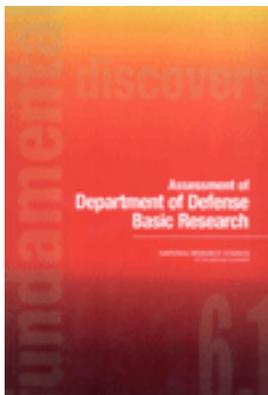


Free Executive Summary



Assessment of Department of Defense Basic Research

Committee on Department of Defense Basic Research,
National Research Council

ISBN: 0-309-09443-7, 70 pages, 6 x 9, paperback (2005)

This free executive summary is provided by the National Academies as part of our mission to educate the world on issues of science, engineering, and health. If you are interested in reading the full book, please visit us online at <http://www.nap.edu/catalog/11177.html>. You may browse and search the full, authoritative version for free; you may also purchase a print or electronic version of the book. If you have questions or just want more information about the books published by the National Academies Press, please contact our customer service department toll-free at 888-624-8373.

This executive summary plus thousands more available at www.nap.edu.

Copyright 2004 © National Academy of Sciences. Permission is granted for this material to be shared for noncommercial, educational purposes, provided that this notice appears on the reproduced materials, the Web address of the online, full authoritative version is retained, and copies are not altered. To disseminate otherwise or to republish requires written permission from the National Academies Press.

Executive Summary

THE BOTTOM LINE

On the basis of its extensive discussions and review of documents, the Committee on Department of Defense Basic Research finds reason to question the appropriateness of the classification of only a small part of the Department of Defense (DOD) 6.1 basic research portfolio. Even in those cases, the issue is usually centered on the implication in the current DOD definition of basic research that having specific applications in mind is inconsistent with the purposes of basic research. And in most of these cases, the issue often comes down to “how specific is specific?” The committee concludes that such discussion is not productive, just as that distinction in the DOD definition is not useful. Hence, the committee’s conclusion is that there is no evidence of significant misapplication of DOD basic research funding.

The committee concludes that those responsible for directing and managing basic research in the DOD are well motivated and generally successful in directing basic research resources for purposes appropriate to the DOD definition of basic research: that is, “systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards process or products in mind.”¹ Research managers generally comply with the spirit of the definition, although if it was taken literally,

¹Department of Defense, Financial Management Regulation, DOD 7000.14-R, Vol. 2B, Ch. 5, June 2004. Available online at http://www.dtic.mil/descriptivesum/budget_activities.pdf. Last accessed on November 16, 2004.

having specific applications in mind would be disqualifying. The committee found that research managers apply consistent and reasonable judgment on the level of specificity that is appropriate to the purposes of basic research.

There has been a trend within DOD 6.1 basic research, however, toward reduced unfettered exploratory research and increased support for meeting more specific needs. The DOD needs to reset this balance in favor of the discovery of new fundamental understanding.

SPECIFIC FINDINGS AND RECOMMENDATIONS

The committee's findings and recommendations, which appear in the main body of the report with related discussion, are presented below.

Findings

Finding 1. Department of Defense basic research funds under 6.1 have not been directed in significant amounts to support projects typical of 6.2 or 6.3 funding.

Finding 2. Research managers are well motivated and generally successful in focusing 6.1 funding on the discovery of fundamental knowledge in support of the range of Department of Defense needs.

Finding 3. Having specific applications in mind is not a useful criterion for discriminating between basic and applied research.

Finding 4. The set of attributes and desirable characteristics of basic research widely shared among experienced basic research managers can be beneficial in distinguishing between basic and applied research.

Finding 5. The basic research needs of the Department of Defense are complex and do not end when specific applications are identified.

Finding 6. The need for ongoing discovery from basic research can, and usually does, continue through the applied research, system development, and system operation phases.

Finding 7. Included in the range of values expected from basic research in the Department of Defense are (1) discovery arising from unfettered exploration, (2) focused research in response to identified DOD technology needs, and (3) assessment of technical feasibility.

Finding 8. A recent trend in basic research emphasis within the Department of Defense has led to a reduced effort in unfettered exploration, which historically

has been a critical enabler of the most important breakthroughs in military capabilities.

Finding 9. Generated by important near-term Department of Defense needs and by limitations in available resources, there is significant pressure to focus DOD basic research more narrowly in support of more specific needs.

Finding 10. Universities, government laboratories, and industry have overlapping roles in basic research: universities primarily address the creation of broad new knowledge and human competencies, and Department of Defense laboratories and industry are more sharply focused on discovery tied more directly to identified DOD needs.

Finding 11. A clear understanding of the value expected from basic research across its full range provides the most reliable assurance of long-term Department of Defense leadership support for the basic research.

Finding 12. A variety of management approaches in the Department of Defense is appropriate to the widely diverse missions and motivations for basic research.

Finding 13. The key to effective management of basic research lies in having experienced and empowered program managers. Current assignment policies and priorities (such as leaving substantial numbers of program manager positions unfilled) are not always consistent with this need, which might result in negative consequences for the effectiveness of basic research management in the long term.

Finding 14. The breadth and depth of the sciences and technologies essential to the Department of Defense mission have greatly expanded over the past decade.

Finding 15. In real terms the resources provided for Department of Defense basic research have declined substantially over the past decade.

Finding 16. The demand for new discovery argues for significantly increased involvement of university researchers. Yet some younger university researchers in the expanded fields of interest to the Department of Defense are often discouraged by the difficulty in acquiring research support from the department.

Finding 17. Recent pressures to apply restrictions on participation and publication through export controls on Department of Defense-sponsored research funded in 6.1 both disqualify it from being considered basic research as defined by National Security Decision Directive 189 and threaten to change fundamentally the open and public character of basic university research. This finding does not apply to research funded in 6.2.

Recommendations

Recommendation 1. The Department of Defense should change its definition of basic research to the following:

Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and has the potential for broad, rather than specific, application. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, social, and life sciences related to long-term national security needs. It is farsighted high-payoff research that provides the bases for technological progress. Basic research may lead to (a) subsequent applied research and advance technology developments in Defense-related technologies, (b) new and improved military functional capabilities, or (c) the discovery of new knowledge that may later lead to more focused advances in areas relevant to the Department of Defense.

Recommendation 2. The Department of Defense should include the following attributes in its guidance to basic research managers and direct that these attributes be used to characterize 6.1-funded research: a spirit that seeks first and foremost to discover new fundamental understanding, flexibility to modify goals or approaches in the near term based on discovery, freedom to pursue unexpected paths opened by new insights, high-risk research questions with the potential for high payoff in future developments, minimum requirements for detailed reporting, open communications with other researchers and external peers, freedom to publish in journals and present at meetings without restriction and permission, unrestricted involvement of students and postdoctoral candidates, no restrictions on the nationality of researchers, and stable funding for an agreed timetable to carry out the research.

Recommendation 3. The Department of Defense should abandon its view of basic research as being part of a sequential or linear process of research and development (in this view, the results of basic research are handed off to applied research, the results of applied research are handed off to advanced technology development, and so forth). Instead, the DOD should view basic research, applied research, and the other phases of research and development as continuing activities that occur in parallel, with numerous supporting connections among them.

Recommendation 4. The Department of Defense should set the balance of support within 6.1 basic research more in favor of unfettered exploration than of research related to short-term needs.

Recommendation 5. Senior Department of Defense leadership should clearly communicate to research managers its understanding of the need for long-term exploration and discovery.

Recommendation 6. Personnel policies should provide for the needed continuity of research management in order to ensure a cadre of experienced managers capable of exercising the level of authority needed to effectively direct research resources. Further, in light of the reductions in positions reported to the Committee on Department of Defense Basic Research, the Department of Defense should carefully examine the adequacy of the number of basic research management positions.

Recommendation 7. The Department of Defense should redress the imbalance between its current basic research allocation, which has declined critically over the past decade, and its need to better support the expanded areas of technology, the need for increased unfettered basic research, and the support of new researchers.

Recommendation 8. The Department of Defense should, through its funding and policies for university research, encourage increased participation by younger researchers as principal investigators.

Recommendation 9. To avoid weakening the long and fruitful partnership between universities and Department of Defense agencies, DOD agreements and subagreements with universities for basic research should recognize National Security Decision Directive 189, the fundamental research exclusion providing for the open and unrestricted character of basic research. DOD program managers should also explicitly retain the authority to negotiate export compliance clauses out of basic research grants to universities, on the basis of both the program's specific technologies and its objectives.

Assessment of Department of Defense Basic Research

Committee on Department of Defense Basic Research

Division on Engineering and Physical Sciences

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

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 is a report of work supported by Grant No. N00014-00-G-0230 between the U.S. Navy and the National Academy of Sciences. 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 this project.

International Standard Book Number 0-309-09443-7 (Book)

International Standard Book Number 0-309-54649-4 (PDF)

Limited copies of this report are available from:

Air Force Science and Technology Board
National Research Council
500 Fifth Street, N.W.
Washington, DC 20001
(202) 334-3118

Additional copies are available from:

The National Academies Press
500 Fifth Street, N.W.
Lockbox 285
Washington, DC 20055
(800) 624-6242 or (202) 334-3313
(in the Washington metropolitan area)
Internet, <http://www.nap.edu>

Copyright 2005 by the National Academy of Sciences. All rights reserved.

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 ON DEPARTMENT OF DEFENSE BASIC RESEARCH

LARRY D. WELCH, *Chair*, U.S. Air Force (retired), Institute for Defense Analyses, Alexandria, Virginia
C.D. (DAN) MOTE, JR., *Vice Chair*, University of Maryland, College Park
ALBERT J. BACIOCCO, JR., U.S. Navy (retired), Mt. Pleasant, South Carolina
JACK R. BORSTING, University of Southern California, Los Angeles
JOHN M. DEUTCH, Massachusetts Institute of Technology, Cambridge
CHARLES B. DUKE, Xerox Innovation Group, Webster, New York
JOHN S. FOSTER, JR., Northrop Grumman Space Technology (retired), Redondo Beach, California
MARY L. GOOD, University of Arkansas, Little Rock
ROBERT J. HERMANN, Global Technology Partners, Hartford, Connecticut
JAMES C. MCGRODDY, IBM Corporation (retired), Briarcliff Manor, New York
C. BRADLEY MOORE, Northwestern University, Evanston, Illinois
JAMES G. O'CONNOR, Pratt & Whitney (retired), Coventry, Connecticut
RICHARD C. POWELL, University of Arizona, Tucson
FAWWAZ T. ULABY, University of Michigan, Ann Arbor
BARBARA A. WILSON, Jet Propulsion Laboratory, Pasadena, California
JOHNNIE E. WILSON, U.S. Army (retired); Dimensions International, Inc., Alexandria, Virginia

Staff

MICHAEL A. CLARKE, Lead Division Board Director
JAMES C. GARCIA, Study Director
LANITA R. JONES, Program Assistant
DANIEL E.J. TALMAGE, JR., Research Associate
LINDSAY D. MILLARD, Intern

Preface

The U.S. Congress mandated that this study be conducted. The mandate is contained in the U.S. Senate report that accompanied the Senate's version of the National Defense Authorization Act for Fiscal Year 2004 and in the U.S. House of Representatives report that accompanied the House-Senate authorization conference committee version of the act. Specifically, the Senate and House reports, respectively, state:

While the Department [of Defense] is increasing its budget request for the Science and Technology Program, the committee remains concerned that the investment in basic research has remained stagnant and is too focused on near-term demands. Therefore, the committee recommends an increase of \$50.0 million for basic research. In addition, the committee directs the Director of Defense Research and Engineering to commission a study by the National Academy of Sciences to assess the basic research portfolio of the services and the Defense Advanced Research Projects Agency (DARPA). This assessment should review the basic research portfolio in order to determine if the programs are consistent with the definitions of basic research in DoD regulation. This report is not intended to rate the worthiness of the basic research portfolio, but rather to determine whether the basic research portfolio needs to be realigned to be more consistent with the goals of traditional fundamental research activities.¹

¹Senate Armed Services Committee, *FY04 National Defense Authorization Act*, 108th Cong., 2003, S. Rep. 108-46, Title II, Subtitle A. Available online at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_reports&docid=f:sr046.108.pdf. Last accessed on November 16, 2004.

and

The conferees further note their concerns about funding levels and technical content of the basic research activities of the defense science and technology program. The Department's investment in basic research provides the foundation upon which our modern military is built. It is critical the basic research investment remain strong, stable, and focused on the fundamental search for new knowledge. Therefore, the conferees direct the National Academies of Science to evaluate the DOD basic research portfolio. The evaluation shall utilize the official DOD definition of basic research to determine whether the basic research portfolio is consistent with the definition provided in DOD regulation. The conferees expect to work closely with the National Academies of Science and the Secretary to build the terms of reference for this evaluation. The evaluation should be made available to the congressional defense committees prior to the fiscal year 2006 budget request.²

The Department of Defense (DOD) awarded National Research Council (NRC) the study grant with an effective starting date of March 2004.

BACKGROUND AND SCOPE OF STUDY

The Department of Defense currently defines basic research as follows:³

Basic research is systematic study directed toward greater knowledge or understanding of the fundamental aspects of phenomena and of observable facts without specific applications towards processes or products in mind. It includes all scientific study and experimentation directed toward increasing fundamental knowledge and understanding in those fields of the physical, engineering, environmental, and life sciences related to longterm national security needs. It is farsighted high payoff research that provides the basis for technological progress. Basic research may lead to: (a) subsequent applied research and advanced technology developments in Defense-related technologies, and (b) new and improved military functional capabilities in areas such as communications, detection, tracking, surveillance, propulsion, mobility, guidance and control, navigation, energy conversion, materials and structures, and personnel support. Program elements in this category involve pre-Milestone A efforts.

²House Armed Services Committee, *National Defense Authorization Act for Fiscal Year 2004*, 108th Cong., 2003, H.R. Rep. 108-354, Title II, Subtitle D. Available online at http://frwebgate.access.gpo.gov/cgi-bin/getdoc.cgi?dbname=108_cong_reports&docid=f:hr354.108.pdf. Last accessed on November 16, 2004.

³Department of Defense, Financial Management Regulation, DOD 7000.14-R, Vol. 2B, Ch. 5, June 2004. Available online at http://www.dtic.mil/descriptivesum/budget_activities.pdf. Last accessed on November 16, 2004.

The goal of DOD basic research support is to encourage advances in fields that are likely to contribute to national defense, and in doing so, to foster a competitive technology base for the U.S. military.

In order to maintain this competitive technology base, the DOD continues to fund basic research. However, over the past 6 years, it has come to the attention of the congressional committees on armed services that basic research funded by the DOD may be changing. Several organizations, including university research departments and defense laboratories, have described areas of concern. They include the following:

- Some research conducted using funds designated specifically for basic research is not, under the DOD's definition, considered basic research;
- Reporting requirements on DOD grants and contracts have become cumbersome and constraining to basic researchers; and
- Basic research funds are handled differently among the Services, which makes the funds, in some cases, difficult to track and monitor.

These concerns prompted the armed services committees to request that the National Academies perform a study regarding the nature of basic research currently being funded by the Department of Defense. The task includes assessing the DOD's basic research portfolio, including that managed by the Office of the Secretary of Defense, the three military departments, and the Defense Advanced Research Projects Agency (DARPA), to determine if the programs in that portfolio are consistent with the definitions of basic research contained in DOD regulations and consistent with the characteristics associated with fundamental research activities. Specifically, the National Academies' statement of task is shown in Box P-1.

STUDY APPROACH AND CONSTRAINTS

The committee (see Appendix A for biographical sketches of members) approached the study in two basic steps, which corresponded to its first two meetings. The committee devoted its first meeting, on May 5-6, 2004, to understanding the DOD definitions for basic and applied research and the characteristics associated with fundamental research and to gathering data and information that would provide insight into the study issue and background from representatives of the research community. During this meeting, the committee received presentations by personnel from the DOD, the Office of Management and Budget (OMB), the National Science Foundation (NSF), and the Department of Energy (DOE) and from a former member of the Senate Committee on Armed Services staff. Representatives of the Association of American Universities (AAU) and the American Association for the Advancement of Science (AAAS) spoke. The associate provost from the Massachusetts Institute of Technology (MIT) and vice

BOX P-1

Statement of Task

In accordance with Senate Report 108-46, Title II, Subtitle A, and House Report 108-354, Title II, Subtitle D, the National Academies will conduct a study to assess the basic research portfolio of the Department of Defense (DoD), including that managed by the Office of the Secretary of Defense (OSD), the three military departments, and the Defense Advanced Research Projects Agency (DARPA), to determine if the programs in that portfolio are consistent with the definitions of basic research contained in DoD regulations and consistent with the characteristics associated with fundamental research activities. To conduct the study, the National Academies will accomplish the following tasks:

1. Form a study committee that possesses knowledge and expertise in the science and technology areas in which DoD basic research is involved; understanding of the differences and relationships between the DoD science and technology (S&T) program categories of basic research (6.1), applied research (6.2), and advanced technology development (6.3); and understanding of DoD financial management and budget regulations and processes that define basic research and govern the categorization of science and technology programs and related budgets as basic research and understand the historical characteristics associated with fundamental research activities.
2. Review the unclassified and classified DoD basic research portfolio through descriptions and documentation of recent, current, and planned programs; discussions with DoD S&T and basic research policy makers, program managers, and intramural and extramural researchers; on-site examination; testimonies from persons with knowledge relevant to the study issues; and other reference information as applicable.
3. Audit the nature of the research to look at fundamental vs. applied orientation; research program review criteria used by the OSD, military departments, and DARPA; any restrictions being placed upon principal investigators; whether broad agency announcements permit truly innovative approaches to be proposed; and other such indicators.
4. Determine if programs in the DoD basic research portfolio are consistent with the definitions of basic research contained in DoD regulations and consistent with the characteristics associated with fundamental research activities. Identify any instances where programs are not consistent with DoD regulations or are not consistent with the characteristics associated with fundamental research activities.
5. Identify any problems that might arise from the definitions themselves or the regulations, policies, or processes implementing the definitions that have a significant bearing on the study issues.
6. Report findings, conclusions, and recommendations regarding the tasks above.

provosts for research from the University of Southern California (USC) and Howard University made presentations. Speakers from Harvard University and George Mason University discussed how research fits into innovation. The list of guest speakers and titles of their presentations at Meeting 1 is provided in Appendix B.

The committee's second meeting, held on May 26-27, 2004, was devoted to reviewing the DOD's basic research program. It included presentations (see Appendix B) by representatives from the U.S. Army, U.S. Navy, U.S. Air Force, DARPA, the Defense Threat Reduction Agency (DTRA), and the Office of the Secretary of Defense (OSD). Army speakers included representatives of the Assistant Secretary of the Army for Acquisition, Logistics, and Technology (ASAALT); the Army Research Laboratory (ARL) (including the Army Research Office [ARO]); the Army Research Institute (ARI); the Medical Research and Materiel Command (MRMC); the Engineer Research and Development Center (ERDC); and the Research, Development, and Engineering Command (RDECOM). The committee received presentations from Navy representatives of the Office of Naval Research (ONR), the Naval Research Laboratory (NRL), and the Naval warfare centers. Representatives of the Air Force Office of Scientific Research (AFOSR) and the Air Force Research Laboratory (AFRL) made presentations. The director of DARPA's Defense Sciences Office represented DARPA. The DOD chemical and biological defense program was discussed by a DTRA representative. An OSD representative discussed the Department of Defense Experimental Program to Stimulate Competitive Research (DEPSCoR).

The committee also conducted several site visits. Committee members visited DARPA, the three main Service laboratories, and the Navy and Air Force offices responsible for managing their respective Service's basic research program. During each visit, committee members met with key organization leadership personnel in addition to one or more groups of researchers and/or research managers. Discussion topics included the DOD definition of basic research; the perceptions of leadership, researchers, and managers about how well their research fits this definition and about characteristics associated with basic research; trends; concerns; and suggested improvements. Appendix C lists the DOD organizations visited.

Committee members also visited and/or interviewed individuals and groups at the universities shown in Appendix C. Each visit included a meeting with the key person responsible for research at the university (usually a vice president or vice provost for research), as well as one or more groups of DOD-sponsored researchers. In addition to the same topics discussed during the DOD site visits, the discussions at the universities addressed the importance of DOD research funding to the university research enterprise (e.g., faculty development and support, the ability to train graduate students, and the impact on the research agenda of individual researchers and the institution). These same topics were discussed during interviews of university research leaders who were not visited in person.

In selecting the universities that it would invite to participate in its meetings, visits, and/or interviews, the committee attempted to include a representative sample of universities receiving DOD research funding. The universities that received DOD basic and applied research funding in fiscal year 2002 are shown in Appendix E. Although it was impossible for the committee to conduct site visits or interviews with research leaders and others at all of these universities or even a major percentage of them, the committee sought to obtain meaningful information regarding the study issue by selecting a sample that received a significant portion of DOD research funding, included research sponsored by all three military Services and DARPA, and was geographically balanced. In all, the committee's site visits and interviews included discussions with approximately 140 people from 7 DOD research organizations and 14 universities.

Constraints on this study were the normal ones experienced by most such studies—schedule and resources. The primary constraint was the requirement expressed by congressional staff members that the study results be available by the end of 2004.

ACKNOWLEDGMENTS

The committee thanks the many organizations and guest speakers that provided excellent support to the committee. The speakers presented information to the committee that had a direct bearing on the study. From the high quality of the presentations, it was obvious that the speakers and others had spent many hours preparing. From the point of view of the committee, this was time well spent. We hope that the speakers, their organizations, the committee's Department of Defense sponsor, and ultimately the readers of this report will agree.

Finally, the committee thanks the NRC staff members who supported the study. Primary among them were Mike Clarke, Jim Garcia, LaNita Jones, Daniel Talmage, and intern Lindsay Millard.

Larry D. Welch, *Chair*
Committee on Department of Defense Basic Research

Acknowledgment of Reviewers

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 National Research Council's (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:

Duane Adams, Carnegie Mellon University,
Rita Colwell, University of Maryland,
Anthony J. DeMaria, Coherent-DEOS,
Gerald P. Dinneen, Honeywell, Inc. (retired),
Fernando L. Fernandez, Stevens Institute of Technology,
Ernest Henley, University of Washington,
Kathryn Logan, Georgia Institute of Technology (retired),
John W. Lyons, U.S. Army Research Laboratory (retired),
John B. Mooney, Jr., U.S. Navy (retired),
Theodore Poehler, Johns Hopkins University,
Charles V. Shank, E.O. Lawrence Berkeley National Laboratory,
James Siedow, Duke University,
Pace Vandevender, Sandia National Laboratories, and
Charles Zukoski, University of Illinois.

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 William G. Agnew (NAE), General Motors Corporation (retired). Appointed by the NRC, he was 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.

Contents

| | |
|---|---|
| EXECUTIVE SUMMARY | 1 |
| ASSESSMENT OF DEPARTMENT OF DEFENSE (DOD) BASIC RESEARCH | 7 |
| Introduction, 7 | |
| Definitions and Their Role in Managing Basic Research, 8 | |
| Findings, 11 | |
| Recommendations, 11 | |
| Basic Research in the Wider Cycle of Discovery and Technology | |
| Exploitation, 12 | |
| Findings, 13 | |
| Recommendation, 13 | |
| Multiple Missions, Motivations, and Management Approaches, 14 | |
| Findings, 17 | |
| Recommendations, 18 | |
| The Demand Versus the Supply, 18 | |
| Findings, 23 | |
| Recommendations, 24 | |
| APPENDIXES | |
| A Biographical Sketches of Committee Members, 27 | |
| B Guest Speaker Presentations to the Committee, 37 | |

- C DOD Basic Research Organizations and Universities: Committee Site Visits and/or Interviews, 41
- D Definitions of Basic, Applied, and Fundamental Research, 44
- E Universities That Received Department of Defense 6.1 and 6.2 Funding in Fiscal Year 2002, 51