



INSTITUTE FOR DEFENSE ANALYSES

**Assessment of the Defense Experimental
Program To Stimulate Competitive
Research (DEPSCoR): Final Report**

Volume I—Summary

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Preface

This document was prepared for the Office of the Deputy Under Secretary of Defense, Laboratories and Basic Science (ODUSD(LABS)) under the “Assessment of the Defense Experimental Program to Stimulate Competitive Research Program” task. Technical cognizance for this report is assigned to Dr. Robin Staffin, Director for Basic Research, ODUSD(LABS). The Institute for Defense Analyses (IDA) point of contact (POC) is Dr. James Silk.

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Foreword

The Defense Experimental Program To Stimulate Competitive Research (DEPSCoR) was created by Congress in the Fiscal Year (FY) 1991 Department of Defense (DOD) appropriation and legislatively authorized in 1994 (National Defense Authorization Act for Fiscal Year 1995, P.L. 103-337, §257; Oct. 5, 1994, 108 Stat. 2705).

This report is Volume I of a two-volume set of documents. It summarizes the findings of a DEPSCoR program assessment conducted by the Institute for Defense Analyses (IDA), a Federally Funded Research and Development Center (FFRDC) in Alexandria, Virginia. The purpose of this assessment was to determine the effectiveness of the DEPSCoR program. The assessment responds to a requirement in Section 241 of the FY 2008 National Defense Authorization Act (P.L. 110-181, §241, Jan. 28, 2008, 122 Stat. 3).

Summary

A. Purpose of This Assessment

Section 241 of the Fiscal Year (FY) 2008 National Defense Authorization Act directed the Secretary of Defense to use a defense Federally Funded Research and Development Center (FFRDC) to carry out an assessment of the effectiveness of the Defense Experimental Program to Stimulate Competitive Research (DEPSCoR). That legislation includes six specific charges. The first four call for retrospective analyses of program activities and outcomes to date, and the final two are forward-looking. The text of the legislation states the six charges as follows:

1. A description and assessment of the tangible results and progress toward the objectives of the program, including—
 - a. An identification of any past program activities that led to, or were fundamental to, applications used by, or supportive of, operational users
 - b. An assessment of whether the program has expanded the national research infrastructure
2. An assessment of whether the activities undertaken under the program are consistent with the statute authorizing the program
3. An assessment of whether the various elements of the program, such as structure, funding, staffing, project solicitation and selection, and administration, are working effectively and efficiently to support the effective execution of the program
4. A description and assessment of past and ongoing activities of state planning committees under the program in supporting the achievement of the objectives of the program
5. An analysis of the advantages and disadvantages of having an institution-based formula for qualification to participate in the program when compared with the advantages and disadvantages of having a State-based formula for qualification to participate in supporting defense missions and the objective of expanding the Nation's defense research infrastructure
6. An identification of mechanisms for improving the management and implementation of the program, including modification of the statute authorizing the program, Department regulations, program structure, funding levels, funding strategy, or the activities of the state committees.

In February 2008, the Institute for Defense Analyses (IDA) was selected to perform the assessment. IDA is a non-profit corporation that administers three FFRDCs to assist the United States Government in addressing important national security and other issues, particularly those requiring scientific and technical expertise.

This report summarizes assessment findings. Sections B and C provide descriptive information on DEPSCoR's legislative history and awards, respectively. Section D describes the analyses conducted and findings in response to each of the six charges of the legislative mandate.

B. DEPSCoR Origin and Legislative History

The Experimental Program To Stimulate Competitive Research (EPSCoR) was formally authorized in 1988 (P.L. 100-570, title I, § 113, Oct. 31, 1988, 102 Stat. 2870; U.S.C. 42 §1862(g)). EPSCoR was directed at jurisdictions that had historically received lesser amounts of research and development (R&D) funding, and its purpose was to help fulfill the mandate of the National Science Foundation (NSF) to promote scientific progress nationwide. Twenty-five states, Puerto Rico, and the U.S. Virgin Islands are currently eligible to participate in the NSF EPSCoR.¹

During the 1990s, Congress also directed other federal science agencies, including the Department of Defense (DOD), to begin EPSCoRs. In the FY 1991 DOD appropriation (101 P.L. 511; title IV, § 1870, Nov. 5, 1990, 104 Stat. 1856), Congress provided \$7 million for a Defense EPSCoR (DEPSCoR). The FY 1991 program was implemented in the form of supplements to holders of existing DOD R&D awards for training of graduate students.²

In the FY 1992 DOD appropriation (P.L. 102-172, title IV, §1166, Nov. 26, 1991, 105 Stat. 1150), Congress again funded a DEPSCoR program. The appropriation provided \$10 million in funding for FY 1992 and mandated that eligibility requirements should match those used by the NSF EPSCoR.³ In the accompanying conference report (H.R. 102-95, June 4, 1991), Congress stated that the traineeship approach was overly limited, and it identified a range of permissible activities that included infrastructure development, the formation of collaborations and relationships between EPSCoR state planning committees and DOD program and laboratory personnel, instrumentation, and graduate traineeships.⁴

¹ NSF Solicitation 08-500.

² DOD News Release 270-92, "DOD Awards \$7 Million for Science and Engineering Education," June 9, 1992.

³ P.L. 102-172, section § 1166.

⁴ H.R. 102-95.

In the FY 1993 DOD appropriation (P.L. 102-396, title IV, § 1893, Oct. 6, 1992, 106 Stat. 1876) Congress again mandated a DEPSCoR program open to all states eligible for EPSCoR.⁵ The combined FY 1993–1994 competition provided \$20.3 million for research grants to investigators in eligible jurisdictions in science and engineering (S&E) fields valuable for national defense.⁶

The FY 1995 Defense Authorization (National Defense Authorization Act for Fiscal Year 1995, P.L. 103-337, §257; Oct. 5, 1994, 108 Stat. 2705) formally authorized the DEPSCoR program. Key elements of the authorization included

- Two programmatic objectives (§257(b))
 - To enhance the capabilities of institutions of higher education in eligible states to develop, plan, and execute science and engineering research that is competitive under the peer-review systems used for awarding federal research assistance
 - To increase the probability of long-term growth in the competitively awarded financial assistance that institutions of higher education in eligible states receive from the federal government for science and engineering research
- Two eligibility criteria (§257(d))
 - Eligible states must participate in the NSF EPSCoR program
 - Eligible states must receive less than 1.2% of federal university S&E R&D funding
- Authorized activities, which were research grants and financial assistance to graduate students (§257(c))
- Submission of proposals by state EPSCoR committees rather than individual investigators (§257(e)(2)).

Section 264 of the National Defense Authorization for Fiscal Year 1997 (P.L. 104-201, Sept. 23, 1996, 110 Stat. 2465) modified the eligibility criteria in the authorizing language to set the state eligibility threshold at 1.2% of the S&E R&D funding provided to universities by DOD only (as opposed to all federal agencies). EPSCoR participation was not mentioned specifically as a criterion for eligibility in the authorization, but procedural rules involving application through the state EPSCoR committees were retained, making it impossible for investigators in a non-EPSCoR jurisdiction to apply. Most recently, however, Section 239 of the FY 2008 Defense Authorization (P.L. 110-181 §239, January 28, 2008, 122 Stat. 3) potentially removed that

⁵ P.L. 102-396, section § 1893.

⁶ DOD News Release 284-94, “DOD Awards \$18 Million for University Research,” May 13, 1994. The program database provided by DOD staff identified \$20.3 million in funding, even though the news release mentioned “\$18 million.”

barrier by removing the requirement that all proposals be submitted to and all awards be made through the state committees. However, the process by which this change in the authorizing legislation will be incorporated into the program by DOD has not yet been determined. One potential consequence for future competitions is that DOD may accept proposals submitted directly by investigators in jurisdictions that do not participate in EPSCoR but are below the 1.2% eligibility threshold.

C. Program History and Descriptive Statistics

The descriptive statistics presented below focus on the DEPSCoR program beginning with the FY 1993 competition, unless otherwise stated.

Between 1993 and 2008, a total of 729 DEPSCoR research awards have been made, with total programmatic funding of \$243 million.⁷ As shown in Figure S-1, funding and number of awards peaked in FY 2000, followed by a substantial decline through FY 2007. The FY 2008 program represented a departure from previous years, with funding returning to FY 2002–2003 levels (not including effects of inflation). To put the program in perspective, DEPSCoR funding in 2008 represented approximately 0.25% of total DOD research (6.1, 6.2) funding⁸ and less than 0.1% of total federal research funding to universities.⁹

A total of 27 U.S. states and territories have been eligible to participate in DEPSCoR between 1995 and 2008 (see Table S-1).¹⁰ Fourteen states plus Puerto Rico were eligible for all 14 competitions between 1995 and 2008. Four states (Alabama, Hawaii, Mississippi, and New Mexico) were eligible at some point during those 14 competitions but became ineligible when their share of S&E R&D funding increased to the point where they exceeded the eligibility threshold. Two states (South Carolina and Louisiana) were originally eligible for the program, became ineligible for several years, and then reentered the program because their funding levels

⁷ Including the \$7 million appropriated in FY 1991 and \$10 million in FY 1992, total programmatic funding has been \$260 million.

⁸ Fiscal year 2008 DOD 6.1 spending of \$1.78 billion and 6.2 spending of \$5.06 billion. Office of the Under Secretary of Defense (Comptroller), “RDT&E PROGRAMS (R-1): Department of Defense Budget, Fiscal Year 2009” February 2008, page III. Accessed at http://www.defenselink.mil/comptroller/defbudget/fy2009/fy2009_r1.pdf; last accessed, October 8, 2008.

⁹ The most recent data on federal funding to universities is from FY 2006; total funding to universities was nearly \$28.7 billion. National Science Foundation, “Federal S&E Obligations to Academic Institutions Reach New Highs in FY 2006 but Fail to Keep Up with Inflation”, NSF 08-316, October 2008, page 1. Accessed at <http://www.nsf.gov/statistics/infbrief/nsf08316/nsf08316.pdf>; last accessed October 8, 2008.

¹⁰ Investigators in Missouri, which was only eligible in the 1993-1994 competition, won six awards.

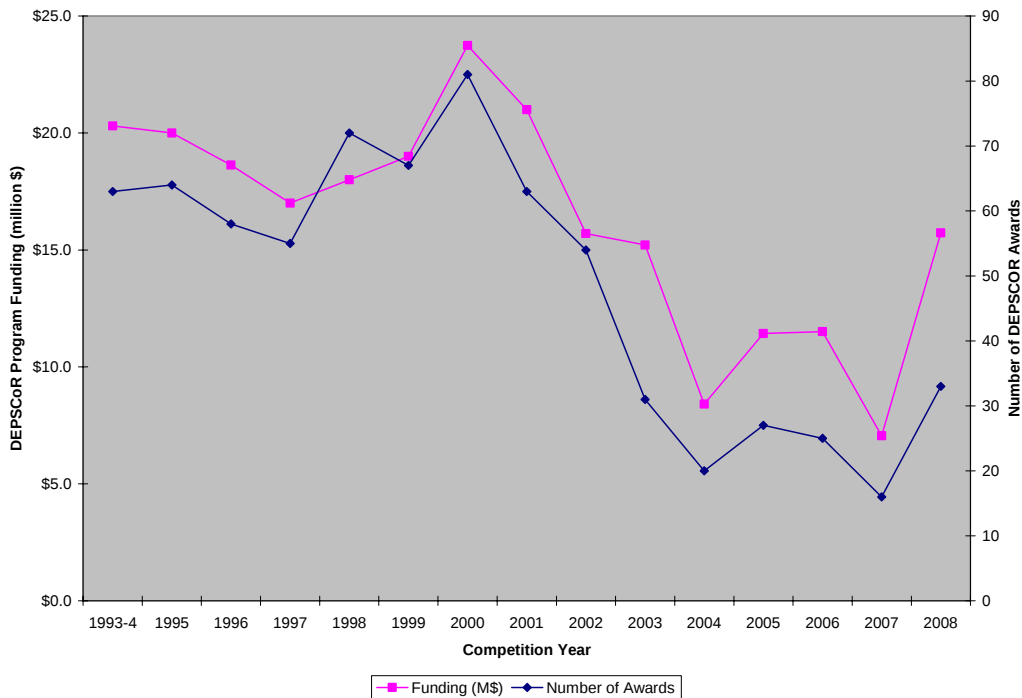


Figure S-1. Number of Research Awards and Program Funding, by Competition

Sources: DEPSCoR programmatic database and IDA database of DEPSCoR awards

Note for Figure S-1: "Program funding" includes co-funding from services' core research funds to DEPSCoR proposals.

returned to below the eligibility threshold. The remaining seven states and the U.S. Virgin Islands became eligible for DEPSCoR subsequent to the 1995 competition due to changes in eligibility for the NSF EPSCoR.

As discussed in Volume II of this report, Congress has recently authorized DOD to accept applications from jurisdictions that fall below the 1.2% threshold but do not participate in EPSCoR. This means that an additional 12 states and territories (American Samoa, Arizona, Commonwealth of the Northern Marianas, Connecticut, Colorado, Guam, Indiana, Iowa, Minnesota, Missouri, Oregon, and Wisconsin) may become eligible in future competitions.

Investigators from institutions located in 27 of the 28 eligible jurisdictions (all but the U.S. Virgin Islands) have won DEPSCoR awards in at least one competition since 1993. As shown in Figure S-2, the distribution of awards by jurisdiction has not been even. Five states (Montana, Alabama, Oklahoma, Nebraska, and South Carolina) have won 35% of all DEPSCoR awards, with the next five states (Wyoming, West Virginia, Kansas, Arkansas, and Kentucky) winning another 25% of awards. At the other end of the distribution, five states and territories (Tennessee, New Mexico, Rhode Island, Hawaii, and the U.S. Virgin Islands) have won fewer than 2% of DEPSCoR awards.

Table S-1. Eligibility for DEPSCoR, by Jurisdiction: FY 1995–2008 Competitions

Jurisdiction	Fiscal Year													
	95	96	97	98	99	00	01	02	03	04	05	06	07	08
Alabama														
Alaska														
Arkansas														
Delaware														
Hawaii														
Idaho														
Kansas														
Kentucky														
Louisiana														
Maine														
Mississippi														
Montana														
Nebraska														
Nevada														
New Hampshire														
New Mexico														
North Dakota														
Oklahoma														
Rhode Island														
South Carolina														
South Dakota														
Tennessee														
Vermont														
West Virginia														
Wyoming														
Puerto Rico														
Virgin Islands														

Source: IDA analysis of DEPSCoR Broad Agency Announcements (BAAs) and DOD DEPSCoR press releases

Note for Table S-1: Red cells denote years in which jurisdictions were not eligible, and blue cells denote years in which states were eligible.

Note for Table S-1: Missouri, which was eligible only in the 1993–1994 competition, was not included in the table.

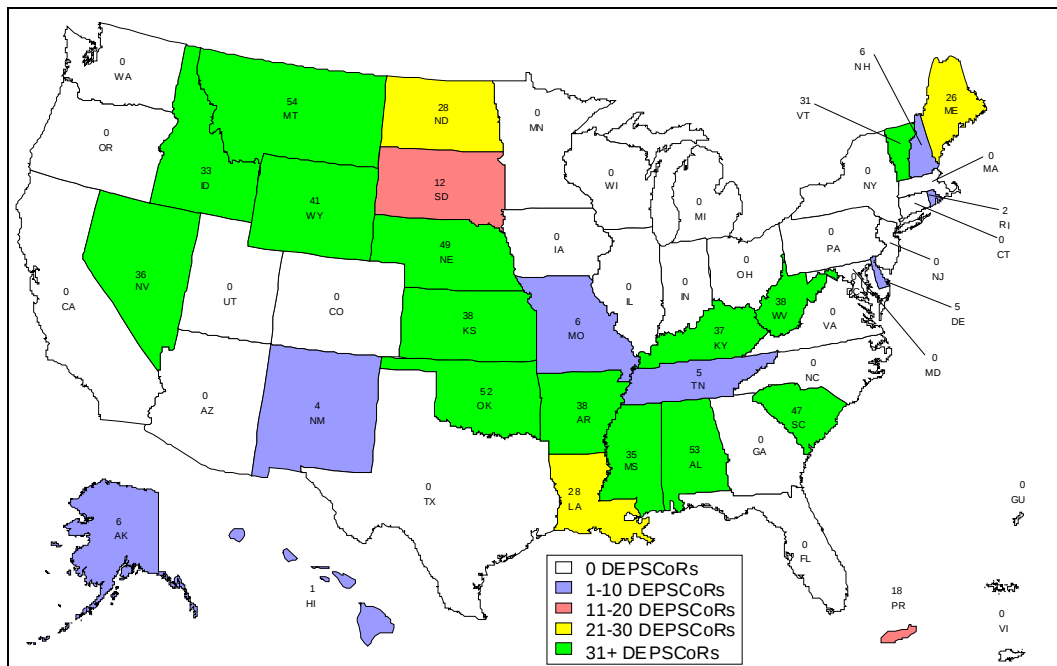


Figure S-2. Distribution of DEPSCoR Research Awards, by Jurisdiction

Source: IDA DEPSCoR awards database

In most of the states that received large numbers of DEPSCoR awards, a single institution has accounted for the bulk of the awards. Table S-2 shows the number of DEPSCoR awards won by investigators from institutions in each of the top 10 states (by total number of awards). In five of these states (Montana, Nebraska, Wyoming, West Virginia, and Arkansas), a single public institution accounts for more than 85% of awards made to that state (Montana State University, University of Nebraska-Lincoln, University of Wyoming, West Virginia University, and the University of Arkansas-Fayetteville, respectively). In fact, 28% of all DEPSCoR awards were won by investigators from those five institutions. Overall, three or fewer institutions account for all awards ever received by 20 of the 27 states and territories that have won awards. Only in Alabama, Mississippi, and Louisiana have had DEPSCoRs awarded to investigators at more than four institutions (see Figure S-3).

The 729 DEPSCoR awards have been made to 546 individual principal investigators. As shown in Figure S-4, 425 investigators (78%) have won a single DEPSCoR award, while 121 investigators (22%) have received multiple awards. The maximum number of awards held by a single investigator is 8, and 42 investigators have won 3 or more awards. In terms of awards, 58% of the awards were given to investigators who won only a single award while 42% of the awards went to multiple award winners.

**Table S-2. Distribution of DEPSCoR Awards
in the FY 1993–2008 Competitions in the Top 10 States, by Institution**

State	Institution	Number of Awards	Percentage of the State's Awards
Montana	Montana State University	50	93
	University of Montana	4	7
Alabama	Auburn University	20	38
	University of Alabama-Birmingham	14	26
	Alabama A&M University	7	13
	University of Alabama-Huntsville	6	11
	University of Alabama-Tuscaloosa	5	9
	University of South Alabama	1	2
Oklahoma	University of Oklahoma-Norman	24	46
	Oklahoma State University	18	35
	University of Tulsa	6	12
	University of Oklahoma Health Sciences Center	4	8
Nebraska	University of Nebraska-Lincoln	47	96
	University of Nebraska-Omaha	2	4
South Carolina	University of South Carolina	25	53
	Clemson University	22	47
Wyoming	University of Wyoming	41	100
West Virginia	West Virginia University	33	87
	Marshall University	5	13
Kansas	Kansas State University	18	47
	Wichita State University	10	26
	University of Kansas	10	26
Arkansas	University of Arkansas-Fayetteville	33	87
	University of Arkansas for Medical Sciences	3	8
	University of Arkansas-Little Rock	2	5
Kentucky	University of Kentucky	19	51
	University of Louisville	16	43
	Western Kentucky University	2	5

Source: IDA DEPSCoR awards database

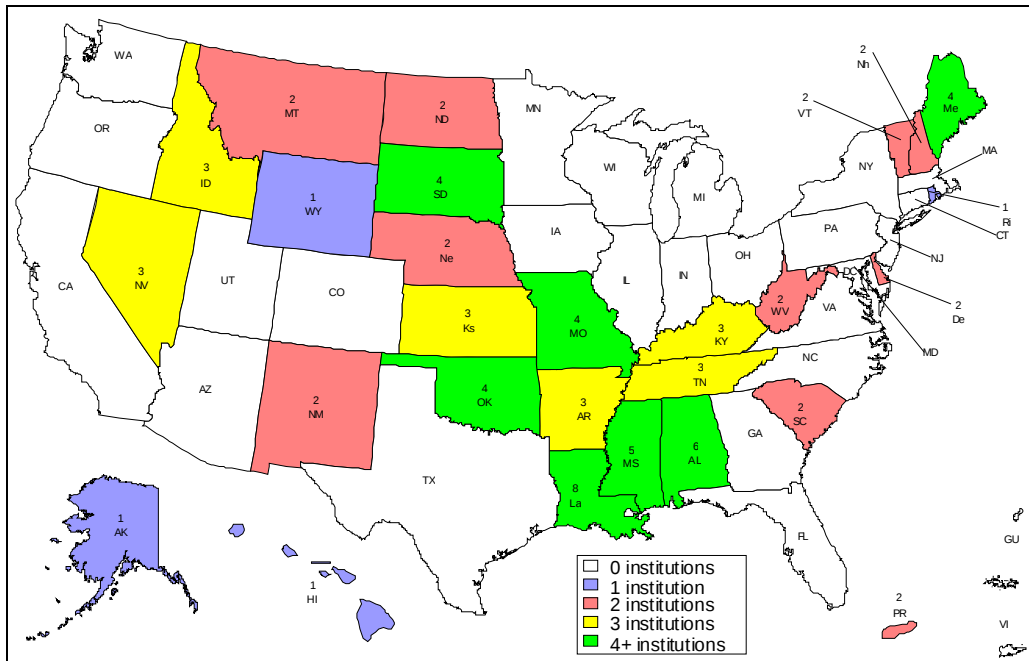


Figure S-3. Number of Institutions Receiving DEPSCoR Awards, by Jurisdiction

Source: IDA DEPSCoR awards database

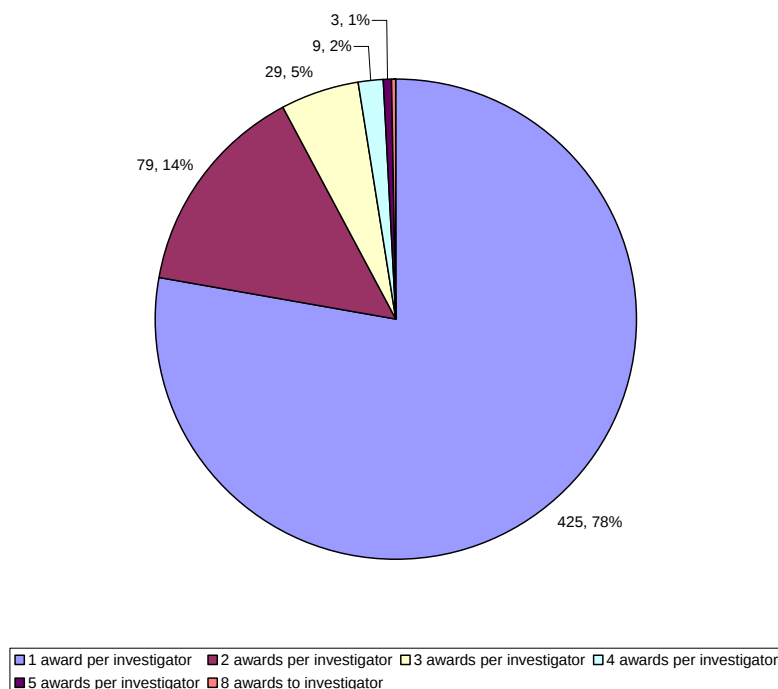
D. Assessment Findings and Recommendations

1. Section 1. Assessment of Tangible Results and Progress

The first charge for this assessment was to describe and assess tangible results and progress toward the objectives of DEPSCoR. Specific questions addressed include whether the DEPSCoR states' share of DOD funding for defense-related R&D to institutions of higher education increased over the lifetime of the program¹¹ and whether any observed changes can be attributed to the DEPSCoR program.

NSF surveys of federal S&E R&D funding to universities were used as the source for information on distribution of DOD research (6.1 and 6.2) dollars by jurisdiction and institution

¹¹ The assessment focused on trends in DOD funding to universities in DEPSCoR states rather than on all federal funding because it was assumed that the most pronounced, and thus the most easily measured, impact of DEPSCoR would be on DOD funding. DOD R&D funding to universities in 2005 was approximately 10% of total federal university R&D funding. Any increase detected in overall funding would more likely be subject to many more variables, including those attributable to the EPSCoR programs of other agencies. The NSF EPSCoR program and National Institutes of Health (NIH) EPSCoR-like programs are each approximately one order of magnitude larger than the DOD EPSCoR program.



**Figure S-4. DEPSCoR Investigators (N = 546) by
Number of Awards Won: FY 1993–2008 Competitions**

Source: IDA DEPSCoR awards database

Note for Figure S-4: The number before the comma (e.g., 425) is the number of investigators represented by the slice, and the number after the comma (e.g., 78%) is the percentage of total investigators represented by the slice.

of higher education.¹² At the time of the assessment, these NSF data were available for the years 1992–2005 only. DOD provided complete DEPSCoR funding data by jurisdiction through the 2008 competition, but data on funding by institution were not available for competitions before 2002. All analyses were, therefore, conducted at the state level.

Finding 1-1: The DEPSCoR states' share of non-DEPSCoR DOD S&E funding to universities increased between 1992 and 2005.

When considered as a group, the DEPSCoR states' share of DOD S&E funding to universities (excluding DEPSCoR funding) did increase steadily between 1992 and 2005 (see

¹² NSF, for the survey, defines research as follows: "Research is systematic study directed toward fuller scientific knowledge or understanding of the subject studied. Research is classified as either basic or applied according to the objectives of the sponsoring agency. In basic research, the objective of the sponsoring agency is to generate knowledge of the underlying foundations of phenomena and of observable facts without specific applications toward processes or products in mind. In applied research, the objective of the sponsoring agency is the creation of knowledge or understanding necessary to determine the means by which a recognized and specific need may be met." http://www.nsf.gov/statistics/nsf07333/content.cfm?pub_id=3795&id=4. The survey's definition of "research," therefore, includes both 6.1 basic and 6.2 applied research.

Figure S-5). These states' share of total DOD S&E R&D funding to universities more than doubled from approximately 7% in 1992 to about 17% in 2005, and similar increases occurred in research (6.1 and 6.2) funding only. The trend was apparent even after excluding from the analysis all formerly eligible states that became ineligible after crossing the 1.2% threshold and those states and territories that were initially ineligible but later became eligible.

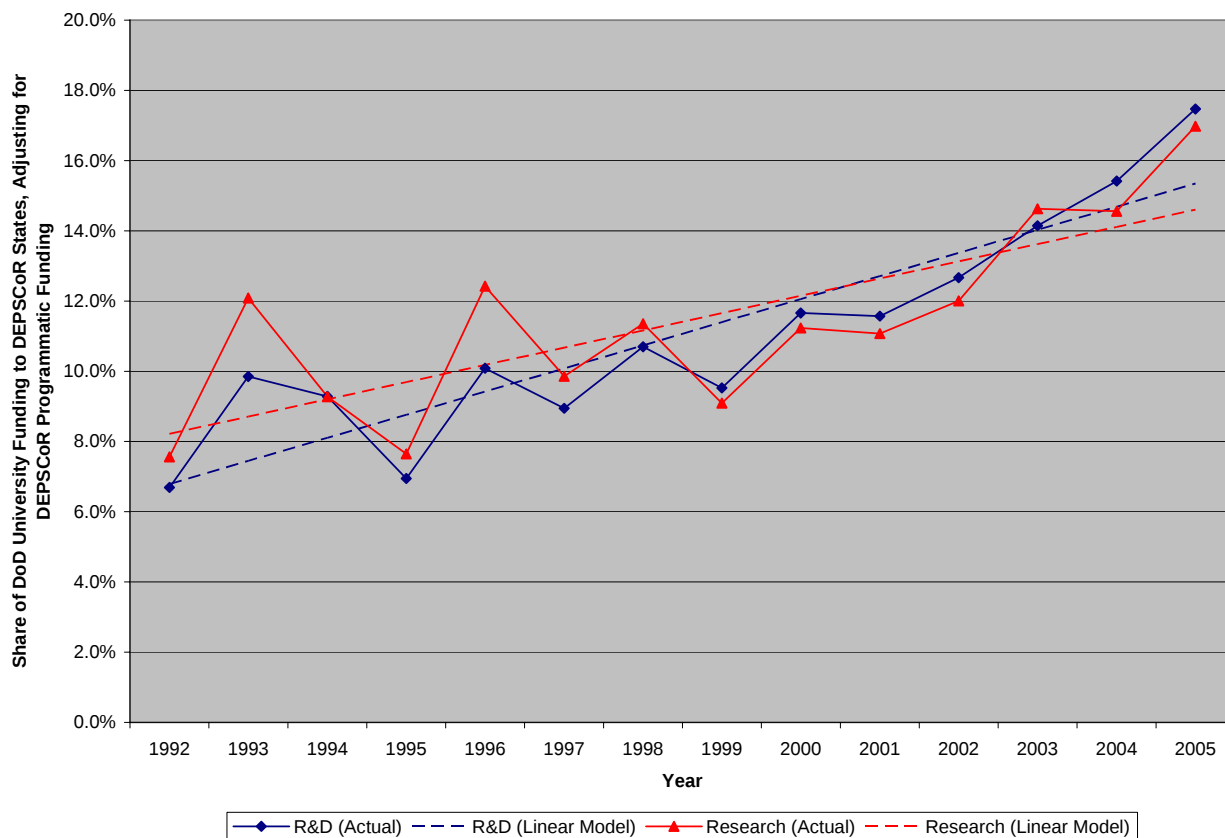


Figure S-5. Results of Linear Regression Models of the Share of DOD University S&E R&D Funding to DEPSCoR-Eligible States: 1992–2005

(Source: IDA analysis of NSF Survey of Federal Science and Engineering Support to Universities, Colleges, and Nonprofit Institutions)

Note for Figure S-5: The dotted lines represent linear regression models applied to the data

Finding 1-2: Looking across all DEPSCoR-eligible states, there was an approximately steady increase in states' shares of non-DEPSCoR DOD funds through 2005 despite variation in program funding levels.

As shown in Figure S-1, DEPSCoR program funding peaked with the 2000 competition after remaining approximately constant between the 1993–1994 and 1999 competitions, and declined sharply after the 2002 competition. DEPSCoR program staff expressed concern that the decline in funding levels may be attenuating the influence of the program. The regression

analyses shown in Figure S-5 did not identify any obvious effects as of 2005, the last year for which funding data were available from NSF. It was not possible to determine, however, whether the cumulative declines in program funding have been having an effect in more recent years (for which comparable data are not yet available through NSF).

Finding 1-3: Fifteen percent of the states that have ever been eligible for DEPSCoR had funding levels above the 1.2% threshold and are not currently eligible for the program.

Of the 27 states and territories that were ever eligible to participate in DEPSCoR since the 1995 competition, four states (15%) were above the 1.2% threshold in 2008 (Alabama, Hawaii, Mississippi, and New Mexico). Alabama and Mississippi were eligible during the early years of the program but exceeded the 1.2% threshold in 2005 and 2003, respectively. Hawaii and New Mexico did not meet the EPSCoR participation requirement until 2002. New Mexico was below the 1.2% threshold for only a single competition (2002), and Hawaii was below the threshold between 2002 and 2006.

a. Section 1a. Operational Use

Finding 1a-1: Two clear examples where DEPSCoR funding led to applications in operational use were identified.

Interviews with DEPSCoR principal investigators (PIs) and “customers” in DOD laboratories and industry identified that Professor Ronald A. DeVore and his collaborators at the University of South Carolina developed a wavelet-based image processing platform in the form of code libraries and various generic defense-specific applications built on this library. These ideas were implemented as a specialized and lean wavelet-based image processing system for navigation in the Tomahawk II missile by programmers at the China Lake Naval Research Station. In addition, Professor Michael Pursley and his collaborators at Clemson University developed the Soldier Level Integrated Communications Environment (SLICE) wideband networking waveforms that have been integrated into the Single Channel Ground and Airborne Radio System (SINCGARS) radio.

b. Section 1b. Expansion of the National Research Infrastructure

This portion of the assessment examined whether DEPSCoR has expanded the national research infrastructure by assessing supported activities and outcomes.

Finding 1b-1: DEPSCoR has supported a variety of activities that might be expected to increase research capacity at supported institutions, but the potential significance of these contributions with respect to national research infrastructure cannot be assessed.

Evidence linking DEPSCoR with a variety of activities and outcomes that have the potential to build research infrastructure at the level of the institution or the individual investigator is described below. However, in the absence of a Congressional definition, it could not be determined whether the sum of these contributions truly expanded the “national research infrastructure.”

DEPSCoR has brought new investigators into defense-related basic research, but only one service possesses data that allow analyses that quantify the extent of new investigator participation. Data provided by the Army Research Office (ARO) on proposals funded between 1980 and 2008 suggest that most Army-funded DEPSCoR awardees (82%) had not previously received funding from ARO. Fifty-two investigators won ARO DEPSCoR awards and then subsequently won their first non-DEPSCoR award from ARO, representing 8% of all ARO-supported investigators in DEPSCoR-eligible states who won at least 1 non-DEPSCoR award.

Analysis of the DEPSCoR awards themselves reveals that 22% of all DEPSCoR investigators received more than one DEPSCoR award. The percentage of funded investigators in each cohort who were new to the DEPSCoR program fell from more than 75% during the 1997–1999 competitions to below 60% in the 2006–2008 competitions, while the total number of awards per year decreased. This finding suggests that DEPSCoR was drawing more new investigators into defense-related research during the early years of the program.

Successful competition for Multidisciplinary University Research Initiative (MURI) awards by former DEPSCoR PIs appears to have been limited. Only 4 DEPSCoR PIs (less than 1%) won a MURI award subsequent to or in the same year as their first DEPSCoR award, and 2 of these investigators were identified from other sources as having received non-DEPSCoR DOD funding in advance of their first DEPSCoR award.

Army (the only service for which publication databases were available) DEPSCoR awards have contributed to publications and patents. ARO data (drawn by ARO from DEPSCoR progress and final reports) indicate that DEPSCoR awards in the 1999–2005 cohorts (a total of 136 awards) contributed to an average of approximately 3 peer-reviewed journal publications per DEPSCoR award. If DEPSCoR awards from the other services and other cohorts produced publications at a similar rate, the program may have contributed to approximately 2,000 publications since research-oriented competitions began in FY 1993. Five U.S. patents and 21 U.S. patent applications were attributed to the same 136 ARO DEPSCoR awards. Again

assuming that the rate for these 136 awards can be generalized to the other services and cohorts, approximately 100 patents and patent applications may have resulted from DEPSCoR-supported research.

DEPSCoR awards have supported training for graduate students and postdoctoral fellows. Data on the number of graduate students and/or postdoctoral fellows has also been collected systematically by only two services (ARO and the Office of Naval Research (ONR)). Interviews with DEPSCoR PIs and department chairs at DEPSCoR institutions, supplemented by the ARO and ONR data, suggest that a 3-year DEPSCoR award funded an average of 1 full PhD and more than 1 Master's degree and supported 2 postdocs. For departments that received multiple DEPSCoR awards, these awards may have accounted for a substantial fraction of available training funds, but data on funding sources for training are not available at the institutional level to test this hypothesis.

Evidence indicates that very few National Defense Science and Engineering Graduate (NDSEG) fellowship winners were trained at DEPSCoR institutions, making connections between the two programs unlikely. Of the 200 NDSEG fellows in the FY 2008 cohort, only 4 of these fellows (0.5%) are being trained at DEPSCoR-eligible institutions.¹³

DEPSCoR awards have supported purchase and maintenance of equipment. DEPSCoR funds are known to have been used to purchase and maintain equipment and for other physical infrastructure, but data on the quantity and types of physical infrastructure built and/or maintained do not appear to have been collected systematically by any service. There was no correlation between DEPSCoR funding and Defense University Research Instrumentation Program (DURIP) awards won at institutions in DEPSCoR-eligible states, although there were some institutions that received a large number of DEPSCoR awards and few DURIP awards (and vice versa). DEPSCoR is therefore likely to have been a more important funder of physical infrastructure for defense-related research at these institutions.

DEPSCoR awards have supported research collaborations. A set of "success stories" assembled by the state EPSCoR committees provide anecdotal evidence that DEPSCoR support enabled investigators to create or strengthen collaborations with industry, DOD laboratories, and university investigators. However, data on the number or potential significance of research collaborations supported by DEPSCoR do not appear to have been collected systematically by any service.

¹³ In contrast, DEPSCoR-eligible states include 20% of the U.S. population and 25% of the institutions ranked by the Carnegie Foundation as "Very High" or "High" research universities in 2005.

2. Section 2. Consistency of Activities with Legislative Mandate

This portion of the assessment aimed to determine whether DEPSCoR activities are consistent with the statute authorizing the program. These analyses were based on the text of the authorizing legislation and the DEPSCoR BAAs.

Finding 2-1: The activities supported by DEPSCoR have been consistent with the authorizing statute but represent a subset of the activities permitted by the statute.

The legislative mandate authorizes the DOD to engage in a broader set of activities than those activities that are currently solicited through the DEPSCoR BAAs. The legislation explicitly allows the DOD to fund research and infrastructure grants, financial assistance for graduate students, and any other activities considered necessary to meet program goals. The program funds research awards that have infrastructure and training components. The authorizing legislation, however, does not limit the program to this approach, and other financial assistance mechanisms, such as fellowships, appear to be allowed.

The funded proposals generally involve defense-related basic research. However, the authorizing legislation does not restrict the program to only defense related research or to only basic research.

The authorizing legislation does not make a distinction between funding private or public universities. Virtually all the awards, however, have been won by researchers at public universities. For example, in the 10 states that have received the most DEPSCoR grants from 1993 to 2008 (see Table S-2), only one school receiving DEPSCoR funding was private—the University of Tulsa, which received 6 awards (or 1.3% of the total number of DEPSCoR awards to these states).

Finding 2-2: DEPSCoR eligibility requirements have been consistent with the authorizing statute.

Consistent with the authorizing legislation, two state-level criteria have effectively determined eligibility since 1997:

1. Participation in the NSF EPSCoR program
2. Receipt, in the most recent 3 years for which data are available, of less than 1.2% of DOD S&E R&D obligations to institutions of higher education.

The legislation also includes a third criterion: that “the state has demonstrated a commitment to developing research bases in the state and to improving S&E research and education programs at institutions of higher education in the state.” No evidence was found that DOD has attempted to exclude states that would otherwise be eligible by the first two criteria for failure to

demonstrate sufficient commitment as required by the third criterion. One state (Alabama) asked for clarification regarding the determination that it was no longer eligible for the DEPSCoR program in advance of the 2005 competition since it exceeded the 1.2% threshold.

3. Section 3. Effectiveness of Program Elements

This portion of the assessment examined whether the various program elements are working to support effective and efficient program execution. Specific program elements examined include the processes for review of proposals, post-award management, and administration. Sources of data for this section included the DEPSCoR BAAs and discussions with DEPSCoR program managers at the Office of the Secretary of Defense (OSD) and the individual services.

Finding 3-1: DOD processes for review of proposals have been partially but not fully consistent with the program mandate to increase competitiveness for research funding.

According to the legislative mandate, DEPSCoR is primarily intended to increase the ability of institutions of higher education in eligible states to compete for federal research funding. Following submission by the state EPSCoR committees, DEPSCoR proposals are evaluated by the services relative to four primary criteria.¹⁴ Two of those primary criteria focus on the capacity-building potential of the proposal. One assesses the potential to train students, and the other assesses the potential to advance the research infrastructure goals of the university or state. The other two primary criteria, however, emphasize the *current* capabilities and experience of the PIs and the scientific merit of the proposed research. By focusing on current capabilities and scientific merit rather than future potential, the second pair of primary criteria suggest that investigators in eligible states who are already more experienced than their peers may fare better in the review process than investigators who have the potential to be competitive but who have not yet had an opportunity to prove themselves.

Finding 3-2: DOD has not established a formal DEPSCoR post-award management process intended to increase future competitiveness of awardees, but DOD program managers do serve as mentors and facilitators for DEPSCoR awardees.

The DEPSCoR awards are not managed by DOD services or part of DOD as a discrete portfolio. As with most DOD research awards, DEPSCoR awards are assigned to the portfolios of DOD program managers by subject area. These program managers, as part of their standard

¹⁴ There are also three secondary criteria: (1) the qualifications, capabilities, experience, and past research accomplishments of the proposed PI, team leader, and other key personnel who are critical to achieving the objectives of the proposal; (2) the proposed involvement and interaction with DOD or other federal laboratories, industry, or other existing research centers of excellence; and (3) the realism and reasonableness of cost, cost sharing, and availability of funds.

practices for management of research awards, work with DEPSCoR awardees to foster collaborations and enhance investigators' understanding of defense research priorities. DOD interviewees stated that the program managers do make a particular effort to mentor their DEPSCoR awardees. However, no formal procedures or guidelines encourage or compel program managers to treat DEPSCoR awards differently from any other award in their portfolios.

Finding 3-3: Available data on DEPSCoR program activities and outcomes are insufficient for monitoring and evaluation purposes.

Processes for collecting data on DEPSCoR program activities are not consistent across the services. While the Army collects the most data (including information on participation, publications, and patents), no service systematically collects information on critical program outcomes such as additional DOD research grants made to awardees and their institutions subsequent to DEPSCoR funding. This lack of consistent program data frustrates attempts at retrospective program assessment and also precludes prospective monitoring of program outcomes that could facilitate adaptive program management.

4. Section 4. Activities of State Committees

This portion of the assessment described and assessed past and ongoing activities of the state EPSCoR committees with respect to DEPSCoR. Specific issues examined included the organization of these committees and their roles in various DEPSCoR processes, such as strategic planning, review of proposals, and coordinating matching funds.

The most important data source for this portion of the assessment was a data call issued by the Coalition of Experimental Program to Stimulate Competitive Research/Institutional Development Award (EPSCoR/IDeA) states (the organization of the state EPSCoR committees) to member committees. The data call asked several open-ended questions regarding current and historical activities. EPSCoR committees from 13 of the 23 states eligible for DEPSCoR as of the 2008 competition responded to the call, including all but 2 of the 15 2008-eligible states with the largest number of DEPSCoR awards. For state committees that did not respond, the only available source of data on committee activities was the anecdotal information contained in the state-level executive summaries from the 2007 and 2008 competitions. Given the small number of eligible states and the variable quality of the available data (even for those state committees who did respond to the data call), it was not possible to analyze the effect of state-level practices on supporting the achievement of the objectives of the program.

Finding 4-1: State committees prioritized proposals that met state infrastructure development goals and reflected the mission/research needs of DOD, but committee processes varied widely from state to state.

While the DEPSCoR-enabling legislation does not explicitly direct the processes by which state committees identify proposals for submission to DOD, state committees typically aimed to submit proposals that were relevant to state infrastructure and capacity-building priorities and also reflected DOD's mission or research needs. Of the committees that responded to the data call, all but one mentioned the use of a pre-proposal, white paper, or letter of intent as an early or initial step in the proposal process. The most common reason given for including this step was to ensure alignment of proposals with DOD goals. Most state committees use external panels for peer review of proposals, and these panels may include members from outside the state.

The state committees are also responsible for coordinating DEPSCoR matching funds. Strategies to identify sources for matching funds varied widely by state, institution, and project. Some states reported relying heavily on the applicants' home institutions to meet the matching funds requirement, while other states sought funding from state government sources or private sector donors.

State EPSCoR committees also vary in how responsibility for DEPSCoR planning and coordination is delegated. In some states, the entire EPSCoR committee participates in DEPSCoR planning. In other states, EPSCoR committees delegate responsibility to a DEPSCoR subcommittee. A third group of state EPSCoR committees appoints a separate DEPSCoR planning committee comprised of members who are not part of the EPSCoR committee. Regardless of organization, however, most committees facilitate coordination of DEPSCoR proposals with other EPSCoR programs.

A small number of committees limit the number of research proposals that can be submitted to DEPSCoR by any one university. Committees also differ in whether and how they facilitate connections between university investigators and DOD program staff or in forming collaborations among university researchers during the pre-proposal process.

5. Section 5. Advantages and Disadvantages of Institution-Based and State-Based Formulae for Determining Eligibility

This portion of the assessment addressed the advantages and disadvantages of institution-based approaches and state-based approaches for determining program eligibility, with particular reference to supporting defense missions and expanding the nation's defense research infrastructure. Although a variety of possible state- and institution-based formulae could potentially

be implemented, the assessment focused on comparing the current state-based formula with an institution-based criterion based on a maximum threshold for DOD S&E research funding.¹⁵ Since the legislative charge for the assessment does not specify how “expanding the nation’s defense research infrastructure” should be interpreted, the assessment considered advantages and disadvantages using a variety of possible interpretations.

Finding 5-1: Even a relatively low institution-based threshold of \$5 million would result in a net increase in the number of eligible institutions while excluding some currently eligible institutions.

Since the number of universities located in DEPSCoR-eligible states is small relative to the number of universities in all other states (i.e., 360 universities received DOD research funding in FY 2005, of which 77 or 21% were in states eligible for the 2008 competition), substituting even a relatively low institution-based threshold for maximum DOD research funding for the current state-based formula would substantially increase the total number of institutions eligible to participate in the program. Some institutions in currently eligible states that have high levels of DOD funding would become ineligible under this scenario, but more institutions in currently ineligible states that have low levels of DOD funding would become eligible. Based on 2005 NSF data, an institution-level threshold of \$5 million per year in DOD research funding would result in a net increase of 192 institutions.^{16,17} Considering only those institutions ranked by the Carnegie Foundation as “Very High” or “High” research universities in 2005, 121 institutions would be eligible under an institution-based threshold of \$5 million as compared with 38 institutions in states that were DEPSCoR eligible in the 2008 competition. Assuming that application rates would be similar under an institution-based formula, an expanded pool of eligible applicants would likely increase the total number of DEPSCoR proposals submitted to the states or to DOD. However, since nothing can be known in advance about the quality or subject matter of the proposals that would be received from the newly eligible institutions relative to the proposals that would have been received from the institutions rendered ineligible, the effect of such a change on the DEPSCoR program’s ability to support defense missions cannot be determined.

¹⁵ State- and institution-based alternatives are not mutually exclusive. Formulae that include both institution and state-based components are possible. Formulae that are neither state based nor institution based might also be worthy of consideration. For example, eligibility could be determined at the level of the individual investigator.

¹⁶ Twelve of the 77 institutions in currently eligible jurisdictions would become ineligible, but 204 institutions in other jurisdictions would become eligible.

¹⁷ Analyses were limited to only those institutions that had non-zero DOD research funding in 2005 because these institutions were considered the most likely to participate if eligible. Including institutions that do not currently receive any funding from DOD would vastly increase the number of potentially eligible institutions.

Finding 5-2: If “expanding the nation’s defense research infrastructure” is interpreted to include increasing equity in funding among states or achieving state-level infrastructure goals, a state-based formula would be advantageous.

One advantage of the current state-based formula for eligibility is that it harnesses the state EPSCoR committees to coordinate infrastructure and capacity-building at the state level. Under the DEPSCoR program as managed through the FY 2008 solicitation, states identify their own capacity-building priorities and carry out strategies to meet them. Examples of capacity-building priorities that might require coordination at the state level include collaborations across multiple institutions or with external stakeholders such as industry or DOD facilities. Similarly, if the intent of “expanding the nation’s defense research infrastructure” is to increase the competitiveness of historically-underrepresented states, eligibility should be determined at a state level.

Finding 5-3: If “expanding the nation’s defense research infrastructure” is interpreted to include involving new investigators or institutions in defense-related research, an institution-based formula would be advantageous.

If “national research infrastructure” is understood to depend on the total number of investigators at the nation’s universities who are conducting defense-related research or the total number of universities with which such investigators are affiliated, an institution-based formula would likely be advantageous. Such an approach would target programmatic resources toward investigators at institutions that have not historically built relationships with DOD, regardless of the success of investigators at other institutions in their state in competing for DOD research funding.¹⁸ While a state-based approach includes the flexibility to channel DEPSCoR proposals toward historically underrepresented universities or new investigators, the institution-based approach reaches a larger number of universities receiving limited DOD funding than does the current DEPSCoR state-based approach.

6. Section 6. Identification of Mechanisms for Improvement

The final portion of the assessment used all previous analyses and findings to identify mechanisms for improving the management and implementation of DEPSCoR.

¹⁸ In fact, the DOD Research Initiation Program (RIP), which was active during the late 1980s and early 1990s, used an institution-based eligibility criterion to accomplish similar goals.

Finding 6-1: Assuming that the current DEPSCoR objectives and structure remain unchanged, several aspects of implementation could be improved.

The assessment identified three changes that would improve the implementation of the DEPSCoR program in its current form.

Recommendation for Improvement 1: The DOD should change the current process for review of proposals to focus more heavily on investigators' future potential to conduct research rather than on their current research capabilities.

As described in Finding 3-1, two of the four primary criteria used by DOD to evaluate DEPSCoR proposals emphasize the current capabilities and experience of the PIs and the scientific merit of the proposed research rather than the proposed project's potential to enhance future research capacity and competitiveness. Applicants should be required to describe in their application materials how participation in the DEPSCoR program would enable them to engage in future research trajectories that increase their probability of receiving future non-DEPSCoR funding, including current capabilities that will be enhanced by the proposed project. It may also be useful to place a limit on the number of DEPSCoR awards for which a single investigator can apply to ensure a robust supply of awards to investigators whose research experience is more limited.

Recommendation for Improvement 2: DOD program managers should be formally encouraged to serve as mentors and facilitators for DEPSCoR investigators seeking to engage in further defense-related research.

As described in Finding 3-2, no set of post-award management guidelines or procedures pertain only to DEPSCoR awards. However, recognizing that many DEPSCoR investigators are new to the defense research community, some program managers who have DEPSCoR awards in their portfolios make a noteworthy effort to serve as mentors. The possibility that DEPSCoR awardees may require particular attention in this regard should be officially acknowledged, and program managers should be formally encouraged to actively manage DEPSCoR awards to maximize capacity-building potential. Effective management can be further enhanced by documenting and sharing best practices across research portfolios and services.

Recommendation for Improvement 3: The DOD should create data systems that will allow systematic tracking of DEPSCoR activities and outcomes.

As described in Finding 3-3, processes for collecting data on key DEPSCoR program activities and outcomes are neither adequate nor consistent across the services. Intensifying and harmonizing data collection processes would likely carry an efficiency cost for the sponsoring agencies up front; however, long-term benefits include streamlined reporting and assessment and

the possibility of active monitoring and adaptive program management. DEPSCoR, although now more than 15 years old, is by title an “experimental program.” Sufficient data are critical to determine whether the experiment has been successful.

Finding 6-2: Certain aspects of the legislative mandate for DEPSCoR are ambiguous, creating potential for misinterpretation of legislative intent.

The legislatively-mandated DEPSCoR objectives are:

- To enhance the capabilities of institutions of higher education in eligible states to develop, plan, and execute science and engineering research that is competitive under the peer-review systems used for awarding federal research assistance
- To increase the probability of long-term growth in the competitively awarded financial assistance that institutions of higher education in eligible states receive from the federal government for science and engineering research.

Two aspects of authorizing language with respect to objectives are worth noting: (1) that both objectives specify that the research *institution* is the level at which competitiveness is to be enhanced and (2) that the program aims to enhance competitiveness for federal research funding in general rather than defense-related research funding in particular. However, the authorizing legislation also specifies that eligibility for DEPSCoR be determined at the *state* level, and, since the Section 264 of the National Defense Authorization for Fiscal Year 1997, in reference to DOD funding levels. Through the 2008 competition, proposals were also required to be submitted through the state EPSCoR committees. Changes to the authorizing language in 2008 suggest that eligibility for future competitions can be determined entirely by state-level DOD funding (thus expanding eligibility to include non-EPSCoR states) and that applications will be accepted directly from investigators as well as through the state EPSCoR committees. The text of the statute leaves ambiguous whether Congress intends DEPSCoR to target competitiveness at the institution or state level and whether the program should focus narrowly on research that is relevant to DOD missions and priorities (and within that focus, whether the program should remain targeted toward 6.1 research as it is currently) or more broadly on increasing the competitiveness of researchers in obtaining all federal R&D funds.

Recommendation for Improvement 4: Congress should re-examine and consider clarifying the DEPSCoR legislative mandate.

To ensure that the program is implemented in a manner that meets current legislative priorities, Congress should clarify whether

- The program is intended to increase competitiveness for federal research funding in general or for particular types of research funding

- The program is intended to fund primarily basic research, primarily applied research, or a combination
- The primary unit at which competitiveness should be enhanced is the institution, state, or other (e.g. individual investigator).

Eligibility criteria, funded activities, and other program elements should be structured in accordance with the program's objectives.

Finding 6-3: As currently implemented, the DEPSCoR program is structured primarily to enhance competitiveness at the level of the individual investigator or small team, although the equipment purchase and training aspects have the potential to enhance competitiveness more broadly within an institution.

As currently implemented, DEPSCoR includes elements that appear to target capacity-building at both the level of the institution (e.g., investigators are allowed and encouraged to support training and purchase of equipment) and at the state (e.g., the state EPSCoR committees play a significant role in screening proposals and coordinating state-level research priorities) level. In terms of basic structure, however, DEPSCoR supports individual or small-group research projects and can therefore be understood to primarily target capacity-building at the level of the *individual*. While it might be argued that institutional competitiveness depends on individual competitiveness and state competitiveness depends on institutional competitiveness, these dependencies are neither straightforward nor self-evident.

Recommendation for Improvement 5: Once the DEPSCoR objectives have been clarified, redesign the program with a clear and focused strategy for enhancing competitiveness at the relevant level.

Discussions about how to redesign the DEPSCoR program would benefit from examining strategies pursued by other programs designed to enhance research competitiveness in historically underrepresented states and institutions. The assessment identified three programs that might serve as potential models for DEPSCoR.

Program #1: State-level Model: Research Infrastructure Improvement (RII)

The NSF EPSCoR RII award provides funds to institutions in eligible states to support research capacity-building activities (e.g., start-up funding for new faculty and retention funding for existing faculty, collaboration development, training, equipment purchase) at the state level.

Only one RII award per EPSCoR state is made, and institutions are eligible to participate as designated by the state EPSCoR committee. Activities must be linked to the EPSCoR state's State Science and Technology Plan. The RII program is administratively similar to the

DEPSCoR program as it has been implemented through the 2008 competition because it relies upon the EPSCoR state committees to determine capacity-building priorities and coordinate proposals at the state level. The RII awards are also substantially larger than the DEPSCoR awards and are managed separately from the NSF portfolio of research awards.

In fact, if the DEPSCoR program objectives were clarified in a manner that suggested that the RII model would be appropriate, DOD might consider exploring options for collaboration with NSF, perhaps by providing co-funding to the RII program to support proposals of joint interest to DOD and NSF. Many of the current RII awards support capacity-building in research areas of potential interest to DOD, which suggests a potential for synergy. Aside from reducing administrative costs to DOD and the EPSCoR committees, collaboration with RII would provide DOD program managers opportunities to forge relationships at a high level with research institutions that could form the basis for future research proposals to DEPSCoR and to other DOD research programs.

Program #2: Centers Model: NIH Centers of Biomedical Research Excellence (COBRE)

The NIH COBRE program supports relatively large awards made to institutions in NIH IDeA states (analogous to the EPSCoR states) with the intention of funding teams of researchers who have excellence in a particular discipline or area of research. The centers of excellence (“centers”) model is based on the assumption that bringing together a critical mass of investigators, research, and infrastructure at a single institution can lead to synergies. Activities supported by COBRE include (1) funding for research projects in similar or complementary fields, (2) career development funding for junior faculty, (3) purchase and maintenance of research equipment, and (4) funding for organizational infrastructure. Each center must have an overall research plan that explains how the research projects, mentoring of junior investigators, and shared facilities funded by the COBRE award cohere into a single center of excellence. Centers are also required to develop a plan and set of milestones that identify how COBRE-participating investigators will transition to support from traditional NIH grant mechanisms.

The centers model is administered differently from the current DEPSCoR program. Applications are submitted directly by the institutions, with no state-level coordination analogous to the role played by the EPSCoR state committees. The awards are also substantially larger than the current DEPSCoR awards.

Program #3: Investigator-level Model: Academic Research Enhancement Award (AREA) Program and the Research Initiation Program (RIP)

The NIH AREA program and the former DOD RIP are examples of programs designed to expand capacity at the level of the individual investigator. AREA funds meritorious research proposals from investigators at institutions that have been traditionally underrepresented in biomedical research.¹⁹ DOD created the RIP program in FY 1989 in response to a Congressional mandate to broaden participation by universities in the DOD University Research Initiative (URI). Investigators were eligible to submit proposals if their universities received less than \$4 million in DOD support (in FY 1989 and 1990) or \$3 million in support (in FY 1991). In FY 1990, the average award size was \$316,000.

The AREA/RIP model is similar to the current DEPSCoR model in that both aim to build capacity by making relatively small research awards to individual investigators at underrepresented institutions. Allowing for inflation, the RIP awards were roughly the same size as DEPSCoR awards. The AREA awards are smaller than the current DEPSCoR awards, and, unlike DEPSCoR, they are intended to support research activities only, rather than support a mix of research, training, and infrastructure-building. Also unlike the current DEPSCoR, AREA and RIP both use an institution-based criterion for eligibility. AREA also limits the number of times an individual investigator can be funded and the additional support that eligible investigators can receive from NIH, thus ensuring that the program continues to draw investigators who are new to NIH.

¹⁹ Specifically, eligibility is limited to institutions that have received no more than \$3 million per year in both direct and facilities and administrative (F&A)/indirect costs from NIH in 4 or more of the last 7 years. AREA awards are currently capped at \$150,000 in direct costs for the entire 3-year award period.

Glossary

§	Section
AREA	Academic Research Enhancement Award
ARO	Army Research Office
BAA	Broad Agency Announcement
COBRE	Centers of Biomedical Research Excellence
DEPSCoR	Defense Experimental Program to Stimulate Competitive Research
DOD	Department of Defense
DURIP	Defense University Research Instrumentation Program
EPSCoR	Experimental Program To Stimulate Competitive Research
FFRDC	Federally Funded Research and Development Center
FY	Fiscal Year
H.R.	House of Representatives
IDA	Institute for Defense Analyses
IDeA	Institutional Development Award
MURI	Multidisciplinary University Research Initiative
NDSEG	National Defense Science and Engineering Graduate
NIH	National Institutes of Health
NSF	National Science Foundation
ONR	Office of Naval Research
OSD	Office of the Secretary of Defense
P.L.	Public Law
PI	principal investigator
R&D	research and development
RDT&E	research, development, test, and evaluation
RII	Research Infrastructure Improvement
RIP	Research Initiation Program
S&E	science and engineering
SINCGARS	Single Channel Ground and Airborne Radio System

SLICE	Soldier Level Integrated Communications Environment
U.S.	United States
U.S.C.	United States Code
URI	University Research Initiative

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14. ABSTRACT The DoD's Defense Experimental Program to Stimulate Competitive Research (DEPSCoR) was created by Congress in the Fiscal Year (FY) 1991 DoD appropriation and legislatively authorized in 1994 (National Defense Authorization Act for Fiscal Year 1995, P.L. 103-337, §257; Oct. 5, 1994, 108 Stat. 2705). The program is authorized to award research grants and graduate traineeships in support of two objectives: (1) to enhance the capabilities of institutions of higher education in eligible States to develop, plan, and execute science and engineering (S&E) research that is competitive under the peer-review systems used for awarding federal research assistance and (2) to increase the probability of long-term growth in the competitively awarded financial assistance that institutions of higher education in eligible States receive from the Federal Government for S&E research. Section 241 of the FY 2008 Defense Authorization required an assessment of the DEPSCoR program. The assessment includes a description of the tangible results and progress toward the program objectives and an evaluation of the activities undertaken by the DoD and the State planning committees. This volume contains summary findings and recommendations for improvement of the DEPSCoR program.					
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