evidence from the U.S. and U.K." In 2003-2004, he will be co-editing special issues of the International Journal of Industrial Organization on the "Economics of Intellectual Property at Universities", Structural Change and Economic Dynamics on the "Economics of Corporate Social Responsibility," and the Journal of Business Venturing on "Science Parks and Incubators."

Dr. Siegel's research interests are the economics of technological change, productivity analysis, and corporate social responsibility. His papers have appeared in such leading journals as the American Economic Review, Economic Journal, Review of Economics and Statistics, Journal of Law and Economics, Journal of Financial Economics, Brookings Papers on Economic Activity, Research Policy, Academy of Management Review, Academy of Management Journal, Strategic Management Journal, IEEE Transactions on Engineering Management, and the Journal of Management. He has also authored or co-authored three books, Skill-Biased Technological Change: Evidence from a Firm-Level Survey, The Economics of Science and Technology: An Overview of Recent Initiatives to Foster Innovation, Entrepreneurship, and Economic Growth, and Technological Change and Economic Performance. Professor Siegel has received grants from the Alfred P. Sloan Foundation, NSF, W. E. Upjohn Institute for Employment Research, the U.S. Department of Labor, and the Samuel Neaman Institute for Advanced Studies in Science and Technology at the Technion-Israel Institute of Technology. He has also served as a consultant to the United Nations, the National Research Council, the United Nations, Her Majesty's Customs and Excise, Chase Manhattan, the Securities Industry Association, Morgan Stanley, Goldman Sachs & Co, Deloitte and Touche, and the National Association of Manufacturers.

Paula E. Stephan

Paula Stephan is Professor of Economics, Andrew Young School of Policy Studies, Georgia State University. Her research interests focus on the careers of scientists and engineers and the process by which knowledge moves across institutional boundaries in the economy. Stephan's research has been supported by the Alfred P. Sloan Foundation, the Andrew Mellon Foundation, the Exxon Education Foundation, the National Science Foundation, the North Atlantic Treaty Organization and the U.S. Department of Labor. She has served on several National Research Council committees including the committee on Dimensions, Causes, and Implications of Recent Trends in the Careers of Life Scientists, Committee on Methods of Forecasting Demand and Supply of Doctoral Scientists and Engineers, and the Committee to Assess the Portfolio of the Science Resources Studies Division of NSF. She is a regular participant in the National Bureau of Economic Research's meetings in Higher Education and has testified before the U.S. House Subcommittee on Basic Science. She currently is serving a three-year term as a member of CEOSE, the National Science Foundation's Committee on Equal Opportunity in Science and Engineering and is a member of the SBE Advisory Committee, National Science Foundation.

Dr. Stephan graduated from Grinnell College (Phi Beta Kappa) with a B.A. in Economics and earned both her M.A. and Ph.D. in Economics from the University of Michigan. She has published numerous articles in journals such as The American Economic Review, Science, The Journal of Economic Literature, Economic Inquiry and Social Studies of Science. Stephan coauthored with Sharon Levin Striking the Mother Lode in Science, published by Oxford University Press, 1992. The book was reviewed in Science, Chemical and Engineering News, Journal of Economic Literature, The Southern Economic Journal and The Journal of Higher Education. Her research on the careers of scientists has been

the focus of articles in The Economist, Science and The Scientist. Stephan is a frequent presenter at meetings such as The American Economic Association, the American Association for the Advancement of Science, and the Society for the Social Studies of Science. Stephan reviews regularly for the National Science Foundation and a number of academic journals including The American Economic Review, The American Sociological Review, Economic Inquiry, The Journal of Political Economy, and The Journal of Human Resources.

Dr. Stephan has lectured extensively in Europe. She was a visiting scholar at the Wissenschaftszentrum Berlin für Sozialforschung, Berlin, Germany, intermittently during the period 1992-1995.

Nicholas Vonortas

Nick Vonortas is the director of the Center for International Science and Technology Policy and of the Science, Technology and Public Policy graduate program of George Washington University's Elliott School of International Affairs. He is also an Associate Professor at the Department of Economics. He holds a Ph.D. in Economics from New York University, an M.A. in Economic Development from Leicester University (U.K.), and a B.A. in Economics from the University of Athens.

Professor Vonortas' teaching and research interests are in industrial organization, the economics of technological change, and science and technology policy. He is currently working on several research topics including technology licensing agreements, strategic partnerships, innovation networks, intellectual property rights protection mechanisms in research collaborations, R&D program evaluation, and the knowledge based economy.

Charles Wessner

Dr. Charles (Chuck) Wessner is recognized as a national and international expert on public private partnerships, early stage financing for new firms, and the special needs and benefits of high technology industry. He regularly testifies to the U.S. Congress and major national commissions, acts as an advisor to agencies of the Executive Branch of the U.S. Government, and lectures at major universities in the U.S and abroad. He is frequently asked to address policy issues of shared international interest with foreign governments, universities, and research institutes. In this capacity, he serves as an advisor to the 30-nation OECD Committee on Science and Technology Policy.
Dr. Wessner's work focuses on the linkages between science-based economic growth, new technology development, university-industry clusters, regional development, and small firm finance. He has also addressed policy issues associated with international technology cooperation and investment as well as trade in high technology industries. Dr. Wessner's work at the National Academies has included a study for the White House on U.S. aerospace competitiveness and a major cooperative review of international competition and cooperation in high-technology industry. Currently, he directs a portfolio of activities centered on government measures to support the development of new technologies and the policies that may be required to continue the productivity gains characteristic of the New Economy.

Specifically, the Academy leadership has given him responsibility for three high-profile studies. A major study, now in its concluding phase, is the first program-based review of Public-Private Partnerships, carried out under the direction of Gordon Moore, Chairman Emeritus of Intel and Bill Spencer, Chairman Emeritus of SEMATECH. The second area of work focuses on the New Economy. The Chairman of the NRC Board on Science, Technology, and Economy Policy, Dale Jorgenson of Harvard University, has charged him with a major research program focused on Measuring and Sustaining the New Economy. In addition, the successful review of the Small Business Innovation Research Program at the Department of Defense led the Congress to task the NRC with a major study, to be led by Dr. Wessner, of this $1.2 billion R&D program at the five agencies responsible for 96 percent of the program's expenditures. A better understanding of early stage finance for new firms, a key phase in the U.S. innovation system, should improve our ability to capitalize on the nation's substantial R&D investment.

Dr. Wessner holds degrees in International Affairs from Lafayette College (Phi Beta Kappa) and the Fletcher School of Law and Diplomacy where he obtained an M.A., an M.A.L.D. and a Ph.D. as a Shell Fellow. He began his career in the Office of the Secretary at the Department of the Treasury, joined the OECD to work on economic development issues, served in the Diplomatic Corps, and directed the Office of International Technology Policy in the Department of Commerce.

Annex I: Tasks to Further Develop and Implement the Methodology

Summarized below are a series of tasks to be undertaken in assessing the SBIR program.

Task 1: Collect and interpret information on the mission of each agency's SBIR program.
Initial research suggests that the missions of the five agencies will differ in varying dimensions, and, further, that divisions or sub-groups within each agency have unique missions associated with the SBIR program. This first task of mission definition will be an essential for designing survey questions and case studies, and interpreting evaluation results. In conjunction with this task, the Committee will utilize:

- printed information about the SBIR program, including program descriptions as well as intramural (e.g., agency) and extramural (e.g., academic, consulting, public agency) studies of the program and databases related to the program;
- Face-to-face meetings with agency administrators and managers of the SBIR program to collect and clarify institutional information, with an eye to understanding the subtleties of the agencies' SBIR program missions, and their modes of operation
- Discussions and presentations from public symposia convened by the Committee.

Draft descriptions of the SBIR program will be prepared for each of the five agencies, using a common template. Based on each draft report, a summary matrix will be developed presenting similarities and differences in the SBIR program among the agencies.

Task 2: Collect and interpret information fundamental to a review of (1) the value to the federal research agencies of SBIR-funded projects; and (2) the quality of research being conducted by small business.[1]
Information associated with "value to" the Federal agency from SBIR projects will be drawn primarily from internal agency sources. Individuals directly associated with SBIR are in the best position to assess the relative worth of the program. This will include managers at the agency and, in the case of DOD and NIH, at the sub-agency level. Non-SBIR officials with senior positions in the agency may also be interviewed for their view of the "importance" of SBIR to the agency. This information could be collected though face-to-face meetings and/or through survey instruments directed to appropriate individuals within each agency. If instruments are used, they will rely on a working definition of "value" developed with input from appropriate individuals in each agency.
Information on value, collected through face-to-face meetings, an internal survey, or both, will be summarized in a draft description of the SBIR program. (See Task 1.)[2] "Value" may also be determined indirectly through other indicators – for example, the allocation of non-SBIR resources to support SBIR management functions may be a key indicator.
Information associated with the "quality of research" being conducted could be collected externally from non-agency sources using several methods. For the case of basic research, Arnold and Balázs (1998) argue that the "quality should be assessed in terms of its potential usefulness to others.[3] Of course, SBIR is not related to basic research but rather early stage development, but the standard of usefulness may also be applicable.
Bibliometrics is a commonly used proxy to gauge the potential usefulness of research to others, and will be considered in this study. This method measures the number of peer-reviewed articles and citations to research articles. The relevant data can be gathered from external sources, such as the ISI Web of Science and similar resource bases.[4] Data on the number of patents directly associated with the research applied for and awarded and the citations to such patents are a complementary indicator. External awards for the significance of the research, such as the IR100 Awards, constitute another important measure of research quality.
Sources internal to each organization conducting the research are also important to identify the scale and quality of research. Information on research activity can most effectively be collected through surveys sent to the funded

[1] The Committee interprets "review" to mean a summary of facts. A review should not contain conclusions or recommendations.
[2] Based on the study's goal as expressed in Task 6, one implicit element of value relates to the ability of the agency to meet certain procurement needs through the SBIR program.
[3] See Arnold, E., and Balázs, K. "Methods in the Evaluation of Publicly Funded Basic Research," OECD Report, March 1998**.** Implicit in the Arnold and Balázs argument is a linear view of the innovation process, although each segment in the linear progression need not be within the same organization.
[4] Overviews of citation and bibliometric analyses are in Melkers, J. "Bibliometrics as a Tool for Analysis of R&D Inputs," in *Evaluating R&D Impacts: Methods and Practices* (edited by B. Bozeman and J. Melkers), Boston: Kluwer Academic Publishers, 1993. See also Narin, F. and Hamilton, K.S. "Bibliometric Performance Measures," *Scientometrics*, Summer 1996.

organizations/agencies, and probably to program managers within those organizations.[5] Another measure of quality specific to SBIR research is the utility of outputs to the funding agency and/or to the market. Information about commercialization will also come from the surveys and case studies.[6]

Task 3: Collect information and evaluate, using traditional metrics, the economic benefits of the SBIR program.[7]
Griliches (1958) and Mansfield (1977) pioneered the application of fundamental economic insight to the measurement of private and social rates of return to innovative investments.[8] Streams of investment costs generate innovations and associated streams of economic benefits over time. Once identified and measured, these streams of costs and benefits are used to calculate such performance metrics as social rates of return and benefit-to-cost ratios. Thus, the evaluation question that can be answered from this traditional approach is: Given the investment costs and the social benefits, what is the social rate of return from the innovation?
The economic benefits achieved by the SBIR program can be evaluated using several methods, including survey and case study methods. Information collected in Task 1 and Task 2 will underpin the details of the approach.
The evaluation literature and the evaluation experience of the Committee and that of the expert consultants reporting to the Committee,[9] suggests that the first-level net benefits will be quantified based on both retrospective and prospective survey data. The information collected in Task 1 and Task 2 should identify relevant first-level output measures such as sales, employment growth, new products and processes, leveraged R&D investments (including additional R&D investment dollars as well as the establishment of new research partnerships[10]), and enhanced access to capital markets.[11] The surveys will also include questions that address management issues.
Second-level beneficiaries from the SBIR program include the agency that funded the project under evaluation. Third-level beneficiaries are the public- and private-sector consumers of the commercialized innovation developed by the award recipient. Both the evaluation literature and the evaluation experience of the Committee and others suggest that second- and third-level benefit data – quantitative and qualitative –can be collected through focused case studies.
Task 3 relates to the second objective of this study. As noted above, part of the Congressional charge to the NRC is to compare the findings from Task 3 to evaluations of similar Federal research and development expenditures. Several Committee members and contract researchers have experience in evaluating Federal research and development programs. At the completion of Task 3, this expertise and experience will be applied to the task of assessing and evaluating the SBIR research results.

---

[5] For an example of an analysis of NASA SBIR program managers' qualitative information, see Archibald, R.B. and Finifter, D.H. "Evaluating the NASA Small Business Innovation Research Program: Preliminary Evidence of a Trade-off Between Commercialization and Basic Research," *Research Policy*, April 2003.
[6] Information about commercialization will also be collected from funded company officers and individual research scientists in a later task.
[7] The Committee interprets "evaluation" to be a broader analysis than would be undertaken in an "impact assessment." An impact assessment focuses on the impact (e.g., measured in terms of rates of return or benefit-to-cost comparisons) of the funded research on the agency's stakeholders (e.g., small businesses). An evaluation includes an impact assessment as well as an examination of the portfolio of research vis-à-vis the objectives of the funding agency and an examination of how well the agency's funding program are being managed. See Link, A.N. *Economic Impact Assessment: Guidelines for Conducting and Interpreting Assessment Studies*, Planning Report 96-1, National Institute of Standards and Technology, May 1996, for the application of these important terms as applied within the National Institute of Standards and Technology (NIST). See Georghiou, L., Dale, A., and Cameron, H. Special Issue of *Research Evaluation* on National Systems for Evaluation of R&D in the European Union, April for an application of these terms as applied within the European Union. As such, preliminary discussions with agencies suggest that a review of commercialization after the award would be useful to them for management purposes. The team anticipates viewing commercialization as an output of research and thus would logically become a part of the evaluation effort in this task.
[8] See Griliches, Z. "Research Costs and Social Returns: Hybrid Corn and Related Innovations," *Journal of Political Economy,* 1958. See also Mansfield, E., Rapoport, J., Romeo, A. Wagner, S., and Beardsley, G. "Social and Private Rates of Return from Industrial Innovations*," Quarterly Journal of Economics*, 1977.
[9] Some of the team members were involved in the evaluation of the Department of Defense's Fast Track program. See National Research Council, *SBIR: An Assessment of the Department of Defense Fast Track Initiative,* 2000, op cit.
[10] See Hagedoorn, J., Link, A.N., and Vonortas, N.S. "Research Partnerships," *Research Policy*, April 2000. (2000) for a review of the theoretical and empirical literature related to research partnerships and R&D efficiency.
[11] The Advanced Technology Program (ATP) within the National Institute of Standards and Technology (NIST) has a long and successful history of collecting through surveys such output measures to proxy first-level social benefits. See Ruegg, R.T. "The Advanced Technology Program, Its Evaluation Plan, and Progress in Implementation," *Journal of Technology Transfer*, November 1997. See also Ruegg, R.T. and Feller, I. "A Toolkit for Evaluating Public R&D Investments: Models, Methods, and Findings from ATP's First Decade," NIST GCR 02-842, National Institute of Standards and Technology, May 2003. Finally, see the research papers contained in National Research Council, *The Advanced Technology Program: Assessing Outcomes,* C. Wessner (ed.). Washington, D.C.*:* National Academy Press, 2001.

Task 4: Collect and interpret information relevant to an evaluation of the non-economic benefits of the SBIR program.

The Committee will explore how best to gauge the potential non-economic benefits of the SBIR program. Non economic benefits include the impact of SBIR on small business growth and development, knowledge effects, environmental benefits and public safety. These factors are related to cluster phenomena, links among SBIR firms, universities, government laboratories, and large firms, and the availability of highly qualified workers.

Task 5: Collect and interpret information on Federal research and development funds to small businesses (between fiscal year 2000 and fiscal year 1983).

Trend analysis is the appropriate methodology if "federal research and development funds to small businesses" is interpreted as support to small businesses through the SBIR program only. In such an analysis, two other factors must be controlled for: political factors associated with the supply of such funds and demand factors associated with changes in the extent of technological competition.

A more comparative framework will be necessary if a broader definition, which includes other non-SBIR agency funding for small business R&D, is adopted.

Task 6: Collect and interpret information on the extent to which SBIR Phase II awards fulfill the procurement needs of Federal agencies.

Here, the Committee seeks to develop, particularly through case studies knowledge about how and why Federal agencies procure technology and how they use such technology. Implicit in Task 6 is the charge to understand the frontier associated with the effective use of SBIR Phase II technology, to understand how close Federal agencies are to that frontier, and to determine what factors are associated with such positioning.

Annex J:
Template for Individual Agency Reports[98]

Introduction

Program history at the agency

Basic demographics of the agency program – number of awards, $ awarded, trends over past 20 years [drawing on program manager survey]

Organization – who runs what, under what offices, etc.

Short description – number of competitions annually, use of topics etc.

General methodology problems and approaches*

Comparability

Measurement

Bias

Multiple methodology approach, plus brief description of major instruments and approaches

Success stories box

Outcomes at the Agency

Commercialization Strategies and Outcomes

Difficulties of evaluating*

Research methodology

P2 survey data for the agency

Selected case study data for the agency

Agency-initiated analysis and data

Conclusions

Mission support

Short intro on agency differences, and procuring vs. non-procuring agencies*

Identification of specific agency as procuring/non-procuring

Research methodology

[98] Note: starred (*) items are expected to be identical across all agency reports.

Agency interviews [within SBIR program and at more senior levels]

Procuring agencies only: Agency contracts analysis (DoD, NASA, parts of DoE)

Conclusions

Small business support

Problems of measuring additionality, and impact*

Research methodology*

If available, comparative impact study for specific agency (funded vs. unfounded applicants to SBIR)

Basic demographics of agency support for small business

Small business research $ as share of agency R&D spending; SBIR share of all agency R&D spending on small businesses

Conclusions

Knowledge base

Largely indirect character of knowledge expansion in the commercial environment; other "knowledge base" issues; comparability issues*

Research methodology*

Patents and trademarks

Licensing

Citation analysis

Equity sales [why is this here?]

Partnerships

Indirect path: indications, not measurement*

Conclusions

Program management

Topic development and selection

Sources for topic ideas

Agency-driven vs. investigator driven approach to topics

Topic decision-making

Outreach (before successful application)

Agency outreach objectives (e.g. reaching low-application states and regions; educating very likely applicants.)

Outreach programs that the agency runs or participates in (including brief description)

Agency support for P1 applicants

Agency outreach benchmarks and metrics

Grant selection

Description of selection processes for P1 and P2

Peer review panels – membership, selection, qualifications

Fairness – any issues and changes in procedures to meet problems; (P2 winner and non-winner views from surveys) [make sure there is a "fairness" question in the P2 survey]

Scoring procedures

Role of program manager

Re-submission procedures and outcomes

Training (after successful application)

Training programs for agency P1 and P2 grantees

Benchmarks used to evaluate effectiveness

Take-up rates and projections

Constraints

Phase 2+ program

Description of agency's P2+ program

Use of matching funds

Application and selection procedures

Role of program manager

Funding "gaps."

P1 – P2 gap. Average size, drivers. Options for addressing.

After P2. Data on subsequent agency funding/take-up of technologies. Agency perceptions of its role.

Bridge funding programs (after P2). Program description and objective Limitations (e.g. matching funding requirements)

What is the average extent of the gap
What is the primary cause of the gap

Does the agency think there is a problem
Is the agency finding ways to address the problem

Reporting requirements

Reports submitted to the agency by SBIR winners

Report utilization, and utility to the agency

Evaluation and assessment

Annual and intermittent agency evaluations of its SBIR program

Operational benchmarks for the agency SBIR program

Evaluators (internal and external)

Annual evaluation and assessment budget, and funding sources

Flexibility

Program managers discretion (project selection, project size, program management)

Program manager tools (e.g. shifting funding from one sub-agency to another; adjusting scoring criteria; changing the size of awards)

Agency manager perceptions of constraints

Size

Formal and effective limits on size and duration of awards

Distribution of P1 and P2 awards within those limits

Availability of additional funding. Amounts and distributions.

Online capabilities and plans

Components of the grant application, management, and reporting process NOT yet online

Plans and timelines for putting these remaining elements online

Barriers obstructing implementation of these plans

Administrative funding

Funding of program administration

Control of administration budget

Administration budget as percent of agency SBIR funding

Evaluation and assessment funding

Recommendations
Appendices

Draft Phase I Survey.[99]

Introduction

This survey is an important part of a major study commissioned by the US Congress to review operations of SBIR grant programs at federal agencies.[100] The assessment, by the National Research Council, seeks to determine both the extent to which the SBIR programs meet their mandated objectives, and to investigate ways in which the programs could be improved.[101]

Your participation in this survey will help to address these questions. We anticipate that the survey should take about 5 minutes of your time.[102] If you have further questions either about the survey or about the assessment more broadly, please contact Dr. Charles Wessner, Study Director, National Research Council.

Project Information

PROPOSAL TITLE:

TOPIC NUMBER:

PHASE I CONTRACT/GRANT NUMBER:

This project information will be filled in Before the respondent receives the survey

1. Which statement correctly describes why you did not receive a Phase II award after completion of your Phase I effort?
   a. ___ The company did not apply for a Phase II. *Go to question 2*
   b. ___ The company applied, but was not selected for a Phase II. *Skip to question 3.*
   c. ___ The company was selected for a Phase II, but negotiations with the government failed to result in a grant or contract. *Skip to question 3.*

2. The company did not apply for a Phase II because: *Select all that apply.*
   a. ___ Phase I did not demonstrate sufficient technical or commercial promise.
   b. ___ The research goals were met by Phase I. No Phase II was required.
   c. ___ The agency did not invite a Phase II proposal.
   d. ___ Preparation of a Phase II proposal was considered too difficult to be cost effective.
   e. ___ The company did not want to undergo the audit process.
   f. ___ The company shifted priorities.
   g. ___ The PI was no longer available.
   h. ___ The government indicated it was not interested in a Phase II.

3. Did this Phase I produce a non-commercial benefit? *Check all responses that apply*.
   a. ___ The awarding agency obtained useful information.
   b. ___ The firm improved its knowledge of this technology.
   c. ___ The firm hired or retained a valuable employee.
   d. ___ The public directly benefited or will benefit from the results of this Phase I. (*Briefly explain benefit* _____*)*
   e. ___ No

4. Although no Phase II was awarded, did your company continue to pursue the technology examined in this Phase I? *Select all that apply.*
   a. ___ The company did not pursue this effort further.
   b. ___ The company received at least one subsequent Phase I SBIR award in this technology.
   c. ___ The company received at least one subsequent Phase II SBIR award in this technology.

---

[99] One survey per selected Phase I project.

[100] We will probably not have an email address for firms that have not entered into the commercialization database. We have two options if we want to do an electronic Phase I survey. We can mail a letter to them asking that they complete the online survey. Or we can send them a short paper survey in which we ask only the first four questions and their email address, then follow up with an electronic survey where appropriate. With either option, we will need to obtain some firm information if we want to compare Phase I winners with Phase II winners.

[101] This introduction is in part a place holder. It will be revised after the preliminary notification letter and the accompanying introduction/instructions for the firm survey are prepared.

[102] For short paper survey; 10 minutes for full electronic survey.

d. ___ The company received subsequent non-SBIR contracts or grants in this technology.
e. ___ The company commercialised the technology from this Phase I.
f. ___ The company licensed or sold their rights in the technology developed in this Phase I.
g. ___ The company pursued the technology after Phase I, but it did not result in subsequent grants, contracts, licensing or sales.

If an electronic survey, and e or f are checked, go to question 5, else go to question 7.[103]

Part II. Commercialization.

5. Has your company and/or licensee had any actual sales of products, processes, services or other sales incorporating the technology developed during this Phase I? (*Select all that apply.)*

a. ___No sales to date, nor are sales expected. *Go to question 7.*

b. ___No sales to date, but sales are expected. *Go to question 7.*
c. ___Sales of product(s)
d. ___Sales of process(es)
e. ___Sales of services(s)
f. ___Other sales (e.g. rights to technology, licensing, sale of spin off company, etc.)

6. For you company and/or your licensee(s), when did the first sale occur, and what is the approximate amount of total sales resulting from the technology developed during this project? If other SBIR awards contributed to the ultimate commercial outcome, report only the share of total sales appropriate to this Phase I project. *(Enter the requested information for your company in the first column and, if applicable and if known, for your licensee(s) in the second column. Enter dollars. If none, enter 0 (zero)).*

	Your Company	**Licensee(s)**
a. Year when first sale occurred	☐☐☐☐	☐☐☐☐
b. Total Sales Dollars of Product (s) Process (es) or Service(s) to date	$_ _ _, _ _ _, _ _ _	$_ _ _, _ _ _, _ _ _
c. Other Total Sales Dollars (e.g., Rights to technology, Sale of spin off company, etc.) to date	$_ _ _, _ _ _, _ _ _	$_ _ _, _ _ _, _ _ _

7. How did you, or do you, expect to commercialise your SBIR award?
a. ___No commercial product, process, or service was/is planned.
b. ___As software
c. ___As an intermediate hardware product or component
d. ___As a final hardware product
e. ___As process technology
f. ___As new or improved service capability

8. In you opinion, in the absence of this Phase I award, would your company have undertaken this project? *(Select one.)*
a. ___Definitely yes b. ___Probably yes
c. ___Uncertain d. ___Probably not e. ___Definitely not

Answer Q. 9 and Q. 10 only if you answered e, f, or g to question 4, else go to Question 11

9. If you had received a Phase II award as a result of this Phase I, your subsequent efforts to commercialize this technology would have been. *Select best one answer.*
a. ___Broader in scope
b. ___Similar in scope

[103] If a paper survey, the final question would ask the name, phone and email address of the person completing the survey for possible contact if there were further questions.

c. ___Narrower in scope

10. Due to the absence of Phase II SBIR funding, (Please provide your best estimate of the impact)
    a. Further development effort were delayed about____months.
    b. The expected duration/time to completion was
        1) ___ longer
        2)___ the same
        3)___ shorter
    c. In achieving <u>similar</u> goals and milestones to those that were or would been proposed for Phase II , commercialization is
        1)___ ahead
        2)___ the same place
        3)___ behind

11. If applicable, please give the number of patents, copyrights, trademarks, and/or scientific publications for the technology developed as a result of this project. *(Enter numbers. If none, enter 0 (zero).)*

Number Applied For/ Submitted		**Number Received/ Published**
	Patent(s)	
	Copyright(s)	
	Trademark(s)	
	Scientific Publication(s)	

Part III. Other SBIR funding

12. How many SBIR awards has your company received <u>that are related to the project/technology</u> supported by this Phase I award?

a. Number of related Phase I awards | | | |

b. Number of related Phase II awards | | | |

Part IV. Funding and other assistance

13. Prior to this SBIR Phase I award, did your company receive funds for research or development of the technology in this project from any of the following sources?
    a. ___Prior SBIR
    b. ___Prior non-SBIR federal R&D
    c. ___Venture Capital
    d. ___Other private company
    e. ___Private investor
    f. ___Internal company investment (including borrowed money)
    g. ___State or local government
    h. ___College or University
    i. ___ Other *Specify* _____

The following questions apply only to those who answered b, c, d, e, or f to question 5.

Commercialization of the results of an SBIR project normally requires additional developmental funding. Questions 14 and 15 address additional funding. Additional Developmental Funds include non-SBIR funds from federal or private sector sources, or from your own company, used for further development and/or commercialization of the technology developed during this Phase I project.

14. Have you received or invested any additional developmental funding in this project?

a. Yes *Go to question 15*
b. No *Go to Question 16*

15. To date, what has been the approximate total additional developmental funding for the technology developed during this project?

Source	Developmental Funding
a. Non-SBIR federal funds	$_ _, _ _ _, _ _ _
b. Private Investment	
(1) U.S. venture capital	$_ _, _ _ _, _ _ _
(2) Foreign investment	$_ _, _ _ _, _ _ _
(3) Other Private equity	$_ _, _ _ _, _ _ _
(4) Other domestic private company	$_ _, _ _ _, _ _ _
c. Other sources	
(1) State or local governments	$_ _, _ _ _, _ _ _
(2) College or Universities	$_ _, _ _ _, _ _ _
d. Your own company (Including money you have borrowed)	$_ _, _ _ _, _ _ _
e. Personal funds of company owners	$_ _, _ _ _, _ _ _

Question 16 applies to all respondents.

16. Did you receive assistance in Phase I or Phase II proposal preparation for this award?

	Phase I	Phase II
a. State agency provided assistance	□	□
b. Mentor company provided assistance	□	□
c. Regional association provided assistance	□	□
d. University provided assistance	□	□
e. We received no assistance in proposal preparation	□	□

FIRM Survey.[104]

The following additional information will help us understand how the SBIR program is contributing to the formation of new small businesses active in federal R&D and how they impact the economy.

1. When was your company founded? ____

2. Was your company founded because of the SBIR Program?

   a. ___ Yes
   b. ___ No

3. What was the most recent employment of the company founders prior to founding this company? *(Indicate all that apply.)*

   a. ___ Other private company

   b. ___ College or University

   c. ___ Government

4. What year did your company receive its first SBIR Phase I award? ____

5. How many employees (equivalent full time) did your company have when it received its first Phase I award? ____

6. How many employees (equivalent full time) does your company have today? ____

7. The company's total revenue for the last fiscal year:
   a. ___ <$100,000
   b. ___ $100,000-$499,999
   c. ___ $500,000-$999,999
   d. ___ $1,000,000-$4,999,999
   e. ___ $5,000,000-$19,999,999
   f. ___ $20,000,000 +

8. For the past fiscal year about ____% of the company's revenues came from the SBIR program.

[104] The following questions will only be asked of firms, which have not received any Phase II surveys.

Draft Phase II Survey[105]

Introduction

This survey is an important part of a major study commissioned by the US Congress to review operations of SBIR grant programs at federal agencies.[106] The assessment, by the National Research Council, seeks to determine both the extent to which the SBIR programs meet their mandated objectives, and to investigate ways in which the programs could be improved.

Your participation in this survey will help to address these questions. We anticipate that the survey should take about 30 minutes of your time.[107] If you have further questions either about the survey or about the assessment more broadly, please contact Dr. Charles Wessner, Study Director, National Research Council.

Project Information

PROPOSAL TITLE:

TOPIC NUMBER:

PHASE II CONTRACT/GRANT NUMBER:

This project information will be filled in Before the respondent receives the survey

Part I. Current status of the Project

1. What is the current status of the project funded by the referenced SBIR award**?** ***Select the one best answer***

a. ___ Project has not yet completed Phase II. *Go to question 20*
b. ___ Efforts at this company have been discontinued. No sales or additional funding resulted from this project. *Go to question 2*
c. ___ Efforts at this company have been discontinued. The project did result in sales, licensing of technology, or additional funding. *Go to question 2*
d. ___ Project is continuing post Phase II technology development. *Go to question 3*
e. ___ Commercialization is underway. *Go to question 3*
f. ___ Products/Processes/ Services are in use by target population/customer/consumers. *Go to question 3*

2. Did the reasons for discontinuing this project include any of the following?
(PLEASE SELECT YES OR NO FOR EACH REASON AND NOTE THE ONE PRIMARY REASON)

	Yes	No	Primary Reason
Technical failure or difficulties	☐	☐	☐
Market demand too small	☐	☐	☐
Level of technical risk too high	☐	☐	☐
Not enough funding	☐	☐	☐
Company shifted priorities	☐	☐	☐
Principal investigator left	☐	☐	☐
Project goal was achieved (e.g. prototype delivered for federal agency use)	☐	☐	☐
Licensed to another company	☐	☐	☐

[105] One survey per selected Phase II project. At the end of this project survey, there is a separate firm survey. The firm survey will be filled out once each firm.
[106] This introduction is in part a place holder. It will be revised after the preliminary notification letter and the accompanying introduction/instructions for the firm survey are prepared.
[107] Placeholder number of minutes until testing of instrument has been completed.

Product, process, or service not competitive	☐	☐	☐
Inadequate sales capability	☐	☐	☐
Other (please specify): _____	☐	☐	☐

The next question to be answered depends on the answer to Question 1. If c., go to Question 3. If b., skip to Question 16

Part II. Commercialization activities and planning.

Questions 3-7 concern actual sales to date resulting from the technology developed during this project. **Sales** includes all sales of a product, process, or service, to federal or private sector customers resulting from the technology developed during this Phase II project. A sale also includes licensing, the sale of technology or rights etc.

3. Has your company and/or licensee had any actual sales of products, processes, services or other sales incorporating the technology developed during this project? (*Select all that apply.)*

   a. ___No sales to date, but sales are expected *Skip to Question 8*
   b. ___No sales to date nor are sales expected *Skip to Question 11*
   c. ___Sales of product(s)
   d. ___Sales of process(es)
   e. ___Sales of services(s)
   f. ___Other sales (e.g. rights to technology, licensing, etc.)

4. For your company and/or your licensee(s), when did the first sale occur, and what is the approximate amount of total sales resulting from the technology developed during this project? If multiple SBIR awards contributed to the ultimate commercial outcome, report only the share of total sales appropriate to this SBIR project. *(Enter the requested information for your company in the first column and, if applicable and if known, for your licensee(s) in the second column. Enter approximate dollars. If none, enter 0 (zero)).*

	Your Company	**Licensee(s)**
a. Year when first sale occurred	☐☐☐☐	☐☐☐☐
b. Total Sales Dollars of Product (s) Process (es) or Service(s) to date	$_ _ _, _ _ _, _ _ _	$_ _ _, _ _ _, _ _ _
c. Other Total Sales Dollars (e.g., Rights to technology, Sale of spin off company, etc.) to date	$_ _ _, _ _ _, _ _ _	$_ _ _, _ _ _, _ _ _

Your company reported sales information to DoD as a part of an SBIR proposal or to NAS as a result of an earlier NAS request. This information may be useful in answering the prior question or the next question. You reported as of *(date)*: DoD sales *($ amount), Other* Federal Sales *($ amount), Export* Sales *($ amount), Private* Sector sales *($ amount*), and other sales *($ amount).*

5. To date, approximately what percent of total sales from the technology developed during this project have gone to the following customers? *(If none enter 0 (zero). Round percentages. Answers should add to approximately 100%)*[108]

   Domestic private sector ___ %
   Department of Defense (DoD) ___%

[108] Please note: If a NASA SBIR award, the Prime contractors line will state "Prime contractors for NASA." The "Agency that awarded the Phase II" will only appear if it is not DoD or NASA. The Name of the actual awarding agency will appear.

Prime contractors for *DoD or NASA* ___%
NASA ___%

Agency that awarded the Phase II ____ %
Other federal agencies *(Pull down)* ____ %
State or local governments ___%
Export Markets ___%
Other (Specify) _____ ___%

The following questions identify the product, process, or service resulting from the project supported by the referenced SBIR award, including its use in a fielded federal system or a federal acquisition program

6. Please provide the name of the Federal system or acquisition program that is using the technology (if applicable):

_____

7. Please provide any applicable trade or commercial name, the generic name, and the model number for this product, process, or service:

a. Trade or Commercial Name: _____

b. Generic Name: _____

c. Model Number (if applicable): _____

8. If you have had no sales to date resulting from the technology developed during this project, what year do you expect the first sales for your company or its licensee?

a. ___ Sales are expected. The year of expected first sale is ☐☐☐☐

b. ___ No sales are expected. *Skip to question 10*

9. For your company and/or your licensee, what is the approximate amount of total sales expected between now and the end of 2005 resulting from the technology developed during this project? *(If none, enter 0 (zero).)*

a. Total sales dollars of product(s), process (es) or services(s) expected between now and the end of 2005. $_ _ _, _ _ _, _ _ _

b. Other Total Sales Dollars (e.g., rights to technology, sale of spin off company, etc.) expected between now and the end of 2005. $_ _ _, _ _ _, _ _ _

c. Basis of expected sales estimate. *Select all that apply*
   1) ___ Market research
   2) ___ Ongoing negotiations
   3) ___ Projection from current sales

4) ___ Consultant estimate
5) ___ Past experience
6) ___ Educated guess

10. How did you (or do you expect to) commercialize your SBIR award?
a. ___No commercial product, process, or service was/is planned.
b. ___As software
c. ___As an intermediate hardware product or component
d. ___As a final hardware product
e. ___As process technology
g. ___As new or improved service capability
h. ___Other, please explain_____

11. Which of the following, if any, describes the type and status of marketing activities by your company and/or your licensee for this project? *(Select one for each marketing activity)*

	Marketing activity	**Planned**	**Need Assistance**	**Underway**	**Completed**	**Not Needed**
a.	Preparation of marketing plan	☐	☐	☐	☐	☐
b.	Hiring of marketing staff	☐	☐	☐	☐	☐
c.	Publicity/advertising	☐	☐	☐	☐	☐
d.	Test marketing	☐	☐	☐	☐	☐
e.	Market Research	☐	☐	☐	☐	☐
f.	Other (*Specify)*	☐	☐	☐	☐	☐

Part III. Other outcomes

12. As a result of the technology developed during this project, which of the following describes your company's activities with other companies and investors? *(Select all that apply.)*

		US Companies/Investors		**Foreign Companies/Investors**	
	Activities	**Finalized Agreements**	**Ongoing Negotiations**	**Finalized Agreements**	**Ongoing Negotiations**
a.	Licensing Agreement(s)	☐	☐	☐	☐
b.	Sale of Company	☐	☐	☐	☐
c.	Partial sale of Company	☐	☐	☐	☐
d.	Sale of technology rights	☐	☐	☐	☐
e.	Company merger	☐	☐	☐	☐
f.	Joint Venture agreement	☐	☐	☐	☐
g.	Marketing/distribution agreement(s)	☐	☐	☐	☐
h.	Manufacturing agreement(s)	☐	☐	☐	☐
i.	R&D agreement(s)	☐	☐	☐	☐
j.	Customer alliance(s)	☐	☐	☐	☐
k.	Other *Specify*_____	☐	☐	☐	☐

13. In you opinion, in the absence of this SBIR award, would your company have undertaken this project? *(Select one.)*

a. ___Definitely yes b. ___Probably yes

(If you selected a. or b., go to question 14)

c. ___Uncertain d. ___Probably not e. ___Definitely not

(If you selected c., d. or e., skip to question 16.)

14. If you had undertaken this project in the absence of SBIR, this project would have been

d. ___Broader in scope
e. ___Similar in scope
f. ___Narrower in scope

15. In the absence of SBIR funding, (Please provide your best estimate of the impact)

d. The start of this project would have been delayed about____months.
e. The expected duration/time to completion have been
   1) ___ longer
   2) ___ the same
   3) ___ shorter
f. In achieving similar goals and milestones, the project would be
   1) ___ ahead
   2) ___ the same place
   3) ___ behind

16. Employee information. *(Enter number of employees. You may enter fractions of full time effort (e.g. 1.2 employees). Please include both part time and full time employees, and consultants, in your calculation.)*

Number of employees (if known) when Phase II proposal was submitted	
Current number of employees	
Number of current employees who were hired as a result of the technology developed during this Phase II project.	
Number of current employees who were retained as a result of the technology developed during this Phase II project	

17. Please give the number of patents, copyrights, trademarks, and/or scientific publications for the technology developed as a result of this project. *(Enter numbers. If none, enter 0 (zero).)*

Number Applied For/ Submitted **Number Received/ Published**

Number Applied For/Submitted		**Number Received/Published**
	Patent(s)	
	Copyright(s)	
	Trademark(s)	
	Scientific Publication(s)	

Part IV. Other SBIR funding

18. How many SBIR awards did your company receive prior to the Phase I that led to this Phase II?

a. Number of previous Phase I awards | | | |

b. Number of previous Phase II awards | | | |

19. How many SBIR awards has your company received that are related to the project/technology supported by this Phase II award?

a. Number of related Phase I awards ☐☐☐

b. Number of related Phase II awards ☐☐☐

Part V. Funding and other assistance

20. Prior to this SBIR Phase II award, did your company receive funds for research or development of the technology in this project from any of the following sources?

a. ___Prior SBIR (*Excluding the Phase I, which proceeded this Phase II.)*
b. ___Prior non-SBIR federal R&D
c. ___Venture Capital
d. ___Other private company
e. ___Private investor
f. ___Internal company investment (including borrowed money)
g. ___State or local government
h. ___College or University
i. ___ Other *Specify* _____

Commercialization of the results of an SBIR project normally requires additional developmental funding. Questions 21 and 22 address additional funding. Additional Developmental Funds include non-SBIR funds from federal or private sector sources, or from your own company, used for further development and/or commercialization of the technology developed during this Phase II project.

21. Have you received or invested any additional developmental funding in this project?

a. Yes *Continue*
b. No *Skip to Question 23*

22. To date, what has been the total additional developmental funding for the technology developed during this project? Any entries in the **Reported** column are based on information previously reported by your firm to DoD or NAS. They are provided to assist you in completing the **Developmental funding** column. Previously reported information did not include investment by your company or personal investment. *Please update this information to include breaking out Private investment and Other investment by subcategory. Enter dollars provided by each of the listed sources. If none, enter 0 (zero).)*

Source	Reported	Developmental Funding
c. Non-SBIR federal funds	$_ _, _ _ _, _ _ _	$_ _, _ _ _, _ _ _
d. Private Investment	$_ _, _ _ _, _ _ _	$_ _, _ _ _, _ _ _
(1) U.S. venture capital	$_ _, _ _ _, _ _ _	
(2) Foreign investment	$_ _, _ _ _, _ _ _	
(3) Other Private equity	$_ _, _ _ _, _ _ _	
(4) Other domestic private company	$_ _, _ _ _, _ _ _	
e. Other sources	$_ _, _ _ _, _ _ _	
(1) State or local governments	$_ _, _ _ _, _ _ _	
(2) College or Universities	$_ _, _ _ _, _ _ _	

f. Not previously reported

(1) Your own company $_ _, _ _ _, _ _ _
(Including money you have borrowed)
(2) Personal funds $_ _, _ _ _, _ _ _

23. Did this award identify matching funds or other types of cost sharing in the Phase II Proposal?[109]

a. ___ No matching funds / co-investment/cost sharing were identified in the proposal.
If a, skip to question 26.
b. ___ Although not a DoD Fast Track, matching funds/co-investment/cost sharing were identified in the proposal.
c. ___ Yes. This was a DoD Fast Track proposal.

24. Regarding sources of matching or co-investment funding that were proposed for Phase II, check all that apply.

a. ___Our own company provided funding (includes borrowed funds)
b. ___ A federal agency provided non-SBIR funds
c. ___ Another company provided funding
f. ___ Another company provided facilities, equipment and/or other in kind support
g. ___ An angel or other private investment source provided funding
h. ___ Venture Capital provided funding
i.

25. How long in months did it take to obtain and finalize agreement(s) for third party funding/in kind support?
☐☐ months.

26. Did you experience a gap between the end of Phase I and the start of Phase II?
a. Yes *Continue*
b. No *Skip to question 29*

27. Project history. Please fill in for all dates that have occurred.

Date Phase I ended Month*/ year* ☐☐☐☐
Date Phase II proposal submitted Month */year* ☐☐☐☐
Date Phase II started *Month /year* ☐☐☐☐
Date Phase II ended Month*/ year* ☐☐☐☐

28. If you experienced funding gap between Phase I and Phase II for this award*, select all answers that apply*

a. Duration of gap in months. ☐☐
b. ___Stopped work on this project during funding gap.
c. ___Continued work at reduced pace during funding gap.
d. ___Continued work at pace equal to or greater than Phase I pace during funding gap.
e. ___Received bridge funding between Phase I and II.

29. Did you receive assistance in Phase I or Phase II proposal preparation for this award?
a. ___ State agency provided assistance
b. ___ Mentor company provided assistance
c. ___ Regional association provided assistance

[109] The words underlined appear only for DoD awards.

d. ___ University provided assistance
e. ___ We received no assistance in proposal preparation

If e, then end of survey. If a, b, c, or d go to question 30

30. How important was this proposal preparation assistance to your success with the Phase II application?
    a. ___Critical – would never have succeeded without it
    b. ___Helpful
    c. ___Limited Use
    d. ___No use at all

FIRM Survey

You have already provided significant firm information in the DoD SBIR submissions database or in response to an earlier NAS request. In conjunction with that information, the following additional information will help us understand how the SBIR program is contributing to the formation of new small businesses active in federal R&D and how they impact the economy.

3. Was your company founded because of the SBIR Program?

c. ___ Yes
d. ___ No

4. Information on company founders. *(Please enter zeros or the correct number in each pair of blocks.)*

a. Number of founders. ☐☐

d. Number of other companies started by one or more of the founders. ☐☐

c. Number of founders who have a business background. ☐☐

d. Number of founders who have an academic background ☐☐

3. What was the most recent employment of the company founders prior to founding this company? *(Indicate all that apply.)*

a. ___ Other private company

b. ___ College or University

e. ___ Government

d. ___ Other

4. What percentage of your company's growth would you attribute to the SBIR program after receiving its first SBIR award?
a. ___ Less than 25%
b. ___ 25% to 50%
c. ___ 51% to 75%
d. ___ More than 75%

5. What Percentage of your Total R&D Effort (Man-hours of Scientists and Engineers) was devoted to SBIR activities during the most recent fiscal year? ___%

6. What Percentage of your Total R&D Expense was devoted to SBIR activities during the most recent fiscal year? _____%

7. Which, if any, of the following has your company experienced as a result of the SBIR Program? *(Select all that apply.)*

a. ___Made an initial public stock offering in calendar year ☐☐☐☐

b. ___Planned an initial public stock offering for 2003/2004.

c. ___Established one or more spin-off companies
How many spin-off companies? ☐☐

d. ___None of the above.

The remaining questions address how market analysis and sales of the commercial results of SBIR are accomplished at your company.

8. This company normally first determines the potential commercial market for an SBIR product, process or service

a. ___ Prior to submitting the Phase I proposal
b. ___ Prior to submitting the Phase II proposal
c. ___ During Phase II
d. ___ After Phase II

9. Market research/analysis at this company is accomplished by *Select all that apply*

a. ___The Director of Marketing or similar corporate position
b. ___ One or more employees as their primary job.
c. ___ One or more employees as an additional duty
d. ___ Consultants
e. ___ The Principal Investigator
f. ___ The company President or CEO

10. Sales of the product(s), process (es) or service(s) that result from commercialising an SBIR award at this company are accomplished by *Select all that apply*

a. ___ An in house sales force
b. ___ Corporate officers
e. ___ Other employees
f. ___ Independent distributors or other company (ies) with which we have marketing alliances
g. ___ Other company (ies), which incorporate our product into their own.
h. ___ Spin off company (ies)
g. ___ Licensing to another company

Draft Program Manager Survey

I Basic schedule
II Outreach
III Topic development
IV Phase I Selection
V Phase I Tracking
VI Phase I Program Characteristics
VII Phase II Application Support and Preparation
VIII Phase II Selection
IX Phase II Tracking
X Phase II Program Characteristics
XI Phase III Application Support and Preparation
XII Phase III Selection
XIII Phase III Tracking
XIV Phase III Program Characteristics
XV Outcomes Analysis
XVI Electronic services

I Basic Schedule

Please identify completion dates for the following activities in 2002-2003 cycle

a Phase I

Topics set
Solicitation published
Application deadline
First step review completed (for basic program compliance)
In-agency review completed
Outside reviews completed
Initial selection completed
Final selection completed
Grant begins

b Phase II

Phase I awardees invited to apply
Pre-application workshops completed
Application deadline
In-house review completed
Outside reviews completed
Initial selection completed
Final selection completed
Grant begins

II Outreach

a How many outreach conferences does your staff attend each year [measured in staff attendances]
b How important are the following elements of your outreach program [sum to 100%]
   i SBIR conferences
   ii State conferences
   iii Academic conferences
c How much do you rely on your web site to provide basic information to applicants [0-100%]

d Do you partner with the following to provide outreach services:
  i Business organizations
  ii State and other non-Federal government agencies
  iii Academic units
  iv Private firms
e What share of your work year is consumed by outreach activities [0-100%]
f can you identify the most successful outreach activities?
  i Those drawing the largest number of applicants
  ii Those that are most cost effective

III Topic Development

a Who initially develops the topics for solicitation
b Who edits or adjusts them
c Who makes the final topic selection
d What criteria are used to guide the development of topics [please weight the influence of the following, summing to 100%]
  i Technical needs of the agency
  ii Cutting edge of the field
  iii Likely commercial technologies
  iv Other (describe)
e On average, what percentage of topics change substantially year on year?
f Is "topic management" (e.g. topic narrowing) used to help manage the number of proposals received?

IV Phase I Selection

a How many Phase I applications were received in
  i 2003
  ii 2002
  iii 2001
b Is there an initial determination that the proposal falls within the scope of the solicitation
  i Yes/no
  ii If yes, who makes that determination
c Is An initial technical assessment made in house?
  i Yes/no
  ii If yes, who makes that determination
d Outside reviewers
  i Maximum number used for a proposal
  ii Minimum number used
  iii Sources of reviewers [please assign percentages, summing to 100%]
    i) Agency staff
    ii) Academics
    iii) Industry scientists
    iv) Other industry personnel
    v) Other
e Commercial review
  i Is a commercial review conducted for Phase I projects (Y/N)
  ii If yes, who makes that determination
    i) Agency staff
    ii) Academics
    iii) State or other govt economic development officers
    iv) Other industry personnel
    v) Consultants
    vi) Other
f Do Phase I awards in practice range in amount, or are they almost always awarded at or near the maximum value (currently $100,000)

g In scoring proposals, please assign relative weights to the following areas and sub areas. Total should sum to 100%

- i Technical merit
  - i) Significant advance in field
  - ii) Appropriate technical approach
  - iii) Strength of scientific approach
  - iv) PI qualifications
  - v) Adequate facilities
  - vi) Sufficient and qualified staff
- ii Commercial potential
  - i) Market understanding
  - ii) In-company commercial capacity
- iii Agency benefit
  - i) Addresses identified agency technical/scientific need
  - ii) Endorsed by relevant COTAR
  - iii) Other program agency staff (e.g. procurement officers)

h Are all administratively acceptable proposals sent for outside review?
- i) If not, who makes that decision
- ii) Which of the following criteria are used to make that determination
  - a) Obvious technical weakness
  - b) Not R&D
  - c) Other DOE criteria
  - e) Other DOE criteria
  - f) Other DOE criteria

i Who initially scores and ranks proposals
- i SBIR office staff
- ii Agency program staff

j Who makes final selection of winners
- i SBIR office staff
- ii Agency program staff

k What percentage of final scores deviate substantially from the average of outside reviewer scores (i.e. how much flexibility does the program officer have?)
- i 0-20%
- ii 21-40%
- iii 41% or more

l How is the funding for each topic or program area decided?
- i Strictly on the basis of funds to SBIR provided by that program
- ii By the SBIR office
- iii Other

m Who decides how to allocate that funding across winning proposals
- i Allocations are for practical purposes fixed (very few deviate from the standard award)
- ii SBIR staff
- iii Agency program staff

n Are the following criteria known to selecting staff or reviewers? Do they play a role in selection?
- i Geographical location of proposed work
- ii Minority status of PI or proposing company

iii Prior awards
iv Outcomes from prior awards

V Phase I Tracking

a Is any contact maintained by SBIR staff with Phase I awardees during the course of Phase I
b The final report for Phase I is sent to the following:
  i SBIR office staff
  ii The relevant agency technical contact
  iii Contracts office
  iv Other
c The final report is assessed to evaluate Phase I outcomes (yes/no)
d If yes, who makes that evaluation
  i SBIR office staff
  ii The relevant agency technical contact
  iii Contracts office
  iv Other
e Are Phase I recipients ever surveyed for program satisfaction?
f If so, are results used for program modification (please explain/give examples)

VI Phase I Program Characteristics

a Multiple awards
  i On average, what percentage of awards go to companies with no prior SBIR wins in your agency?
  ii On average, of the companies winning Phase I awards, how many have never won an award from your agency before
  iii On average, how many awards does your biggest Phase I award winner receive
b Minority/women led companies. If known, what percentage of awards go to minority/women-led companies?
c Does your program have a fixed start and fixed end date. If so, what are they for 2003?

VII Phase II Application Support and Preparation

a Do you directly solicit or encourage Phase I recipients to apply for Phase II awards?
b If so, do you solicit all Phase I awardees
c How long before the Phase II deadline do you solicit interest?
  Do you provide any assistance with the development of a Phase II proposal?
  i Assistance with the business case
  ii Assistance with matching funds
  iii Assistance with technology partnering or other technology support
d Do you now plan to encourage non-Phase I companies to apply directly for Phase II
e If that was permitted would you support such a change of policy
f What percentage of Phase I recipients apply for Phase II
g Are Phase I recipients permitted to apply to subsequent Phase II competitions (a year or two behind their "cohort.")
  i If so, are there any limitations to the delay

VIII Phase II Selection

a Is An initial technical assessment made in house?
  i Yes/no
  ii If yes, who makes that determination
b Outside reviewers
  i Maximum number used for a proposal
  ii Minimum number used
  iii Sources of reviewers [please assign percentages, summing to 100%]
    i) Agency staff

ii) Academics
iii) Industry scientists
iv) Other industry personnel
v) Other

c Commercial review
  i Is a commercial review conducted for Phase II projects (Y/N)
  ii If yes, who makes that determination
    i) Agency staff
    ii) Academics
    iii) State or other govt economic development officers
    iv) Other industry personnel
    v) Consultants
    vi) Other
d Do Phase II awards in practice range in amount, or are they almost always awarded at or near the maximum value (currently $750,000)
  i If awards vary, please provide
    i) The average size of the awards for the most recent year
    ii) the number of awards not receiving the maximum amount
    iii) The number of awards greater than the standard maximum (i.e. more than $750,000)
e In scoring proposals, please assign relative weights to the following areas and sub areas. Total should sum to 100%
  i Technical merit
    i) Significant advance in field
    ii) Appropriate technical approach
    iii) Strength of scientific approach
    iv) PI qualifications
    v) Adequate facilities
    vi) Sufficient and qualified staff
  ii Commercial potential
    i) Market understanding
    ii) In-company commercial capacity
  iii Agency benefit
    i) Addresses identified agency technical/scientific need
    ii) Endorsed by relevant COTAR
    iii) Other program agency staff (e.g. procurement officers)
f Are all administratively acceptable proposals sent for outside review?
  i) If not, who makes that decision
  ii) Which of the following criteria are used to make that determination
    i) Obvious technical weakness
    ii) Not R&D
    iii) Other DOE criteria
    iv) Other DOE criteria
    v) Other DOE criteria
g Who initially scores and ranks proposals
  i SBIR office staff
  ii Agency program staff
h Who makes final selection of winners

i SBIR office staff
ii Agency program staff

i What percentage of final scores deviate substantially from the average of outside reviewer scores (i.e. how much flexibility does the program officer have?)
i 0-20%
ii 21-40%
iii 41% or more

j How is the funding for each topic or program area decided?
i Strictly on the basis of funds to SBIR provided by that program
ii By the SBIR office
iii Other

k Who decides how to allocate that funding across winning proposals
i Allocations are for practical purposes fixed (very few deviate from the standard award)
ii SBIR staff
iii Agency program staff

l Are the following criteria known to selecting staff or reviewers? Do they play a role in selection?
i Geographical location of proposed work
ii Minority status of PI or proposing company
iii Prior awards
iv Outcomes from prior awards

IX Phase II Tracking

a Is any contact maintained by SBIR staff with Phase II awardees during the course of Phase II

b The final report for Phase II is sent to the following:
i SBIR office staff
ii The relevant agency technical contact
iii Contracts office
iv Other

c The final report is assessed to evaluate Phase II outcomes (yes/no)

d If yes, who makes that evaluation
i SBIR office staff
ii The relevant agency technical contact
iii Contracts office
iv Other

e Are Phase II recipients ever surveyed for program satisfaction?

f If so, are results used for program modification (please explain/give examples)

X Phase II Program Characteristics

a Multiple awards
i On average, what percentage of awards go to companies with no prior SBIR wins in your agency?
ii On average, of the companies winning Phase II awards, how many have never won an award from your agency before (other than the related Phase I)
iii On average, how many Phase II awards does your biggest Phase II award winner receive in each year

b Minority/women led companies. If known, what percentage of awards go to minority/women-led companies?

c Does your program have a fixed start and fixed end date. If so, what are they for 2003?

XI Phase III Application Support and Preparation

a Do you directly solicit or encourage Phase I recipients to apply for Phase III awards?
b If so, do you solicit all Phase II awardees
c Do you provide any assistance with the development of a Phase III proposal?
  i Assistance with the business case
  ii Assistance with identifying and acquiring funding
  iii Assistance with technology partnering or other technology support
  iv Assistance with general marketing
  v Assistance with marketing within your agency
d Can Phase I companies skip directly to Phase III
f What percentage of Phase II recipients apply for Phase III

XII Phase III Selection

a Does your agency have a formal Phase III program, providing further funding or support for companies completing Phase II's but not quite ready for full commercialization
b If so, does you agency provide funding
  i If so, what is the average size of the Phase III award
c Does the award require matching funds
  i What is the required match?
  ii Is advantage given to companies which provide a higher match
  iii Are there requirements or advantages attached to specific sources of the match (e.g. government agency funding, private venture money, etc.
d Is a further technical assessment made in house?
  i Yes/no
  ii If yes, who makes that determination
e Are outside reviewers used for Phase II proposals. If so,
  i Maximum number used for a proposal
  ii Minimum number used
  iii Sources of reviewers [please assign percentages, summing to 100%]
    i) Agency staff
    ii) Academics
    iii) Industry scientists
    iv) Other industry personnel
    v) Other
f Commercial review
  i Is a detailed review of commercial opportunities conducted for Phase III projects (Y/N)
  ii If yes, who conducts that review
    i) Agency staff
    ii) Academics
    iii) State or other govt economic development officers
    iv) Other industry personnel
    v) Consultants
    vi) Other
g Do Phase III awards in practice range in amount, or are they almost always the same amount (and what is that amount)
  i If awards vary, please provide
    i) The average size of the awards for the mort recent year
    ii) the number of awards not receiving the maximum amount
h In scoring proposals, please assign relative weights to the following areas and sub areas. Total should sum to 100%
  i Technical merit
    i) Significant advance in field
    ii) Appropriate technical approach
    iii) Strength of scientific approach

iv) PI qualifications
v) Adequate facilities
vi) Sufficient and qualified staff

ii Commercial potential
i) Market understanding
ii) In-company commercial capacity
iii) Advanced marketing and distribution plans
iv) Existing marketing and distribution arrangements
v) Further product development plans

iii Agency benefit
i) Addresses identified agency technical/scientific need
ii) Endorsed by relevant COTAR
iii) Other program agency staff (e.g. procurement officers)

i Is there are formal competition or are proposals treated case by case3

j Are Phase III proposals subject to outside review? If so, to whom are they sent?

k Who initially scores and ranks proposals
i SBIR office staff
ii Agency program staff

l Who makes final selection of winners
i SBIR office staff
ii Agency program staff

m How is the funding for each topic or program area decided?
i Strictly on the basis of funds to SBIR provided by that program
ii By the SBIR office
iii Other

n Who decides how to allocate that funding across winning proposals
i Allocations are for practical purposes fixed (very few deviate from the standard award)
ii SBIR staff
iii Agency program staff

o Are the following criteria known to selecting staff or reviewers? Do they play a role in selection?
i Geographical location of proposed work
ii Minority status of PI or proposing company
iii Prior awards
iv Outcomes from prior awards

XIII Phase III Tracking

a Is any contact maintained by SBIR staff with Phase III awardees during the course of Phase III

b The there a final report for Phase III. If so, is it sent to the following:
i SBIR office staff
ii The relevant agency technical contact
iii Contracts office
iv Other

c The final report is assessed to evaluate Phase III outcomes (yes/no)

d If yes, who makes that evaluation
i SBIR office staff
ii The relevant agency technical contact
iii Contracts office
iv Other

e Are Phase III recipients ever surveyed for program satisfaction?

f If so, are results used for program modification (please explain/give examples)

XIV Phase II Program Characteristics

XV Outcomes analysis

a Which of the following indicators of success do you regularly capture from your grantees or other sources

	Phase I	Phase II	Phase III
Commercialization			
	Actual sales of related products		
	Expected sales of SBIR-related products or services		
	Further development funding		
	Investment in the company		
	Business plan		
	Marketing staff		
	Distribution arrangements		
	Licensing agreement		
	Trademarks filed/granted		
	Copyrights filed/granted		
Agency mission			
	Knowledge adoption by agency		
	Knowledge adoption by prime contractor		
	Other agency indicators		
Field development			
	Patents filed/granted		
	Scientific publications		
	Scientific conference presentations		
	Other field development activities		

b on what criteria is the success of the program offer judged
- i Efficient program management (grants made on time)
- ii Commercial outcomes
- iii Agency outcomes
- iv Customer (grantee) satisfaction

XVI Electronic Services

a Which of the following elements are available online at your agency:
- I Phase I application
- ii Phase I reporting
- iii Phase II application
- iv Phase II reporting
- v Survey capability

b What other services are available electronically

c What other services would you like to make available electronically

Case Study Template for SBIR Award Winners

Agency Program of Focus: _____

Case Study Writer: _____

I. Characterize the Firm

1. Name of Firm: _____
2. Location: _____
3. Check any of the following characteristics that apply to the firm:

__Recipient of many PI awards __of many PII awards __of many PIIB awards
__Recipient of an unusually large award amount
__Noted for successful commercialization __ agency supplier __ marketplace
__Noted for large spillover benefits
__Primarily a contract R&D operation (without commercial orientation)
__Women Owned __Minority Owned
__No more than 5 employees __No more than 50 __No more than 100
__Founded within the past 5 years __6 to 10 years ago __10 to 20 years ago

4. Describe the firm's principal business: _____
5. Provide any other relevant descriptors: _____

II. Identify Interviewee(s)

1. Name: _____
2. Position: _____

III. Describe SBIR Effects on the Firm

Ask the interviewee to describe what the SBIR has meant to the firm, how important it has been as a source of financing, and the role it has played in shaping the firm's technological base or competitive capabilities. The following questions may be useful in shaping the discussion:

1. Did the SBIR program play a role in the initial formation of the firm? Describe.
2. Has the SBIR helped the firm survive? Helped it become revitalized? Describe.
3. Has the SBIR been an important factor to growth? Describe.
4. Has the SBIR affected the ability of the firm to secure other financing? How?

a. What were the firm's major sources of funding at the time it applied for its first SBIR award? How important was SBIR funding relative to total firm financing at the time of the first award: How important is SBIR funding now in terms of total firm financing?
b. Do you think you have been able to obtain more R&D funding as a result of the SBIR? More Federal R&D funding?

5. Has the SBIR affected development of the firm's technological base or capabilities? Describe.

a. What can your firm do that you think it wouldn't be able to do without the SBIR?
b. Describe how your firm would likely be different today, had there been no SBIR?

IV. Identify Innovation Area, Outputs, and Impacts of an SBIR Funded Project

Innovation Area

1. What has been the most important innovation pursued with SBIR funding? Describe.

Commercial Outputs

2. With respect to this most important innovation, is the firm selling products or services derived from SBIR funding in the market place?

3. Is the firm supplying products or services to a Federal agency?

4. Are there other modes of commercial outputs? Describe extent of each of these activities.

5. Are there plans for commercial activity in the near future?

Commercialization Strategy

6. If the firm has commercialized this most important innovation, what was its strategy, e.g., did it: __ form a strategic alliance with another firm for production? __license the technology to one or more other firms? __produce in-house?

Private Returns and Spillover Effects

7. What are the effects on the firm's customers from having the results of this innovation, e.g., __lower costs? __higher quality? __new performance capability? __increased ability to achieve agency mission? __improved health or safety? __environment effects? __other effects? Describe.

8. Can the firm provide information on projected market sizes, returns to the firm, and returns to others from the most important area of innovation?

9. Did scientific papers result from this area of SBIR-funded research? How many? Please provide references for published papers.

10. Has this SBIR-funded innovation generated any patents? Filed and granted or filed only? If granted, obtain patent description and number if patent citation analysis is planned. Are more filings expected?

12. Are there examples of carryover of know-how from this or other SBIR funded projects to other endeavors of the firm? To the endeavors of other organizations?

V. Views on Applying for and Receiving SBIR Awards

Applying for an SBIR Award

1. How did the firm become aware of the SBIR program?

2. Was the geographical location (State and region within) important to the firm's awareness of the SBIR opportunity? It's ability to propose and receive an SBIR? Describe.

3. What determined the agency(s) to which you have proposed?

4. Do you find important differences among the application processes among SBIR programs? Elaborate.

5. Does the firm have a strategy for proposing to SBIR, e.g., propose many PIs hoping to get at least one awarded, and then narrow the R&D focus?

6. What have you found to be the approximate relationship between the cost of proposing and the amount of funding you have been awarded -- at the PI stage? PII? PIIB?

7. Have you applied for and received awards from other government R&D programs? Which ones? How did this experience compare with your SBIR experience?

8. What would you like to change about the SBIR application process?

9. What's your opinion of the topic specification? Would you have preferred a tighter or a more open specification? Why? Do you think you would have had greater success commercializing the technology in the marketplace if you'd had greater freedom in defining the technology?

10. What is your opinion of the frequencies of solicitation? For PI? For PII?

11. If the SBIR program to which you proposed had a 3rd party investment requirement for obtaining Phase IIB (or equivalent) awards, how did it affect your firm? What is your opinion about the requirement?

Selection Process

12. Did you find the selection process to be fair? For PI? For PII? For PIIB?

13. Did you receive feedback from the review process, and, if so, how useful was it?

Funding Amounts and Timing

14. Did the firm face any serious delays in obtaining funding? At what stage? For how long? What were the consequences?

15. Would you prefer that agencies grant a small number of larger SBIR awards?

Overall Program

16. What do you see as the strengths of the SBIR program?

17. What do you see as the weaknesses of the SBIR program?

18. If you could change the SBIR program, what changes would you make?