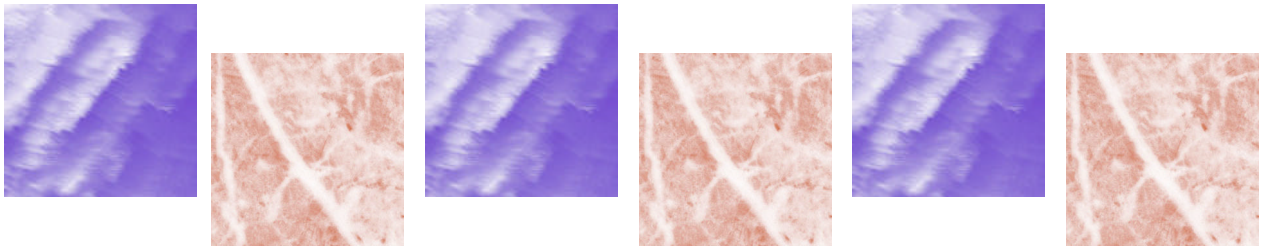
NSF's Program for Persons with Disabilities:

A Decade of Innovation and Progress



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Contents

"Despite many notable efforts to date, students with disabilities continue to be underrepresented in science, technology, engineering, and mathematics education and career development opportunities, making the National Science Foundation's Program for Persons with Disabilities and its mandate not only timely but also essential."

—Internal Report to the National Science Foundation by the Division of Human Resource Development, Directorate for Education and Human Resources

Executive Overview

One in five Americans is identified as having some kind of disability. Half of these individuals—24 million citizens—possess a significant disability. However, the broad diversity of this population and the disparity of their conditions have obscured the true magnitude of this constituency and the myriad of obstacles they must face in a world poorly equipped to accommodate them. Despite the laudable progress of Federal legislation such as the Americans with Disabilities Act, the 1996 Telecommunications Act, the Section 508 guidelines for government agencies, and the tireless efforts of countless individuals and organizations, persons with disabilities represent just 13 percent of the national workforce and, as of 1997, only about 6 percent of the science and engineering labor force. For students with disabilities, the unintended barriers of the mainstream educational system, the paucity of effective educational tools, misdirection of suitable resources, and the lack of effective role models can drastically compromise the participation of such students in higher education and graduate school. This reduction by attrition is particularly evident in courses of study leading to careers in science, technology, engineering, and mathematics (STEM) fields.

A Unique Kind of Federal Support

For nearly ten years, the Program for Persons with Disabilities (PPD) at the National Science Foundation (NSF) has been making a difference in the number of opportunities and resources available to its constituents and beneficiaries. With awards totaling more than $39 million to 92 projects and 56 sponsors representing 30 states and the District of Columbia, the program's investment in the Nation's research, education, and special-needs communities has been formidable and inspiring.

PPD activities are united by two overarching objectives—

- To develop and implement strategies to promote full inclusion of students with disabilities throughout the educational continuum; and
- To increase the number of individuals with disabilities entering careers in science, technology, engineering, and mathematics (STEM).

Although several engineering and biomedical programs seek to develop better assistive technology, and all NSF programs are encouraged to fund activities for making education and research opportunities appropriate for all students (including those with disabilities), the unique focus of PPD highlights the issues endemic to this particular group, which continues to be greatly underrepresented in STEM education and career opportunities.

Today, NSF's Program for Persons with Disabilities is virtually unique among Federal programs in addressing disability issues in education—informing and educating all U.S. citizens, but especially enabling students with disabilities at every education level and attending all types of learning institutions. Reports to NSF show that better than 70 percent of students with disabilities who participate in PPD projects go on to higher education studies, the majority in STEM disciplines.

A Decade of Growth and Commitment

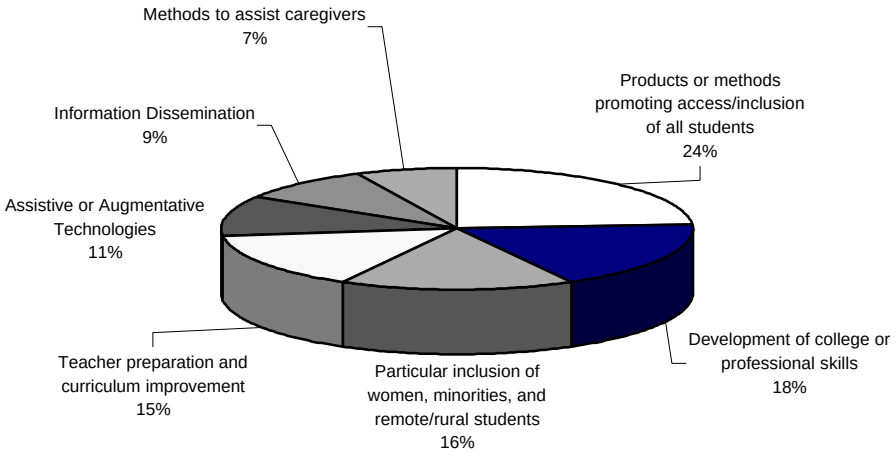
Established in response to the recommendations of national and internal advisory committees to the National Science Foundation's Directorate for Education and Human Resources, PPD's beginnings were modest. Lacking a budget for their new program, PPD staff initially co-funded 15 awards totaling $236,838 in Fiscal Year (FY) 1993. By FY 1997, the program was receiving more than 60 proposals annually. These proposals, representing foundations, corporations, and research and educational institutions in more than 35 states, the District of Columbia, and Puerto Rico, reflected the great interest—and great need—for Federal support of researchers and educators working on disabilities-related issues. Such efforts benefit not only students and professionals with disabilities but, by extension, all persons with disabilities. By FY 1998, PPD projects involved nearly 6,000 participants. Additionally, the program's principal investigators have made presentations at dozens of conferences and distributed thousands of print and electronic materials in the name of community outreach and education. Accordingly, the volume and quality of proposals submitted to the program has continued to increase: In FY 1999, even though PPD's budget had grown to $4.35 million, the program could afford to fund only four of 21 proposals recommended for funding by merit review panels. Despite such financial constraints, by FY 2001 the program had 49 active projects in 24 states.

Historically, PPD has given awards to proposals broadly defined as *experimental projects*, *model programs*, and *information dissemination* projects in disabilities research and education, as well as *facilitation awards*, which seek to directly assist scientists and engineers with disabilities. Beginning in FY 2001, the program's focus included Regional Alliances for Persons with Disabilities in STEM education, a model that builds upon lessons learned from various small but effective projects in PPD as well as in other successful NSF programs. These Alliances—posited as five-year, multi-million dollar Cooperative Agreements—will undoubtedly place even greater constraints on the already limited program budget, but to do otherwise would be irresponsible given our current knowledge on the efficacy of alliance-based systems and motivated, campus-to-community cooperation.

Informing and Assisting the Nation's Educators and Employers

PPD-supported information dissemination activities are key in efforts to change attitudes regarding the appropriateness of full participation of students with disabilities in science-related education and careers. Through the program, thousands of people with disabilities, service providers, educators, and employers have learned about methods to achieve full inclusion of students with disabilities in science, mathematics, and engineering education. Thousands more have learned of PPD successes through media coverage; mass-market publications; conference presentations; radio, television, and Internet broadcasts; discussion groups; and electronic databases.

Specified Goals of PPD-Awarded Projects



Source: NSF Division of Human Resource Development.

Dissemination of exemplary products and practices will be needed for years to come, building on what we have learned regarding effective pedagogy, assistive technologies, universal access, and human cognition. To this end, PPD continues to support smaller standard and continuing grants that specifically promote dissemination of effective products and practices as well as various focused research initiatives.

Fostering Effective Mentors, Role Models, and Community Resources

Changing faculty and campus attitudes regarding students with disabilities, informing administrators and standards-based boards on the requirements of various disabilities, and giving all educators the tools they need to address these populations more effectively are the true legacies of PPD awards. PPD funding helped the American Association for the Advancement of Science publish its *Directory of Scientists and Engineers with Disabilities* to serve as a resource for expertise and professional role models. Several PPD projects are using mentoring and tiered-mentoring to give encouragement to students at all levels of study while "teach the teacher" workshops give educators new tools and practices for more inclusive classroom environments. In other arenas, PPD has supported assistive technology products that are bringing unprecedented levels of technical and computational information to students as well as professionals. Finally, resources centers such as the Equal Access to Software and Information (EASI) and the National Center for Accessible Media (NCAM) promote awareness of disability issues to the broadest national audience.

The various and diverse successes of PPD projects are at once the program's greatest triumph and its greatest impetus for doing even more in the future. As the program begins its second decade, we look forward to such challenges and the tremendous rewards that will unquestionably be returned.

An Imperative Need:
NSF's Program for Persons with Disabilities

Who has a Disability?

Historically, the National Science Foundation (NSF) has used a definition of *disability* patterned after one developed for a survey of individuals with disabilities by the Census Bureau (DoC, 1994). This measure was based on asking individuals, "What is the usual degree of difficulty you have with (specific tasks involving seeing, hearing, walking, and lifting)?"[1] Respondents were given five choices for each item, ranging from "none" to "unable to do," where having a disability is defined as having at least moderate difficulty in performing one or more of these tasks. Although this definition was designed to provide a relatively objective measure of disability, it is important to note that it does not capture all disabilities.
For example, learning disabilities and behavioral disorders—which may comprise significant proportions of the total population potentially considered as possessing a disability—are not included.

Reported Trends—Persons with Disabilities in Science, Technology, Engineering, and Mathematics

The representation of persons with disabilities in the science and engineering population can be estimated by comparing the results of the NSF National Survey of College Graduates with similar results from the Bureau of the Census' Survey of Income and Program Participation (NSF, 1996). Comparisons of the two survey results indicate that persons with significant sensory-motor disabilities are underrepresented among scientists and engineers. As representative excerpts from the series, *Women, Minorities, and Persons with Disabilities in Science and Engineering ¾ Statistical Reports on U.S. Science*, we note[2]—

[1] The full wording of these alternatives in the survey forms is "SEEING words or letters in ordinary newsprint (with glasses/contact lenses if you usually wear them)", "HEARING what is normally said in conversation with another person (with hearing aid, if you usually wear one)", "WALKING without assistance (human or mechanical) or using stairs", "LIFTING or carrying something as heavy as 10 pounds, such as a bag of groceries."

[2] Data and text for this section are reproduced from *Women, Minorities, and Persons with Disabilities in Science and Engineering ¾ Statistical Reports on U.S. Science* (NSF 1996, 1998, 2000), a congressionally mandated, biennial series published by the National Science Foundation.

- "Persons with disabilities are a smaller proportion of the science and engineering labor force than they are of the labor force in general. About 20 percent of the population has some form of disability; about 10 percent have a severe disability (McNeil, 1993). Persons with disabilities are 13 percent of all employed persons (DoC, 1994) and about 5 percent of the science and engineering labor force." (NSF, 1996, p.84).
- "Unlike women and minorities, persons with disabilities are not particularly concentrated in certain fields, although a somewhat higher fraction of those with doctorate degrees in the social sciences have disabilities (6.6 percent) than is true of those with doctorate degrees in science and engineering as a whole (5 percent)." (NSF, 1996, p.84).
- "The proportion of scientists and engineers with disabilities increases with age. More than half became disabled at age 30 or older. Only 7 percent had been disabled since birth, and 30 percent had been disabled before the age of 20" (NSF, 1998, p. 115).
- "Scientists and engineers with disabilities do not differ in educational background from those without disabilities: 13 percent of both have the doctorate as their highest degree. ... Scientists and engineers with disabilities are less likely than those without disabilities to be employed in for-profit business or industry ... Faculty who have disabilities are more likely than those without disabilities to be full professors and to be tenured. These differences in rank and tenure between persons with or without disabilities, as was noted in the discussions of women and minorities, can be explained by differences in age. Because incidence of disability increases with age, scientists and engineers with disabilities tend to be older and to have greater years of professional work experience than those without disabilities." (NSF, 1998, p. 117).
- "Persons with disabilities also make up only a small percentage of those in science and engineering occupations. In 1997, they were 6 percent of the scientists and engineers in the labor force; this was about the same as in 1993." (NSF, 2000, p. 52).
- "Although age accounts for some of the tendency for persons with disabilities to be out of the labor force, chronic illness or permanent disability is also a factor. The primary reason for not working for both persons with and without disabilities was retirement (78 and 62 percent, respectively), but 19 percent of persons with disabilities and 2 percent of those without cited chronic illness or permanent disability." (NSF, 2000, p. 57).
- "Scientists and engineers with disabilities were less likely than those without to be employed in for-profit business or industry: 53 versus 60 percent in 1997. They were also somewhat less likely to be employed in academia than their counterparts without disabilities: 18 versus 20 percent." (NSF, 2000, p. 59).

Inception of the Program

Although about 20 percent of the population in the United States possesses some kind of disability, the number of persons with any particular disability may only number in the thousands or tens of thousands. This gives such persons the dubious distinction of small, specialized audiences often overlooked by codified academic, corporate, and legislative consideration. In the late 1980s, NSF convened a task force to address similar indicators that had been collected from academe and the national science, technology, engineering, and mathematics (STEM) workforce. The recommendations from these advisors, in part, led to the establishment of the Program for Persons with Disabilities.

The final report of the National Task Force on Women, Minorities, and the Handicapped in Science and Technology (1987-1990) indicated that the number of people with disabilities was seriously underrepresented in science and technology careers in the country. The Task Force—consisting of 20 members from industry and 20 members from governmental agencies appointed by the President's Science Advisor—recommended that the U.S. Government should establish and operate targeted programs to recruit, train, and retain people with disabilities for careers in these disciplines. During 1989, when the National Task Force report was under development, the NSF Committee on Equal Opportunities in Science and Engineering (CEOSE), a congressionally mandated oversight committee, created an Internal Task Force on People with Disabilities in Science and Engineering. The Internal Task Force report included a lengthy series of recommendations to the NSF Director regarding how NSF could increase participation of people with disabilities in the Nation's science and engineering enterprise.

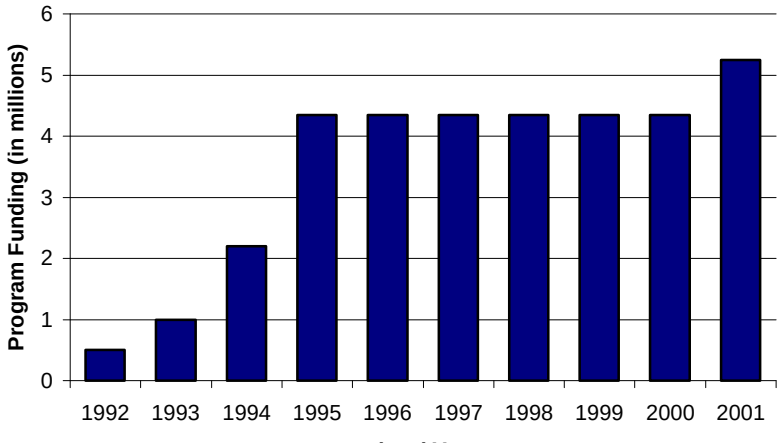
Following the completion of the National Task Force in 1990, the NSF Director appointed Lawrence Scadden to be a member of CEOSE. During the following year, CEOSE promoted implementation of the Internal Task Force report to the Director and to the National Science Board. In 1991, Luther Williams, then Assistant Director of NSF's Directorate for Education and Human Resources, asked Dr. Scadden to form an advisory group of national leaders in the education of

students with disabilities and to set priorities for NSF from the CEOSE Internal Task Force on Disabilities. The advisory group made its report to Dr. Williams in September of 1991 (CEOSE, 1991). The first priority related to establishing a Program for Persons with Disabilities in Science, Engineering, and Mathematics that would support innovative projects designed to encourage and advance students with disabilities into graduate training and careers in these disciplines. NSF officially established the Program for Persons with Disabilities (PPD) late in 1991 and the Directorate for Education and Human Resources put PPD into its funding plans for Fiscal Year 1994—the earliest possible year to receive a congressional line item for the new program. The first award administered by PPD staff began in late 1992 and the first program announcement for PPD was published in 1993.

Levels of Funding and Program Administration

Initially, program directors in NSF's Directorate for Education and Human Resource Development allocated approximately $500,000 and $1 million to PPD awards and activities in Fiscal Year (FY) 1992 and FY 1993, respectively. For FY 1994, PPD was allocated approximately $2.2 million. Beginning in FY 1995, the program's budget was increased to $4.35 million, where it remained level until FY 2001. Currently, the program's budget is approximately $5.25 million.

PPD Funding, FY 1992 - 2001



Source: NSF Division of Human Resource Development.

Dr. Lawrence A. Scadden

"An institution is but the lengthened shadow of one man."
—Ralph Waldo Emerson

The following is excerpted and paraphrased from "Let Their Expectations Soar: The Life Story of Dr. Larry Scadden," by Libby G. Cohen, edited by Robert G. Atkinson, published in the Journal of Science Education for Students with Disabilities (D. Caseau and J. Marshall, eds.), Volume 8, Winter 2000.

Larry Scadden has served as a guide, advocate, pioneer, leader, and mentor to thousands of persons around the world. His warmth, gentleness, vision, and integrity have enabled him to provide national and international leadership on issues relating to science, engineering, and mathematics for persons with disabilities. [Born in California in 1939, Scadden was blinded by a household accident in 1943. He greatly missed reading and by the age of six resolved to learn Braille. Overcoming the stereotypes regarding blind persons of the era, he was inspired by his third-grade teacher who recognized his intellectual skills and advised that he should carry his education through to a Ph.D. Scadden has always possessed a great fondness for music and a knack for mathematics. In high school he demonstrated a passion for science and technology. He wanted to go into engineering but was steered away from it. Eventually he found an interest and a niche in experimental psychology. He went on to get his Master's Degree from the University of the Pacific in 1966 and, in 1971, received a Ph.D. in Medical Sciences from San Francisco's Pacific Medical Center where he also established the rehabilitation engineering research center. His extensive experience in product evaluation, including the first optical character recognition reading machine, led to his serving as a consultant to the House Committee on Science and Technology and his role in establishing what is now the National Institute on Disability and Rehabilitation Research within the United States. In 1992 Scadden came to NSF as Senior Program Director for the Program for Persons with Disabilities.]

"I recognized that technology represents tools and everyone uses tools to increase their abilities, to decrease their limitations, to speed up their performance, and to decrease the energy they use. So, all we are talking about in technology for people with disabilities is providing them with the tools that allow them to overcome their limitations." ... "The projects that [NSF is] now supporting around the country differ significantly from one another. We have three different emphases. One relates to research and development to make information more accessible. We also have information dissemination projects aimed at teachers and counselors to help reduce the negative attitudes towards the capacity of people with disabilities working in the field of science. Then we have projects that I call enrichment projects that really provide students who have disabilities with hands-on experiences in science."

"All people have limitations. If people could write as fast as they want, they wouldn't be using a computer, and before that a typewriter. The computer has made a tremendous difference in my life, and I am fully convinced that the computer is valuable to virtually everybody, but there is no group that computers help more than people with disabilities because of the level of independence computers provide." ... "I spend a lot of time now working on the issues of diversity and equity of minorities, women, and people with disabilities. In talking to people, I know from the other two underrepresented groups in science, virtually all successful people tell me about the mentors or support they received from peers or something of that kind. When I talk to my colleagues who are successful scientists and engineers who have disabilities, we all agree we didn't have many mentors and we recognize how important this is. Most of us who succeeded fought against the gradients of sometimes discrimination, sometimes prejudice, sometimes this mythology that disabled people can't do science."

"The primary thing has to do with abilities. People who have disabilities also have *abilities* and their life should be focused around where their interests and abilities lay. Their disabilities can be reduced through the use of tools. We are getting better and better tools to reduce the number of limitations they have. All people should be allowed to rise to their own desired goals, and should be provided with the kinds of tools that they need to accomplish the education and function they want. That doesn't mean you just give something to somebody. You allow them to work for it and allow them to achieve. In my talks to disabled populations, I always just tell them to let their expectations soar, and the people around them should let their expectations soar for someone with a disability, and give them the opportunity to succeed."

PPD Goals and Objectives

In accordance with the program's goals, successful PPD proposals are those that investigate innovative techniques in STEM education and apply such innovations to promoting the successful participation of students with disabilities. Proposals submitted to PPD are initially reviewed by panels of experts familiar with the fields of research and education involving persons with disabilities. The number of reviewers selected to provide a balanced and knowledgeable evaluation of proposals depends upon the number of proposals submitted. Proposals are then reviewed for their to intellectual merit, the broader impacts of the proposed activity, and other program-specific criteria. As stated in the most recent program solicitations (NSF 01-67, NSF 02-25), the specific goals of PPD are to—

- Develop new methods of teaching science and mathematics;
- Increase the awareness and recognition of the needs and capabilities of students with disabilities;
- Promote the accessibility and appropriateness of instructional materials and learning technologies; and
- Increase the availability of mentoring resources.

With program objectives to—

- Bring about needed changes in academic and professional climates leading to increased participation of people with disabilities in science, technology, engineering, and mathematics;
- Increase the awareness and recognition of the needs and capabilities of students with disabilities;
- Promote the accessibility and appropriateness of instructional materials, media, and educational technologies; and
- Increase the availability of student enrichment resources including mentoring activities.

While NSF encourages all of its programs to support education and research activities accessible for all students, including those with disabilities, the explicit focus of PPD is to improve the access to quality education, special learning requirements, and appropriate mentoring of persons with disabilities. PPD remains unique in this regard and for this mission in the entire Federal government.

Progress and Innovation: Award Outcomes

Award Statistics

The first project awarded PPD funds began, administratively, in October of 1992[3]; program awards subsequently ranged from 4 to 16 grants annually. Average project awards were also variable, from a low of $150,254 in 1993 to a high of $657,903 in 1994. Since 1992, the number of active PPD projects has increased steadily; as of FY 2001, the program's tenth year, there were 49 active PPD projects in 24 states. To date, PPD has made 92 awards among projects in 30 states and the District of Columbia with a total disbursement of $39,426,107 or an average annual disbursement of approximately $3.9 million. Awardees have included 66 principal investigators representing 56 sponsors. The program has received an average of 49 full proposals and granted an average of 9.9 awards per year, with the average award through FY 2001 calculated as $433,254 and approximately 2.7 years' duration.

PPD award averages, by year

Year	No. of Projects Begun	Avg. Award Commitment	Avg. Project Duration (Years)
1992[4]	4	$438,444	2.0
1993[4]	4	$150,254	2.6
1994	13	$657,963	2.2
1995	9	$562,910	2.3
1996	6	$372,466	2.3
1997	9	$231,865	3.9
1998	16	$529,170	2.5
1999	11	$374,727	2.8
2000	11	$397,812	3.1
2001	16	$386,238	2.8
Average	9.9	$433,254	2.7

PPD award numbers and state representation, by year

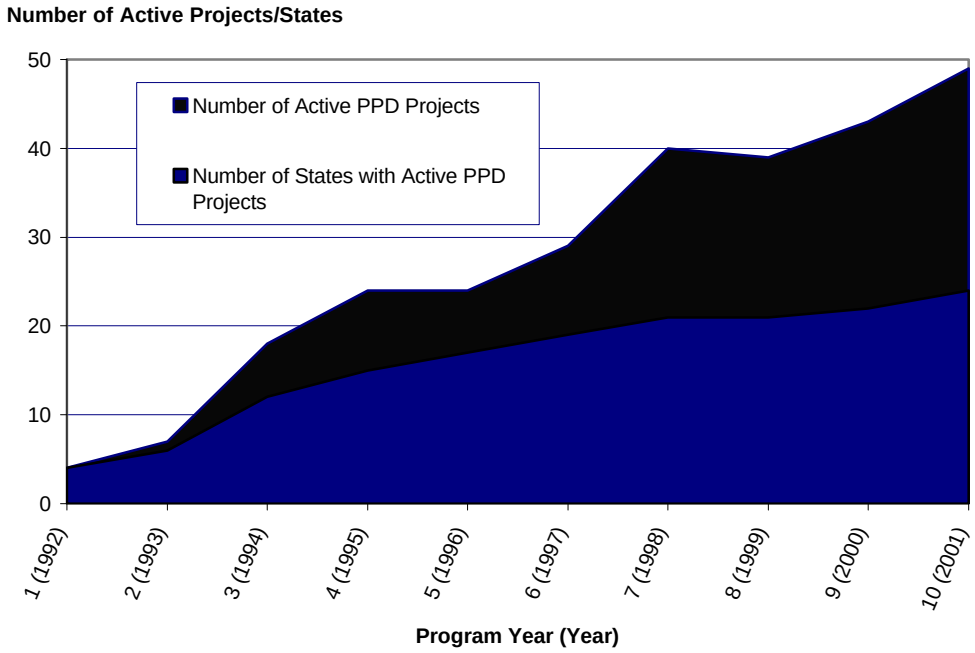
Year	Total Award Commitments	Number of Active Projects	Number of States with Active Projects
1992[4]	$ 1,753,776	4	4
1993[4]	$ 901,523	7	6
1994	$ 7,895,561	18	12
1995	$ 3,940,370	24	15
1996	$ 1,862,332	24	17
1997	$ 1,854,916	29	19
1998	$ 8,995,890	40	21
1999	$ 5,995,635	39	21
2000	$ 1,591,247	43	22
2001	$ 4,634,857	49	24

Source: NSF FastLane.

[3] Though addressing students with disabilities, award #9153492 to East Carolina University (begun in January, 1992) was actually administered through NSF's Directorate for Mathematical and Physical Sciences.

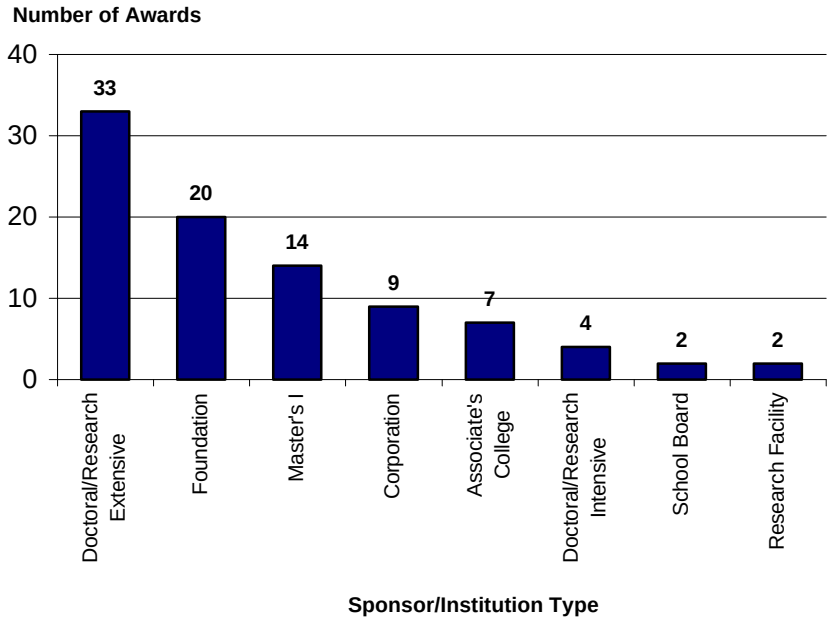
[4] Data include 2 FY 92 and 2 FY 93 projects totaling $681,328 administered in conjunction with the Career Access Program. PPD staff monitored eight programs on disability research and education and funded four unsolicited proposals.

PPD Project Activity, 1992 - 2001



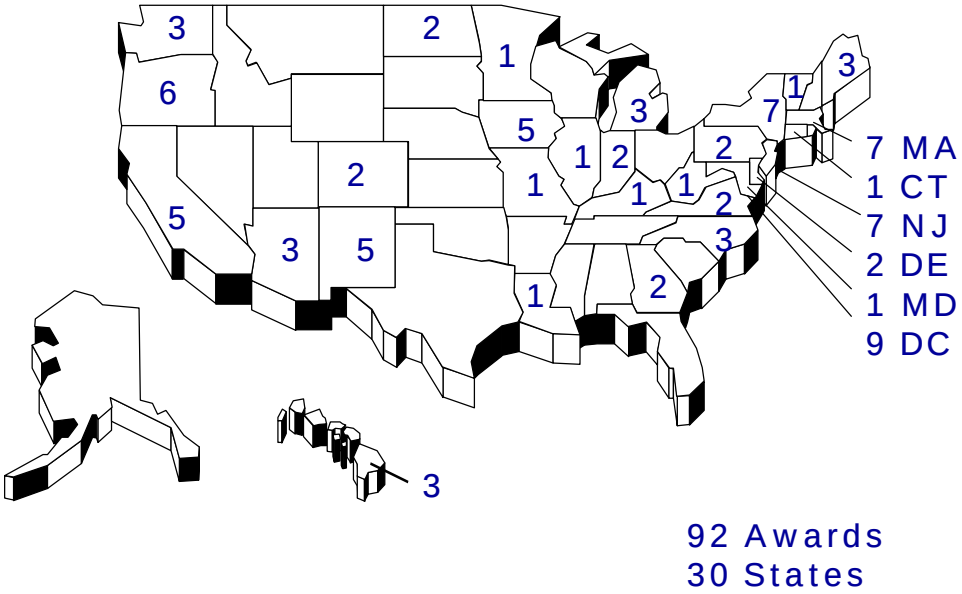
Source: NSF Division of Human Resource Development.

PPD Awards by Carnegie Foundation Classification, 1992 – 2001



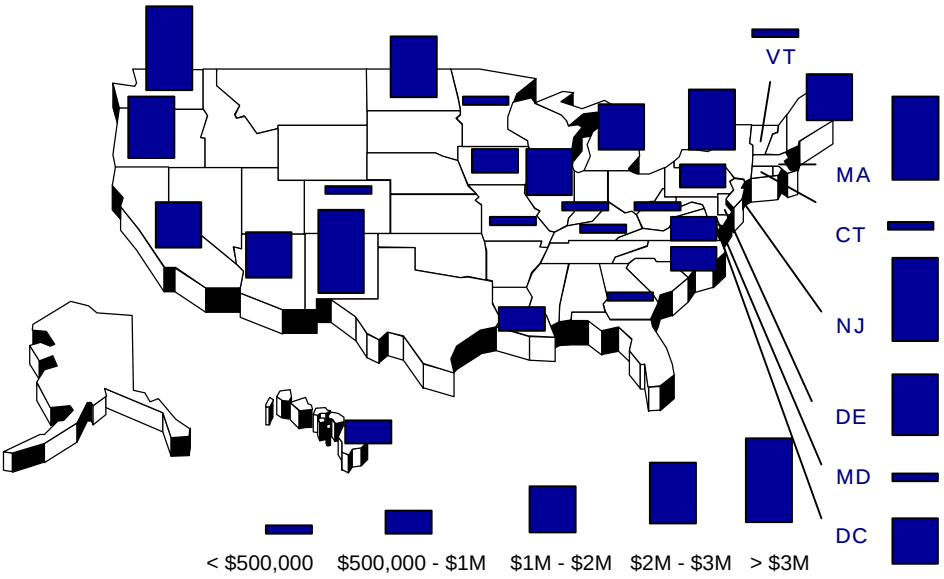
Source: NSF Division of Human Resource Development.

PPD Awards by State, 1992 - 2001



Source: NSF Division of Human Resource Development.

PPD Funding by State, 1992 - 2001



Source: NSF Division of Human Resource Development.

Taken collectively, PPD awards very nearly represent a microcosm of NSF's programs and missions in education, numerically as well as philosophically. Among the 92 projects, 26 percent proposed methods or products that could be considered applicable—directly or by broader application—to all students in any STEM discipline. A further 19 percent specifically addressed K-12 students; 25 percent addressed undergraduates; 23 percent addressed teachers, teacher educators, parents, and counselors; and 8 percent addressed the general public via commercial products or informal education facilities and exhibits.

Among the goals specified by award abstracts, 22 projects (24 percent) focused on improved pedagogical methods or products designed to engage and retain students with disabilities to STEM education and 17 projects (18 percent) identified college or career preparation skills. Fifteen awards (16 percent) identified women and girls with disabilities or students in rural or remote locales as their main target audience. Six projects (7 percent) specified the involvement of caregivers or family members to encourage and fulfill the responsibility to the whole student and education's role within the entire lifestyle. Finally, nine projects (10 percent) sought to promote information exchange via conferences or directories and catalogs of extant products, research, or resources. These projects were crucial not only to identify common areas most in need of attention but also to provide a baseline of known results upon which future efforts should be based.

In FY 2000, PPD received 81 preliminary proposals and 54 full proposals, representing all of the program's research tracks. For FY 2001, the requirement for preliminary proposals was waived and award criteria shifted to a regional alliance model, including collaboration-based projects with a strong knowledge of other activities in the community and an emphasis on recruiting and training students with disabilities. In response to these revised requirements, only 10 full proposals were received by the submission FY 2001 deadline, of which 9 were forwarded for panel review. These proposals represented a total Year-1 request of $5,726,959 with an average project Year-1 request of $572,695 and an average proposed duration of 4.7 years. Eight of the 10 proposed five-year plans included regional or local networks of institutions and represented nine different states, including four states not previously awarded PPD grants. Typically, preliminary proposals have been submitted by as many as 38 different states, the District of Columbia, and Puerto Rico in response to each program solicitation. Except for facilitation awards, countless requests from researchers, educators, and students for individual support must also go unfulfilled because direct support is not included in PPD's mandate. However, such observations provide a clear indication that there is a broad, nationwide interest in PPD initiatives, including the new Regional Alliances.

Milestones

Through reports, meetings with project directors, and site visits, the program staff is kept well informed of the successes and revised strategies of all PPD projects. Reports submitted by various projects estimate than over 70 percent of students with disabilities in PPD projects go on to studies in higher education studies, with the majority of them in STEM courses. (The majority of these students reported little or no such motivation prior to participating in PPD projects.) Some are better or more easily able to obtain work in private industry because of their experiences in these projects.

In the first two years of PPD operation, program staff focused their efforts on: 1) information dissemination and outreach to NSF program staff and the science and education communities at large concerning the goals of PPD; 2) promotion of opportunities provided through facilitation awards to scientists and engineers with disabilities; 3) preparation and publication of a program guide; and 4) management of the review of unsolicited proposals and processing and management of four new awards and five continuing projects begun under the Career Access Program.

As is typical of many programs, several initial proposals sought funds to facilitate communication and determination of baseline issues via directories, resource guides, and conferences. Publications that offered career options available to persons with disabilities were also popular among early PPD awards. Expectedly, the awards well represented the program's mandate—

1. To ensure accessibility of instructional materials, educational media and technology, and informal science educational opportunities and facilities;
2. To develop and test innovative techniques and activities that will increase the recruitment, training, and retention of students with disabilities in science, engineering, and mathematics education; and
3. To change attitudes of pre-college teachers and college faculty in science and mathematics toward the ability of students with disabilities to perform competitively in their disciplines and to provide them with the knowledge needed to make classrooms and laboratories accessible to students with disabilities.

FYI

For the interested reader, project abstracts and detailed award information for the PPD projects summarized on the following pages can be searched at: http://www.fastlane.nsf.gov/a6/A6AwardSearch.htm using the award number indicated in parentheses.

The University of Washington's DO-IT (Disabilities, Opportunities, Internetworking, and Technology) project (#9255803, $1,543,804) was the first to receive long-term funding from PPD. It was also among the first program awards to show tangible impacts in the community. DO-IT began in October 1992 with the intent of recruiting and retaining more students with disabilities in academic and professional careers in science, mathematics, engineering, and technology. To this day, the project introduces students to adaptive technology that helps them access computers and the Internet; counsels high-school students in career and college transition; and prepares faculty, staff, and institutions of higher learning to better receive such students. DO-IT's activities also extend beyond the classroom to include camps, summer programs, mentoring, and exposure to various career fields. PPD has also encouraged the dissemination of DO-IT materials and information through various print and electronic media.

With the exception of the University of Washington grant and FY 1994 awards to the Foundation@NJIT (#9450074, $1,223,574), the University of Illinois Urbana-Champaign (#9450020, $1,660,246), and the University of Delaware (#9450019, $1,418,141), most of PPD's early awards were in the $100,000 range or less. The Foundation@NJIT project was designed to promote better inclusion of students with disabilities through improved access and more inclusive teaching methods. The proposal, which included the teaming of science, engineering, and mathematics (SEM) teachers with experts in accessibility issues, offered a cornerstone practice reflected in many PPD projects today. Illinois' "Project PRIMES (Promoting & Retaining In Math, Engineering & Science)" and Delaware's "Engaging, Recruiting, Retaining Students with Disabilities in SEM" were similarly configured as experimental projects aiming to increase the retention and enrollment of STEM students with disabilities. Additionally, their intent was to better identify factors leading to the observed inequity in the representation of such students using workshops and seminars addressing equitable access to education. Projects began to research the environmental factors that might promote or discourage persons with disabilities considering careers in STEM; activities to attract and retain disabled persons in scientific careers were immediate outcomes of these efforts. Coincident with this was the development of more products to better facilitate the delivery of complex material to the visually and hearing impaired. Other noteworthy awardees included Oregon State University's "Science, Engineering, Education and Disabilities (SEED)" project (#9452881, $1,050,940) and the University of North Dakota's, "Enhancement of Mathematics and Science for Fourth and Fifth Grade Native American Students with Disabilities" (#945007, $1,336,552). The mode amount for other projects had by this time approached $200,000 by FY 1994 and would approach half a million dollars per award by the end of the decade.

Project rewards were realized early, particularly with regard to human factors in the PPD community. In New Jersey, the effect on the families and educators of students with disabilities were profoundly affected by the PPD project at the New Jersey Institute of Technology (NJIT). Not only was the students' interest in STEM increased, but the harmony and support of the communities in which they lived were also enhanced. The PPD award to the University of Delaware also yielded a host of results in areas such as haptic feedback and improved tactile pictures. An award to the City University of New York (#9450166, $382,092) also produced advances in technology and techniques in the form of an improved touch tablet and improved presentation of tactile graphics.

In FY 1995, the University of Washington was given a further $1,539,282 for its DO-IT Extension project (#9550003) and a $1,508,302 award to New Mexico State University (#9550064) provided seed funding for its Regional Alliance on Science Engineering and Mathematics for Students with Disabilities (RASEM). RASEM continues in 2001 with eight internships and impacting approximately 25 undergraduates with outreach to hundreds of high-school students. In proposing measures for, respectively, adapting and adopting proven practices and forming alliances among regional networks, both of these projects proved to be exemplars for future programmatic directions in PPD and throughout NSF's Directorate for Education and Human Resources.

FY 1996 included an award to the WGBH Educational Foundation's "CD-ROM ACCESS Project" (#9623958, $600,000), an initiative to draft a set of design guidelines for making CD-ROMs more accessible to the visually and hearing impaired. Libraries, publishers, and the media have received the guidelines with great interest; now the center is applying the design parameters to its own adaptation of the physics interactive video tutor project (PIVOT, #9906159) first developed at the Massachusetts Institute of Technology. An award to Recording for the Blind, Inc. (#9610308, $300,000) helped to develop digital audio recording with text support for dyslexics. Elsewhere, the "Enabling SUCCESS" project at Louisiana Tech University (#9622322, $553,289) sought to develop inexpensive and practical science-activity kits for use at home as well as in the classroom. Hands-on experiments using little more than economical and readily accessible materials were highly successful in engaging middle-school students' interest in the pursuit of science. The project developed a science-activity kit and accompanying manual for home and classroom use that did show an initial increase in STEM interest (and high-school enrollment by participants).

By FY 1997, several PPD projects had identified the need for better tools and technologies to retain the interest of STEM students with disabilities. Representative of these awards are the American Association for Higher Education's use of adaptive computer technology to prepare K-12 students (#9700134, $222,649), CAST, Inc.'s, "Understanding Science Through Captioning Project" for hearing impaired students (#9712964, $207,121), Purdue University's audiotactile general chemistry course for visually impaired students (#9722030, $221,385), and Space is Special, Inc.'s, project, "Using Space Science to Enhance Science, Mathematics, Technology Skills and Self-Esteem in Special Needs Students" (#9732913, $436,850).

Into FY 1998 and FY 1999, PPD awards continued to reach out to "minorities within the minority," including female, rural, and American Indian/Alaskan Native/Pacific Islander students. The University of North Dakota received funding (#9800634, $900,000) for its "Disability Research Encompassing American Indians in Math and Science (DREAMS)" project. The University of Hawaii Manoa was awarded a grant (#9800692, $462,882) for its "Ocean of Potentiality" project. In Hawaii, students at all levels as well as their teachers and counselors are afforded fun, instructive hands-on science experiences. The goodwill on behalf of science afforded by such projects extends far beyond individual participants to benefit relatively isolated communities. The project's principal investigator, marine biologist Richard Radtke, was also one of ten individuals nationwide to receive NSF's Presidential Award for Excellence in Science, Mathematics and Engineering Mentoring (PAESMEM) in 1999. During FY 1998, PPD support was continued for projects ongoing at the University of Washington, Oregon State University, New Mexico State University, the University of Delaware, and the Foundation@NJIT with awards to these centers averaging approximately $800,000.

Taking science education beyond the classroom, the New York Hall of Science (#9800577, $186,377) was awarded a PPD grant for their proposal to provide visitors to science museums with enhanced audio tours. The Association of Science-Technology Centers also received PPD funds (#9906095, $467,921) for their proposal for making science-center exhibits more appealing, accessible, and rewarding for all persons with disabilities. An award to San Francisco State University (#9800281, $388,698) helped to produce a Braille periodic table and some remarkable new 3-dimensional models for the study of biochemistry.

Among other noteworthy PPD projects, a multi-year effort at the Marie H. Katzenbach School for the Deaf (#9906123, $439,474) has developed a distance-learning project to increase the interest in science and science aptitude for deaf and

hard of hearing students in kindergarten through twelfth grade. At Duke University (#9800201, $449,972), a system of tiered mentoring is impacting students through the entirety of the supply pipeline, grade school through graduate study.
Two FY 2000 awards to TERC, Inc. (#0090070, $449,999 and #0095392, $448,403) will help apply National Council of Teachers of Mathematics (NCTM) standards-based curricula to students with disabilities and will develop the SigningAvatar™ to accentuate distance-learning programs. Other new PPD projects such as the Rochester Institute of Technology's Clearinghouse on Mathematics, Engineering, Technology, and Science (COMETS, #0095948) will provide unprecedented on-line access to education materials for hard-of-hearing students and their mentors, tutors, and caregivers.

Viewed from a national perspective, the program's awards are clearly starting to produce tangible results in three broad-based categories: 1) Products; 2) Improving educational environments; and 3) Advances in teacher practices and standards-based teaching for students with disabilities in STEM disciplines.

Products

Among the products of PPD projects highlighted in the program's annual reports (HRD 1994-2001) are—

- Live interviews, print materials, on-line courses and discussion lists, and Web broadcasts of weekly interviews with research and education leaders working in the STEM fields. —*Teaching, Learning and Technology Group/Equal Access to Software and Information, American Association for Higher Education* (#9906134).
- Computer-controlled chemistry and physics lab experiments (including computers running software for visually and mobility impaired students) and a resource guide for teachers to implement these technologies elsewhere. —*Georgia Tech Research Corporation* (#9700150).
- Use of a force-feedback mouse to enable better comprehension of two-dimensional graphs by visually impaired students has been developed by PPD-funded researchers in Virginia. —*Automated Functions, Inc.* (#9906143).
- The Accessible Graphing Calculator (AGC), a Windows application that makes mathematics more accessible to the blind or dyslexic and learning math more fun for everyone. The AGC is designed to be equally usable either visually or audibly via a speech engine included with the product. For non-disabled students, the audible tones can make learning more fun, reducing "math anxiety," increasing numerical comprehension, and even enhancing the learning process by doubling the user's sensory perceptions. —*Oregon State University* (#9800041).

Improving Educational Environments

As a result of the products such as those listed above, PPD-supported initiatives are making an impact on the learning environment for persons with disabilities, including—

- Videos from the DO-IT project have been disseminated nation-wide to affect change in pre-college science and math pedagogy. —*University of Washington* (#9800324).
- The web site for Equal Access to Software and Information (Washington, DC) is receiving an increased number of visits and requests for information as K-12 science and mathematics teachers seek accommodations for students with disabilities. —*Teaching, Learning and Technology Group/Equal Access to Software and Information, American Association for Higher Education* (#9906134).
- In Massachusetts, the Center for Accessible Media is receiving an increased number of requests to assist in providing closed-captioning and audio description of STEM instructional media. —*CPB/WGBH National Center for Accessible Media* (#9906159).
- The New York Hall of Science is beginning to receive requests for assistance in making other informal science programs accessible to students with disabilities. —*New York Hall of Science* (#9800577).
- The University of Northern Iowa (#9988729 and others) recently published two volumes on "Science Teaching in Inclusive Classrooms" of use to anyone trying to address issues of parity and equity in diverse classrooms. —*University of Northern Iowa* (#9988729 and others)
- At the University of Washington (#9800324) and New Mexico State University (#9800298), PPD-supported projects with extensive undergraduate-student activities are now graduating students with disabilities who have completed their baccalaureate degrees. Among them, three graduates have moved from schools of engineering into employment in industry and two physical-sciences graduates elected to continue academic training in graduate school.

Advances in Teacher Practices and Standards-Based Teaching

Advances in standards-based teaching and assessment as a result of PPD funding include—

- The Education Development Center (EDC) in Massachusetts has been developing materials to use with national and state science and mathematics standards programs to promote accessibility for students with disabilities. EDC's efforts address this important issue while new educational standards are developed and revised. Similarly, EDC is working with the Educational Testing Service and other national assessment organizations in efforts to ensure that future assessment instruments for science and mathematics will be appropriately accessible for students with disabilities. —*Education Development Center* (#9800287).

- Rutgers University is adapting its science teams project for racial- and gender-equity in the classroom to include students with disabilities. The project is devising a professional-development program especially for teachers of third- to fifth-grade students with special needs. The teams' outreach tools include hands-on environmental science activities, suggestions for promoting inclusion of students with special needs, and an emphasis on balanced, cooperative learning strategies intended to encourage and support all science students, regardless of their ability.—*Rutgers University New Brunswick* (#9800336).
- The PPD-supported "Daughters with Disabilities" (DWD) project is showing special education and general elementary school teachers engaging, hands-on methods in STEM education adapted to the special requirements of their students. —*Temple University* (#9906079).

Learning Valuable Lessons Through Necessity

As summarized by Scadden (2001), PPD projects have long dealt with several issues only now being addressed by most curriculum designers:

> "Educators working with disabled students have found themselves on the leading edge of techniques now considered state-of-the-art. Most, if not all, PPD projects necessarily address many of the self-same principles now being adopted across the board as effective teaching. These include:
>
> - structuring lesson plans and exercises to encourage participation, increase retention, and provide the student with a positive experience that fosters the need for ongoing study;
> - promoting self-esteem in the student and involving teachers, parents, counselors and caregivers in the education process beyond the classroom;
> - diversifying content delivery from text- or lecture-only formats;
> - accommodating alternate learning styles by using hands-on experiences and by engaging multiple or concurrent sensory channels;
> - employing peer instruction and active participation in smaller student groups; and
> - facilitating distance learning and tele-learning for students in rural or remote locales."

Guiding Principles for New Proposals

The opportunity to review PPD proposals—successful as well as not—and to chart the progress of many funded projects for the past decade have revealed to program staff a number of guiding principles that could well be applied to the years ahead.

1. Proposals should provide an intelligent, research-based plan of action with realistic, defined outcomes.

2. Project management should be established and leadership must be consistent. Changing principal investigators mid-course can drastically cost projects time, progress, and organization.

3. Seek to make a difference. Changing attitudes, beliefs, and practices is more important than absolute numbers, at least initially.

4. Numbers are important, too, especially in light of the Government Performance and Results Act (GPRA) and Government Accounting Office standards for increases in performance-based outcomes.

5. Actively seek partnerships for product development and networks for dissemination of information and proven good practices: Consult other PPD awardees; communicate with local and regional institutions; partner with special-needs as well as mainstream curricula; and use non-profit societies or similar venues established in the community to disseminate results to the broader public.

6. If a project's methods are demonstrating tangible results, support and perseverance should be encouraged to the maximum extent possible, finding alternate sources of funding, approaching other institutions, or appealing to other principal investigators if necessary. Every reasonable attempt should be made to lengthen the effective duration of project outcomes, whether by extending the duration of the award or by tracking participants' progress after leaving the project.

7. Seek autonomy. While dissemination mechanisms are now a required part of nearly every proposal, too many efforts simply lose momentum once the term of funding has ended. Modest, realistic dissemination strategies should be part of every project practically from the outset, with networks and successful outreach continually built upon during the project's successive years. At the end of the development phase, cost-effective dissemination mechanisms such as third-party agents and product clearinghouses should be employed to "spread the word" about the time, energy and funds invested.

8. Aspire to full access and full inclusion. This perhaps puts a new but motivational spin on the term "planned obsolescence." We look forward to a day when special considerations for students with disabilities will be considered redundant if applied broadly and intelligently to regular curricula in use by all.

A Community of Excellence: Program Evaluation

January 1997 marked the first Committee of Visitors (CoV) evaluation of PPD.[5] At that time there were approximately 20 active PPD projects. There was also a discussion at this time whether addressing 1993's Government Performance and Results Act too stringently would emphasize short-term evaluations over long-term outcomes. Overall, the CoV's review of PPD was very positive, going further to add— "We are especially impressed by the expertise, dedication, and leadership of Lawrence Scadden and (program officer) Mary Kohlerman, as evidenced by the continued improvement in the number and quality of the proposals and the thoughtful feedback provided by PPD staff on pre-1996 proposals. The quality and scope of the work done in this important area by a small staff is exemplary." (CoV, 1997, p. 2.) The committee additionally noted the success of PPD staff in bringing awareness of PPD program objectives to the general educational establishment. The review methods examined and the use of appropriate expert reviewers were also deemed appropriate.

What gets measured, gets done.
If you don't measure results, you can't tell success from failure.
If you can't recognize failure, you can't correct it.
If you can't see success, you can't reward it.
If you can't see success, you can't learn from it.
—From *Reinventing Government*
by David Osborne and Ted Gaebler (1992)

These words, reproduced from the first page of the 1999 Urban Institute report on PPD, exemplify the prevailing interest in quantified, outcome-based indicators for government-sponsored programs that characterized the late twentieth century. The Urban Institute of Washington, DC, was asked to provide this independent evaluation of PPD in partial response to the revised expectations for program performance stipulated in GPRA and the above excerpt set a clear tone for the recommendations that followed. The intent of this evaluation was to conduct a review of the program's key outcomes and, in the interest of quantifying the outcomes of PPD project activities, to conduct a pilot study on the feasibility of collecting student-outcome data from principal investigators as well as from school boards and individual students one to two years after project participation. Recommendations for the development of data-collection procedures, forecasting future project outcomes, and otherwise contributing to the knowledge base of "effective process" were also included in the Institute's reports provided to NSF in December of 1999 (Urban Institute 1999 a,b,c).

[5] Committees of Visitors are an established means of independent, third-party evaluation used by NSF.

Similarly, the change in individual student performance should be weighed more heavily than absolute performance level at the completion of project participation. "Breakout" results, summarizing outcomes beyond those stipulated by the core indicators, would also be considered valuable, with all outcomes distilled and consolidated by PPD staff prior to reporting to higher NSF management. The Urban Institute also recommended that PPD should aggregate its outcome data annually and use updated editions of this information to guide current and prospective applicants.

In its final report, the Urban Institute advised that the Division of Human Resource Development—and indeed the Directorate for Education and Human Resources—would be well served to devise a standard set of performance indicators for projects and their participants, which ideally would be charted for up to two years after the project's completion. They ceded the difficulty in doing so, given the frequent change or movement of project staff and student participants, and added the following caveats on the use of outcomes-based indicators:

1. That quantified outcomes in and of themselves do not indicate why such outcomes occur and are insensitive to factors beyond the core indicators that may improve/decrease individual performance. In this regard, the collection of breakout data and explanatory information was advocated.
2. Time and effort—perhaps significant levels of each—are required to construct or revise any data collection procedures. In this regard, project officers seemed interested in collecting more quantified data provided additional funding was offered for this purpose.
3. The use of uniform or standardized outcome data will be resisted as being too expensive to collect and too limited or insensitive in its utility. Securing permission to review school records, expecting consistent or standardized metrics from many different sources, and collecting sufficient data post-participation are major issues. Most awardees felt they lacked the resources to do so effectively.

On May 3 and 4, 2000, PPD program staff met with a second Committee of Visitors to discuss PPD activities and accomplishments for the period 1997-1999. In its report, the CoV was asked to specifically mention areas in need of more attention and to suggest avenues for the future of PPD. The committee was also asked to respond to the advisability of scaling up these programs, based upon the new knowledge that has emerged from NSF's investment. The committee found PPD's merit review procedures to be excellent. The program's use of the new NSF Merit Review criteria was also deemed successful. Reviewers had different expertise and qualifications, which, when combined, brought the overall balance needed to each review panel. Reviewers were also balanced in relation to geography, underrepresented groups, and other criteria.

While the 2000 CoV found PPD's accomplishments were excellent in comparison to NSF's financial investment, they believe that it is imperative to the national agenda that more persons with disabilities participate in programs that improve STEM education and career opportunities. The successful strategies that have emerged from PPD need to be disseminated and pursued more widely in other NSF education and human resource programs. The CoV believed that, with additional funding, this work will create opportunities to expand the impact and scale of the knowledge gained in the program. The CoV commended PPD for the challenging work it is completing in developing a framework that permits an overview of the results of the NSF investment, its impact, and areas needing further discovery.

Commendations from the 2000 PPD Committee of Visitors

- Award processes and management are exemplary.
- The program has a knowledgeable and dedicated program staff, remarkably creative and committed to program goals with extraordinary abilities to get the most "bang for the buck" in quality programs and projects.
- The research framework that is being developed for both programs to gauge progress and evaluate impact is very impressive.
- Considerable new knowledge and best practices are developing through the NSF investment.
- PPD has sufficient positive results that they are well positioned to "scale up" for wider implementation.

Benefits to the Community

PPD and its awardees continue to change research and education in the following areas—

Facilitation Awards for Scientists and Engineers with Disabilities—In FY 1992 alone, before even receiving its own program budget, PPD fully or partially funded eight facilitation awards for scientists and engineers with disabilities, representing over a 100 percent increase in NSF funds allocated to these awards. PPD has remained the central point of contact for NSF's facilitation awards ever since.

Effective Outreach and Information Dissemination—As early as FY 1994, PPD support led to the distribution of more than 3,500 *Barrier Free in Brief* booklets and 1,500 each for the *Find Your Future* and *You're in Charge* career booklets produced by the American Association for the Advancement of Science. The University of

Washington distributed quarterly copies of the *DO-IT News* to 1,400 members on its mailing list while countless others received electronic copies through Internet discussion lists. A random census of 13 FY 1998 PPD projects identified the combined participation of 5,200 students and teachers, 250 counselors and administrators, 150 parents, 3,400 conference attendees, and 156 special-education teaching students.

Leadership in Standards-Based Education—Following the lead of Texas and California, 29 states now have or are considering pending legislation mandating that all instructional materials purchased by public schools must be usable by students with disabilities. To address this, WGBH's National Center on Accessible Media (NCAM, #9623958) has produced "Making Educational Software Accessible: Design Guidelines Including Math and Science Solutions." The guidelines provide curriculum developers and publishers assistance in making software-based materials accessible (for example, captioning for deaf students, audio tracks for the blind, or alternate/enhanced operation via both keyboard or mouse). National associations of publishers and librarians have encouraged members to use the NCAM guidelines. Interest in the guidelines has been strong and the Center has distributed them to the Association of American Publishers schools division, the Department of Education's technology projects meeting, and numerous universities, museums, and software companies. Elsewhere, working with the National Science Teachers Association (NSTA), the Education Development Center (EDC, #9800287) has completed a series of contributions to NSTA's *Pathways to the Science Standards* publications. The additional sections intend to provide educators with guidelines for including elementary, middle, and high-school students with disabilities in activities and assessments. Two FY 2000 PPD awards to TERC, Inc. (#0090070, #0095392) will help apply the NCTM standards-based curricula to students with disabilities and will develop the SigningAvatar™ to enhance distance-learning programs.

Assistive and Augmentative Technologies—PPD-supported principal investigators have made significant gains in the way persons with disabilities can interact with STEM education materials. These successes include improvements to touch tablets by the City University of New York (#9450166); a force-feedback mouse developed by Automated Functions, Inc. (#9906143); and three-dimensional models to enhance the study and comprehension of chemistry, biochemistry, and the life sciences (Arizona State University # 9610289; San Francisco State University #9800281). Oregon State University and ViewPlus Technologies (#9452881, 9800041, 9976548) developed the Accessible Graphing Calculator, Dots Plus Braille code, and the Tiger Advantage Tactile Graphics and Braille Embosser, which provides blind students with a tactile representation of any graphic developed on a computer. This is the first instance of a tactile graphics printer and was co-winner of the B.F. Goodrich university invention of the year in 1996.

Improved Educational Tools—PPD awards have also led to the publication of four mathematics and science books prepared with Dots Plus symbiology as developed at Oregon State University (#9452881). Project staff at the University of Northern Iowa have produced two volumes on *Science Teaching in Inclusive Classrooms* of use to anyone trying to address issues of parity and equity in diverse classrooms (#9988729). PPD awards to Reading for the Blind, Inc., helped to develop new technology to integrate computer files with digital voice recording, ultimately leading to new mathematics and science texts for students with print disabilities (#9610308). PPD awards have also helped to adapt the presentation of calculus to visually impaired students (#9906115).

Improved Access to STEM Education—PPD activities have done much to introduce hundreds of students with disabilities to STEM in supportive and engaging environments, including summer science camps (#9550003, 9550064, 9732913, 9800324) and undergraduate curricula such as Purdue University's model program for engineers with hearing impairments (#9353824). For informal science centers benefiting students and the public at large, the Association of Science-Technology Centers (#9906095) is using PPD support to develop science-center exhibits that are more appealing, accessible, and rewarding for all persons with disabilities.

Mentoring and Role Modeling—A multi-year effort by the New Jersey Department of Education (#9906123) has developed a distance-learning project to increase the interest in science and science aptitude for deaf and hard of hearing students in kindergarten through twelfth grade. Duke University (#9800201) is working on a system of tiered mentoring is impacting students through the entirety of the supply pipeline, grade school through graduate study. At Temple University, the "Daughters with Disabilities" project (#9906079) has also succeeded in using role models, mentors, and family support to retain the interest of girls and young women in STEM courses. New Mexico State University's "RASEM Squared" project (#0124198)—also PPD's first Regional Alliance award—is currently supporting more than 20 students with disabilities majoring in STEM disciplines. Each mentor is required to have a minimum of three weekly consultations with their mentee—younger students with disabilities (either in high school or lower division undergraduates) who have been recommended by science or mathematics faculty as having particular interest and ability in STEM fields. Befitting the expectations of the PPD Regional Alliance model, RASEM² involves commitments from 17 two-year community colleges, 6 four-year colleges and universities, and 9 school district regional center cooperatives in New Mexico; and 2 universities and 2 educational service centers representing school districts in West Texas. The alliance also involves two national laboratories, the statewide agencies serving people with disabilities, and a national organization for the advancement of science.

Going Forward: A Look to the Future

As a part of the preliminary effort to develop the FY 2001 budget request to Congress, the NSF Assistant Director for EHR asked the PPD Senior Program Director to prepare plans for expanding PPD in FY 2001. The result was a multi-year PPD Phase II plan to promote increased participation of students with disabilities in STEM education and career opportunities. A series of programmatic activities that could not be initiated within the existing budget constraints was drafted. The proposed activities include:

- Support of renewals for exemplary demonstration and enrichment projects;
- Outreach to community colleges to promote participation of students with disabilities in STEM[6];
- Research on why a high number of STEM majors with disabilities change majors during their undergraduate years;
- Initiate efforts in retaining interest in STEM by students with disabilities during their undergraduate years by providing faculty and counselors information on improving participation by diverse populations;
- Analysis of science and mathematics teacher-preparation curricula and certification programs to identify means by which to prepare future teachers for diverse populations of students; and
- Research on ensuring accessibility of distance education-based STEM instruction.

The various and diverse successes of PPD projects are at once the program's greatest triumphs and its greatest challenges for the future. Increases in both the number and quality of proposals being submitted is unquestionably the most significant consideration for the program's administrators, particularly if near-level funding is continued. The increased numbers of quality proposals submitted to PPD obviously necessitates increased scrutiny of the work being proposed in order to ensure that it is not duplicative of past efforts.

Looking to the future, PPD will continue to focus on a Regional Alliance strategy. Projects such as RASEM, which spans numerous communities in the U.S. Southwest (#9550064 and #9800298) have increased access and representation of persons with disabilities at the middle-school, high-school, and collegiate levels, reached out to women and minorities, and garnered state and corporate funding support toward long-term institutionalization.

[6] This was achieved, in part, with an assistive-capacity building initiative in PPD targeting community colleges in FY 2000. Of 9 applicants, 5 awards were granted—to Yavapai College (AZ), County College of Morris (NJ), Landmark College (VT), Springfield Technical Community College (MA), and to a network of community colleges led by Western Michigan University (MI).

As suggested above, the projects supported by PPD in the past decade reflect not only the prevailing education policy and climate of the era, but also some outstanding exemplars of "what works" in modern pedagogical practice for all students, irrespective of ability. Increasingly, providing equitable access for students with disabilities is seen not as an additional "obligation" but as a measure for making STEM education more accessible, engaging, and inspiring for everyone. The relatively recent consideration of diversified presentation and consideration of alternate learning strategies have necessarily been addressed by students with disabilities, their teachers, families, counselors, and mentors all long. Given this, the practices and lessons learned from PPD awardees become excellent models for defining what works, what doesn't, and where convention can be improved. As one example, we mention the ongoing research on making the Internet accessible to a broader audience and how that audience prefers to interact with web-based content. The number of people needing assistive tools to see, hear, touch, interact with, and move within their world is tomorrow's pool of potential end-users for the research and education innovators working with persons with disabilities today.

No one intentionally seeks to *exclude* students with disabilities from the full benefit of the educational experience, but too many systems still fail to realize the proven mechanisms for *including* them. With the majority of states now enacting or considering legislation requiring all educational materials to be fully accessible to students with disabilities, we can expect an increase in the amount and diversity of educational products available to address these guidelines. The human intellect and compassion required for utilizing these resources in the most effective manner has never been more obvious or more crucial. Enhanced communication among awardees and between awardees and the broader academic and public communities is also encouraged. In the interest of increased self-sufficiency, future proposals should be guided toward investigating and possibly allying with existing resources and institutions to maximize the outcomes of the existing knowledge base.

While the impact of PPD has been significant, its mandate is far from being fulfilled. As in many (indeed most) areas of STEM education, the particular needs of women, American Indian/Alaskan Native/Pacific Islanders, and rural- and urban-based student populations are not being addressed relative to the representation of these groups in the general student population. We have previously described these individuals as the "minorities within the minority" of students with disabilities, strongly conjecturing that the successful efforts of the research and education communities need to be redoubled and better adapted in these areas.

The preparation of this report has provided the opportunity to take a much-needed overview of PPD's accomplishments during its first decade. From such a perspective, the impact of the program is clear: The diversity and utility of products, training materials, education research and other mechanisms for making STEM education more inclusive of students with disabilities is readily apparent. Equally apparent is that, with the availability of more funds according to the above recommendations, so much more could be done in the future.

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PPD Sponsors and Principal Investigators by State, 1991-2001

States listed in order according to total program funds received; sponsors and current project PIs listed alphabetically.

State	Sponsors and Principal Investigators (# of PPD Awards)
1. WA	University of Washington – J. Ray Bowen (2), Denice D. Denton (1)
2. NJ	County College of Morris – Judith Kuperstein (1) Foundation @ NJIT – Howard Kimmel (2) New Jersey Department of Education - Karen Noble (1) Recording for Blind, Inc. – John Churchill (1) Rutgers University New Brunswick – Yakov M. Epstein (1), Sami Kahn (1)
3. NM	New Mexico State University – Douglas J. Gillan (1), William C. McCarthy (2), Enrico Pontelli (1)
4. MA	CAST, Inc – Amy Rubin (1) Education Development Center – Babette Moeller (1) Springfield Tech Community College – Jack Barocas (1) TERC, Inc. – Cornelia C. Tierney (1), Judy Vesel (1) WGBH Educational Foundation (2) – Geoff Freed (1), Lawrence R. Goldberg (1)
5. OR	Linn Benton Community College – Carolyn Gardner (2) Oregon State University – John A. Gardner (4)
6. DE	University of Delaware – Kenneth Barner (2)
7. NY	CUNY Research Foundation – Michael E. Kress (2) Educational Equity Concepts – Barbara Sprung (1) Girls Incorporated – Heather Johnson Nicholson (1) NY Hall of Science – Alan J. Friedman (1) Rochester Institute of Technology – Harry G. Lang (2)
8. ND	University of North Dakota – John Backes (1), Sue A. Schmitt (1)
9. DC	American Association for Higher Education/TLT Group – Steven W. Gilbert (3) American Association for the Advancement of Science – Virginia W. Stern (6) Association of Science-Technology Centers – Sally Middlebrooks (1)
10. IL	University of Illinois Urbana Champaign – Reginald J. Alston (1)
11. MI	Holt Public Schools – Margaret Lamb (1) Space is Special, Inc – Michael E. Kersjes (1) Western Michigan University – Robert J. Leneway (1)
12. AZ	Arizona State University – Anshuman Razdan (1) University of Arizona – David Lovelock (1) Yavapai College – Kenneth D. Abbott (1)
13. ME	University of Southern Maine – Libby Cohen (2), Sharon M. Locke (1)

14. CA	Center for Accessible Technology (1) - Lisa Wahl International Community Auditory - Elizabeth D. Mynatt (1) San Francisco State University - Dennis M. Fantin (1) University of California Santa Barbara - Willis D. Copeland (1), Reginald G. Golledge (1)
15. HI	University of Hawaii Manoa - Richard L. Radtke (3)
16. NC	Duke University - Olaf von Ramm (1) East Carolina University - David Lunney (1) Shodor Education Foundation, Inc. - Robert R. Gotwals (1)
17. PA	Temple University - Brian Butz (1), Lynda A. Price (1)
18. IA	University of Northern Iowa - Greg P. Stefanich (5)
19. LA	Louisiana Tech University - Paul N. Hale, Jr. (1)
20. VA	Automated Functions, Inc. - Ronald A. Morford (2)
21. CO	University of Colorado Boulder - Lucy Y. Pao (1), Elaine Seymour (1)
22. MN	Winona State University - Joan M. Francioni (1)
23. CT	University of Connecticut at Storrs - Ivar G. Babb (1)
24. MO	University of Missouri Columbia - Gregory Holliday (1)
25. VT	Landmark College - Richard Grumbine (1)
26. IN	Purdue University - Lyle L. Lloyd (1), Phillip C. Wankat (1)
27. GA	Georgia Tech Research Corp (GIT) - John Goldthwaite (1), Karen Milchus (1)
28. KY	University of Louisville Research Foundation - Patricia B. Cerrito (1)
29. MD	Moneta Development Corporation - Christin W. Everly (1)
30. WV	West Virginia University Research Corp - Edward C. Keller (1)

Selected PPD-Sponsored Publications

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Biotechnology Works!: http://www.usm.maine.edu/~coe/bio/. (#9800241).

CD-ROM Access guidelines: http://ncam.wgbh.org/cdrom/guideline. (#9623958).

Center for Applied Technology (CAST): http://www.cast.org/. (#9712964).

Center for Assistive Technology and Environmental Access: http://www.catea.org/. (#9976086).

Clearinghouse on Mathematics, Engineering, Technology, and Science (COMETS): http://www.rit.edu/~comets. (#0095948).

Daughters with Disabilities: http://www.sistersinscience.org/dwd. (#9906079).

Disabilities, Opportunities, Internetworking, and Technology (DO-IT): http://www.washington.edu/doit/. (#9800324).

Equal Access to Software and Information (EASI): http://www.rit.edu/~easi/. (#9906134).

Information Access laboratory: http://www.ee.udel.edu/InfoAccess/. (#9450019).

International Community for Auditory Displays (ICAD): http://www.icad.org/. (#9729148).

Marie H. Katzenbach School Science Camps: http://www.njdeafonline.com/ScienceGrant/mksdsciencecamp01.htm. (#9906123).

Mathematics Accessible to Visually Impaired Students (MAVIS): http://www.nmsu.edu/~mavis/. (#9800209).

National Center for Accessible Media (NCAM): http://ncam.wgbh.org/. (#9623958).

Ocean of Potentiality: http://www.oceanofpotentiality.org/. (#9800692).

Program ACCESS: http://w3.arizona.edu/~access. (#9800210).

Regional Alliance for Science, Engineering, and Mathematics (RASEM): http://rasem.nmsu.edu/. (#9550064).

Science Access Project: http://dots.physics.orst.edu/. (#9800041).

Special Science Teams: http://www.rci.rutgers.edu/~cfis/sst.html. (#9800336).