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ABSTRACT

Many are concerned that America will not have a sufficient supply of scientists and engineers in the workforce for the 21st century. Five regional workshops were held by four organizations (in Boston, Massachusetts; Minneapolis, Minnesota; Seattle-Tacoma, Washington; and Phoenix-Tempe, Arizona) to provide a forum for all those concerned with issues involved in the underrepresentation in science and engineering of students with disabilities. This document is one of two documents that was distributed through the participating national organizations. It contains the formal presentations, the identified barriers and recommended strategies to overcome them, summaries of workshop evaluations, and recommendations. (ZWH)

CONFERENCE PROCEEDINGS

Model Undergraduate Project for the Disabled: A Study of Issues Involved in Underrepresentation

IMPROVING CAREER ACCESS IN SCIENCE AND ENGINEERING FOR STUDENTS WITH DISABILITIES

Conducted by:

National Association for Industry-Education Cooperation

In Cooperation with:

American Association for the Advancement of Science
Association on Higher Education and Disability
National Parent Network on Disability, Federation for Children with Special Needs

National Science Foundation
Directorate for Education & Human Resources
Division of Undergraduate Science, Engineering and Mathematics Education

Grant No. HRD-9054022

January 31, 1994

The **National Association for Industry-Education Cooperation (NAIEC)** is a nationally recognized and utilized resource in the promotion, development and expansion of industry-education cooperation efforts directed at furthering school improvement, the education-to-work process and human resource/economic development with a strong structural base. Headquartered in Buffalo, NY, the Association publishes a bi-monthly newsletter to association members, sponsors an annual industry-education "Showcase Conference," and conducts regional workshops to encourage industry-education programs at the public school and postsecondary levels and to "showcase" present working examples of selected industry-education collaborative programs. NAIEC serves as the National Clearinghouse on Industry Involvement in Education. NAIEC has worked closely with over 26 states, Great Britain and Canada, helping them develop networks of local industry-education councils, coordinated by state industry-education coordinators, and supported by key leaders in education, business, government, labor, and the professions. Central to the Association's mission and goals is the promotion and development of a dynamic and responsive public/private/postsecondary educational system and competitive work force through a comprehensive systemwide industry-education alliances focusing on cooperative planning, curriculum revision, staff development, upgrading instructional materials and equipment, and improving the efficiency and effectiveness of educational management. To accomplish this, key strategies include increasing technical assistance to communities in the U. S. and Canada in all areas of industry-education cooperation, conducting research, and broadening its leadership role through liaison/collaboration with private and public agencies and organizations.

This study was supported by a grant from the **National Science Foundation** (HRD-9054022). Any interpretations and conclusions are those of the authors and do not necessarily represent views of the National Science Foundation.

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TABLE OF CONTENTS

EXECUTIVE SUMMARY

Five regional workshops were conducted to study issues involved in the underrepresentation in science and engineering of students with disabilities. Formal presentations were given by representatives of the four participating organizations: (1) National Association for Industry-Education Cooperation - industry's need for scientists and engineers and career implications for students with disabilities; (2) American Association for the Advancement of Science - education and career experiences from practicing scientists and engineers with disabilities; (3) Association on Higher Education and Disability - disabled student service programs in colleges and universities; and (4) National Parent Network on Disability, Federation for Children with Special Needs - parents' concerns and experiences.

The workshops were held in Boston, Minneapolis, Seattle-Tacoma, Phoenix-Tempe, and Atlanta, and involved senior high school and college undergraduate students, parents of students with disabilities, college and university science and engineering program administrators and faculty, secondary special education program administrators and teachers, college and university disabled student service program directors, practicing scientists and engineers with disabilities, and representatives from business and industry.

The group participation activities, emphasizing the Nominal Group Technique process, were successful in generating high levels of involvement among workshop participants. Participant evaluations were above 80% positive in two workshops, above 75% positive in two workshops, and above 65% positive in one workshop. The workshop model proved to be an effective method for identifying barriers to career access and developing strategies for their removal or alleviation. Participants, numbering 285 total, identified 382 barriers to career access and developed 373 strategies to overcome them.

The project produced two publications which were distributed through the four participating national organizations:

1. A conference proceedings document, Improving Career Access in Science and Engineering for Students with Disabilities, contains the formal presentations of the four national organization representatives, the identified barriers and recommended strategies to overcome them, summaries of workshop evaluations, and recommendations.

2. A workshop guide, Planning and Conducting a Workshop on Career Access: Science and Engineering for Students with Disabilities, or "how-to" manual based upon the project's prototype model. The guide explains the format, procedures, and rationale for the model workshop. The guide includes a listing of key points to be made in panel presentations, identifies resources, and identifies prospective participants and discusses how to recruit them.

It was recommended that the National Science Foundation and participating organizations promote the utilization of the workshop model for studying factors related to underrepresentation in other regions across the country. The workshop can provide the catalyst for energizing resources in a given area and building networks for collaborative efforts between parents, students, institutions of higher education, schools, and industry.

TABLE OF CONTENTS

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I. INTRODUCTION

Background

The National Science Foundation has focused increasing attention on improving career access in science and technology for minorities, women, and persons with disabilities (U. S. Task Force on Women, Minorities and the Handicapped in Science and Technology, 1989; Matyas and Malcom, 1991). The Foundation's Committee on Equal Opportunity in Science and Engineering (CEOSE) has three committees, one for each of these underrepresented groups, with the subcommittee on the disabled being the most recently initiated. The Foundation has strongly encouraged projects designed to study the issues involved in underrepresentation, including regional workshops and national conferences.

This project conducted five regional workshops to study issues involved in underrepresentation of persons with disabilities, as well as formulate strategies to overcome factors associated with underrepresentation. Further, the format and procedures for conducting the regional workshops provide a model for use in other areas of the country, and these have been documented in a workshop guide (Planning and Conducting a Workshop on Career Access: Science and Engineering for Students with Disabilities) to facilitate replication.

Four national organizations were involved in the project, from initial planning through dissemination. The lead organization was the National Association for Industry-Education Cooperation (NAIEC), which conducted the project in cooperation with the American Association for the Advancement of Science (AAAS), the Association on Higher Education and Disability (AHEAD), and the National Parent Network on Disability, Federation for Children with Special Needs (NPN).

Need

The need for this project was supported by five key factors.

First, projected occupational growth in science and engineering into the next century indicates a significant shortfall in meeting the needs of business, industry, government, and higher education. Many positions currently go unfilled because there are too few graduates to meet the demand.

Second, individuals with disabilities have demonstrated that they can complete undergraduate and graduate programs in science and engineering, and can successfully pursue professional careers in business, industry, government, and higher education.

Third, while the number of students with disabilities attending college is increasing, students with disabilities are still significantly underrepresented in science and engineering degree programs at the undergraduate level.

Fourth, it is increasingly being recognized that recruitment and retention of students with disabilities into science and engineering programs must begin during students' secondary school years (if not earlier) because decisions made during these years affect individuals' capacities and opportunities to pursue science and engineering in higher education.

Fifth, parents of students with disabilities have a significant role to play in fostering their sons' and daughters' interests in science and engineering and facilitating opportunities for them to move in this direction.

Workshop Model

A regional workshop program was developed to serve as a model for the study of underrepresentation of undergraduate students with disabilities. The model featured the use of the Nominal Group Technique process (Delbecq, Van de Ven and Gustafson, 1975) to identify barriers to career access and develop strategies to overcome them, and resource persons from the national registry of practicing scientists and engineers with disabilities (Stern, Lifton, and Malcom, 1987).

Five regional workshops were held. Locations and host organizations were:

★ Boston, MA	Stone and Webster Engineering Corporation
★ Minneapolis, MN	Honeywell, Inc.
★ Seattle-Tacoma, WA	Washington PAVE Parent Projects
★ Phoenix-Tempe, AZ	Pilot Parent Partnerships and Arizona Bridge to Independent Living
★ Atlanta, GA	Southern College of Technology

Workshop participants included:

- high school and college students with disabilities
- parents of students with disabilities
- college science and engineering faculty and administrators
- secondary special education teachers and program administrators
- secondary science, mathematics and technology teachers and program administrators
- high school guidance counselors
- rehabilitation professionals
- directors and staff of college/university disabled student service programs
- representatives of business and industry
- practicing scientists and engineers with disabilities

The workshop format included (1) a welcome and opening remarks, (2) conference presentations by representatives from the participating organizations, including a panel of practicing scientists and engineers, (3) small group sessions to focus on the identification of barriers and to develop strategies to overcome them, (4) reports from the small groups, and (5) workshop evaluation and concluding remarks.

Outcomes and Evaluation

The project completed the design and development of a workshop format for studying the issues involved in underrepresentation in science and engineering of students with disabilities.

Background pieces which formed the basis for formal workshop presentations have been researched and prepared by representatives of the participating organizations: (1) NAIEC - industry's need for scientists and engineers and implications for careers for students with disabilities; (2) AAAS - education and career experiences from practicing scientists and engineers with disabilities; (3) AHEAD - disabled student service programs in colleges and universities; and (4) NPN - parents' concerns and experiences. The group participation activities, emphasizing the Nominal Group Technique process, were successful in generating high levels of involvement among workshop participants. Further, the format was modified and improved based on participant feedback and evaluation. Changes were made after the third workshop and incorporated into the fourth and fifth workshops. The changes were effective, resulting in a highly workable format that provides a good mix of expert presentation, small group activity, and informative discussions of issues related to underrepresentation of students with disabilities. Additionally, the workshops have provided the stimulus for the development of informal networks in the areas in which they've been held.

Specific results and evaluations from each of the five workshops conducted are presented below in summary fashion.

Site: Boston, MA
Host: Stone and Webster Engineering Corporation
Number of Participants: 84

Small Group Outputs -	Barriers Identified: 189 Recommended Strategies: 96
Participant Evaluations -	8.31 average across 11 areas; range from 6.51 to 8.98, with 1 = not valuable and 10 = most valuable.

Site: Minneapolis, MN
Host: Honeywell, Inc.
Number of Participants: 62

Small Group Outputs -	Barriers Identified: 141 Recommended Strategies: 59
Participant Evaluations -	8.30 average across 11 areas; range from 7.50 to 9.17, with 1 = not valuable and 10 = most valuable.

Site: Seattle-Tacoma, WA
Host: Washington PAVE Parent Projects
Number of Participants: 47

Small Group Outputs -	Barriers Identified: 52 Recommended Strategies: 49
Participant Evaluations -	3.19 average across 5 areas; range from 2.88 to 3.64, with 1 = positive and 10 = negative.

Site: Phoenix-Tempe, AZ
Host: Pilot Parent Partnerships and ABIL (Arizona Bridge to Independent Living)
Number of Participants: 36

Small Group Outputs -	Barriers Identified: N/A Recommended Strategies: 67
Participant Evaluations -	2.13 average across 5 areas; range from 1.76 to 2.28, with 1 = positive and 10 = negative.

Site: Atlanta, GA
Host: Southern College of Technology
Number of Participants: 56

Small Group Outputs -	Barriers Identified: N/A Recommended Strategies: 102
Participant Evaluations -	2.04 average across 5 areas; range from 1.75 to 2.21, with 1 = positive and 10 = negative.

About This Report

The following four sections of this report (the first part of the project's final report) presents the formal conference presentations given at the workshops by representatives of the participating organizations. These are followed by sections that present a summary of the identified barriers to career access and strategies to overcome them, combined across the five workshop settings, and provide recommendations for future initiatives.

References

Delbecq, A. L., Van de Ven, A. H. and Gustafson, D. H. 1975. Group techniques for program planning. Glenview, IL: Scott, Foresman and Company.

Matyas, M. L. and Malcom, S. M. (Eds.) 1991. Investing in human potential: Science and engineering at the crossroads. (Executive Summary). Washington, DC: American Association for the Advancement of Science.

Stern, V. W., Lifton, D. and Malcom, S. M. 1987. Resource directory of scientists and engineers with disabilities, 2nd edition. Washington, DC: American Association for the Advancement of Science.

Task Force on Women, Minorities, and the Handicapped in Science and Technology. 1989. Changing America: The new face of science and engineering. Washington, DC: National Science Foundation.

II. INDUSTRY'S NEED FOR SCIENTISTS AND ENGINEERS MEANS EXCELLENT CAREER OPPORTUNITIES FOR STUDENTS WITH DISABILITIES

Donald M. Clark, Ed.D.
President and Chief Executive Officer
National Association for Industry-Education Cooperation

A Hudson Institute report, Workforce 2000: Work and Workers in the Year 2000, points out that the fastest-growing jobs will be in professional, technical, and sales fields requiring the highest education and skill levels (Johnston and Packer, 1987). For scientists and engineers, the percentage of new jobs will almost double the number of current jobs. While the average rate of growth among occupations from 1984-2000 is projected at 25%, the rates of growth for technicians, health diagnosing and treating occupations, engineers, architects, and surveyors, natural, computer, and mathematical scientists, and social scientists place them among the fastest growing fields. While America needs to increase its supply of technical personnel by 36 percent in the decade of the 1990s, there are signs that the country may be lucky to even hold its current numbers. According to Career Opportunities News (1990a),

> fewer of today's college students are electing technical majors, high schools are having trouble recruiting teachers with backgrounds needed to introduce students to scientific careers, a high percentage of those studying the fields in college today are from foreign countries, and there are 25 percent fewer people finishing high school today than the 1970s....
>
> Several reports document the problem. Education and Employment of Engineers (National Academy Press, 1989), America's Next Crisis: The Shortfall in Technical Manpower (Aerospace Education Foundation, 1989), Science and Engineering Degrees: 1966-88 and NSF Bulletin 90-315 on Favorable Employment Opportunities (both from the National Science Foundation, 1990). (p. 7)

This expansion of job opportunities will be fueled by the proliferation of advanced technologies in areas such as information storage and processing (terabytes, artificial intelligence), communications (digital telecommunications, fiber optic links), advanced materials (diamond coatings, ceramics, reinforced plastics), biotechnologies (agriculture, health care), and superconductivity (many diverse commercial applications). Some of the "hot track" or "fast track" occupations are projected to include computer software developers, environmental engineers, pharmaceutical sales, biomedical science researchers, industrial designers, mechanical engineers, and operations research analysts (Career Opportunities News, 1990b; 1990c).

Individuals who are well-prepared educationally for these changes in the economy will be at a relative advantage compared to those who are not, primarily because of demographic changes. A couple of demographic "facts" cited in the Hudson Institute report are particularly noteworthy: (1) the population and the workforce will grow more slowly than at any time since the 1930s; and, (2) the average age of the population and the workforce will rise, and the pool of young workers entering the labor market will shrink (Johnston and Packer, 1987).

Despite an average annual growth in engineering employment in the U. S. of about 7% from 1972 to 1986 and a projected annual growth of at least 2% between now and the end of the century, the number of bachelor's degrees in engineering annually awarded by U. S. educational institutions crested in 1986 and continues to decline. (Graduating Engineer, 1989). Engineering enrollment has been dropping since 1982, and interest in engineering among native-born Americans is waning. More than 22% of male U. S. college freshmen and about 4% of female freshmen indicated an interest in majoring in engineering in 1982. By 1986, that interest had dropped to 19% and 3% respectively.

In 1987 about 8.5% of all college freshmen expressed an interest in an engineering career, down from about 12% in 1982, according to annual data collected by the Cooperative Institutional Research Program, UCLA. Compounding the problem of declining engineering baccalaureate degrees awarded is a reduction in the number of college-age Americans, the traditional engineer-producing group. The total peaked by the 1980s, and it will continue to decline at least until the end of the century. As noted by the director of NASA's Langley Research Center, "the foundation for U. S. technological, economic and military leadership is eroding due to retirements and declining student interest. By the year 2000, a very large portion of our university science and engineering faculty will retire. Who will replace them? Interest in engineering is down by 25 percent since 1982. Interest in computing careers has fallen by more than 66 percent since 1982." (Holloway, 1992). The National Science Foundation has predicted a shortage of 675,000 scientists and engineers in the United States by the year 2006 (Career Opportunities News, 1991).

To paraphrase a statement by Johnston and Packer (1987, p. 95), it's fair to assume that organizations will be forced to look beyond their traditional sources of personnel; for qualified persons with disabilities, the opportunities will be unusually great.

Persons with disabilities are a great untapped resource for American business, according to Jack Honeck, Manager of Equal Opportunity Programs at IBM, as quoted in another Hudson Institute report, Opportunity 2000: Creative Affirmative Action Strategies for a Changing Workforce (Hopkins and Johnston, 1988). This report emphasizes that the disabled community is an important, though often overlooked, source of capable new workers for businesses seeking to improve their competitiveness in the labor-short 1990s and beyond. The National Science Foundation (Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1989) estimated that of the 4 million scientists and engineers in the U. S., only 94,000 or about 2 percent identify themselves as disabled, with engineering and computer science the most frequent field choices of persons with disabilities.

Companies recruit at colleges and universities for job applicants with disabilities (e.g., Hewlett-Packard's "Career Day for Disabled Students" in San Francisco) and advertise in such publications as Paraplegia News, Independent Living, and other periodicals directed to the disability community. They do so because they know from experience that "persons with disabilities are, more often than not, highly safety-conscious, reliable, loyal, and motivated employees who perform well on the job, and who tend to keep their jobs." (Hopkins and Johnston, 1988, p. 102).

Opportunities for persons with disabilities in science and technology are expanding as continued developments for them in the computer and electronic fields are creating opportunities for engineers, computer programmers, and others. Hopkins and Johnston concluded, "technology has opened many doors to learning, such that with proper accommodations, individuals with disabilities can perform nearly any job that the non-disabled population can....Today, hiring the disabled is not act of charity, but good business sense." (p. 144). This has certainly been recognized by the over 300 chief executive officers and corporate members of the Disability 2000 - CEO Council, formed by the National Organization on Disability (Kelly, n.d.).

The American Association for the Advancement of Science (AAAS), through a series of research projects and activities spanning more than a decade, has promoted career access opportunities in science and technology for students with disabilities (Raloff, 1991; Lollar, 1991).

Virginia Stern and her colleagues at the AAAS (Stern, Lifton and Malcom, 1987) have compiled a resource directory of practicing applied and research scientists and engineers with disabilities. The resource directory includes over 1000 scientists and engineers as well as students with disabilities who are studying in science and technology fields. The directory serves as a resource for identifying scientists and engineers with disabilities who can serve as role models for others (Stern, 1978; Stern and Redden, 1979). In a video tape production entitled "Science Abled," the Association promotes preparation of students with disabilities for the scientific and technological workforce (Stern, 1987).

During the past decade, programs to improve access and provide for students with disabilities at colleges, universities, and other postsecondary institutions have developed and expanded at a tremendous rate, including projects and programs with special emphasis on science and technology. This proliferation of programs was due to a combination of factors, including federal and state legislation and program initiatives (PL 94-142, the Education for All Handicapped Children Act; PL 101-476, the Individuals with Disabilities Education Act; PL 99-506, the Rehabilitation Act Amendments of 1986; and, PL 101-336, the Americans with Disabilities Act).

Programs and services enacted pursuant to this legislation have provided more quality public education for adolescents and young adults with disabilities, preparing them to both want and to succeed in postsecondary educational opportunities (Jarrow, 1987; Marion and Iovacchini, 1983). In a 1990 survey of 258 disabled student service programs, NAIEC found that the average number of students with disabilities served had increased from 60 students in 1986-87 to 117 students in 1988-89 (National Association for Industry-Education Cooperation, 1990). Professional recognition of postsecondary programs and services for college students with disabilities was given in 1978 with the founding of the Association on Handicapped Student Service Programs in Postsecondary Education, recently renamed the Association on Higher

Education and Disability (AHEAD). Association membership now includes over 1000 individuals and represents more than 700 disabled student service programs.

According to a 1985 college freshmen survey by the Cooperative Institutional Research Program at UCLA, 7.4 percent of college freshmen said they had a disability, up from 2.6 percent in 1978 (Hippolitus, 1987). A more recent statistic on the percent of students with disabilities in postsecondary education is available from a 1989 National Center for Education Statistics study which reported 10 percent participation based on a survey of all recipients of federal financial aid (National Center for Education Statistics, 1989). This survey included all types of postsecondary education and training institutions. No data were available on the percent of students with disabilities who were majoring in science and engineering.

It is our sense that most professionals familiar with the subject feel that students with disabilities have interests in science and engineering similar to their non-disabled counterparts. But, many of these students get deflected into other disciplines, so that actual program enrollment is less than for students who are not disabled. Anecdotal information tends to support this. For example, one disabled student service program coordinator at a large midwestern state university serving 150 students with disabilities reported zero students enrolled in science or engineering curricula.

As the Task Force on Women, Minorities, and the Handicapped in Science and Technology (1989) noted, these three groups are going to account for over two-thirds of new entrants to the labor force in the decade of the 1990s and unless they switch in significantly increased numbers to engineering and science careers America will not meet its critical need for technical personnel.

In sum, we need to emphasize that occupational demand for scientists and engineers is projected to exceed the supply of graduates well into the next century. This situation provides excellent opportunities for persons with disabilities interested in these fields and qualified to pursue them. Business and industry recruit, hire, train, and advance qualified persons with disabilities. Despite these opportunities, and the availability of programs and services to support college students with disabilities, they are still underrepresented in science and technology degree programs.

References

Hippolitus, P. 1987. College freshmen with disabilities preparing for employment: A statistical profile. Washington, DC: President's Committee on Employment of the Handicapped, Committee on Youth Development; and the Higher Education and the Handicapped Resource Center.

Holloway, P. F. 1992. The importance of math and science education in society. Presentation to the Thomas Nelson Community College ATOMS Program. H.J.E. Reid Conference Center, Langley Research Center, Hampton, VA, June 4.

Hopkins, K. R. and Johnston, W. B. 1988. Opportunity 2000: Creative affirmative action strategies for a changing workforce. Indianapolis, IN: Hudson Institute.

Jarrow, J. E. 1987. Integration of individuals with disabilities in higher education: A review of the literature. Journal of Postsecondary Education and Disability, 5, 2, 38-57.

Johnston, W. B. and Packer, A. E. 1987. Workforce 2000: Work and workers for the twenty-first century. Indianapolis, IN: Hudson Institute.

Kelly, L. A. No Date. Disability 2000 - CEO Council. Washington, DC: National Organization on Disability.

Lollar, C. 1991. Access to engineering: New project for students and faculty with disabilities. Science, 251, 952.

Marion, P. B. and Iovacchini, E. V. 1983. Services for handicapped students in higher education: An analysis of national trends. Journal of College Student Personnel, 24, 2, 131-138.

Money Magazine forecasts fifteen fast-track careers. 1990c. Career Opportunities News, December, 8, 3, 1,5.

National Association for Industry-Education Cooperation. 1990. National Assessment of Handicapped Student Service Programs in Postsecondary Education: Survey of Programs. Buffalo, NY: Author.

National Center for Education Statistics. 1989. Profile of handicapped students in postsecondary education, 1987. (1987 National Postsecondary Student Aid Study). Washington, DC: U. S. Government Printing Office.

Raloff, J. 1991. Science: Recruiting nontraditional players. Science News, December 14, 140, 396-7.

Science and engineering: Will supply catch up to demand? 1990a. Career Opportunities News, September, 8, 1, 7.

Stern, V. W. 1978. An education for living: The handicapped scientist as role model. National Elementary Principal, October.

Stern, V. W. 1987. Science Abled: Prepare disabled students for the scientific and technological workforce of today. (Video tape). Ann Arbor, MI: University of Michigan Advisory Board.

Stern, V. W., Lifton, D. and Malcom, S. M. 1987. Resource directory of scientists and engineers with disabilities, 2nd edition. Washington, DC: American Association for the Advancement of Science.

Stern, V. W. and Redden, M. R. 1979. The handicapped scientist as a role model. Education Unlimited, November.

Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1989. Changing America: The new face of science and engineering. Washington, DC: National Science Foundation.

U. S. News reports on "hot tracks jobs." 1990b. Career Opportunities News, December, 8, 3, 1,3.

Wanted! Engineers for aerospace and defense. 1989. Graduating Engineer, 10, 3, 48-58.

Women now earn 22 percent of mathematics doctorates. 1991. Career Opportunities News, May-June, 8, 6, 16.

III. SCIENTISTS AND ENGINEERS WITH DISABILITIES—EDUCATION AND CAREER EXPERIENCES FROM THOSE WHO HAVE BEEN THERE

Virginia W. Stern
Director
Project on Science, Technology and Disability
American Association for the Advancement of Science
Directorate of Education & Human Resource Programs

Herbert Hoffman operates a microcomputer with his left foot and uses a word processing program to prepare environmental weather reports. Dr. Edward Keller, who is deaf, has designed and taught programs in Marine Science for students with physical disabilities. These individuals have received wide recognition for their work and serve as role models for many youth and mid-career professionals with disabilities.

An interest in the sciences starts early. Curiosity about natural phenomena and an ability to solve problems are natural tools for becoming a scientist or engineer, which is as possible for a person with a disability as it is for anyone. Many people with disabilities quickly become familiar with using flexible, questioning and creative skills in finding solutions to physical limitations and attitudinal barriers. Upon entry into a science classroom and laboratory, the opportunities to develop these talents are endless as students examine information and explore hypothetical solutions to scientific problems. Hands-on experiences are essential to this activity. Science and engineering professionals are vital to our advanced industrial society. A federal task force reported in 1988 that the United States will continue to face a shortfall of scientists well past the year 2000 (Task Force on Women, Minorities, and the Handicapped in Science and Technology, 1989). People with disabilities who receive training in technical fields have skills that are critically needed by our nation and importantly, the science offer practical, well-paying careers for people with disabilities.

Patty Anderson, a senior software engineer at UNISYS in Houston, Texas, has an orthopedic disability and uses crutches to get around. As a young child, she was hospitalized several times. Her interest in science was sparked by a medical technician who took the time to explain what kinds of tests she was doing on patients. A guidance counselor in Patty's high school was also an important motivator, because she believed in her ability to succeed and encouraged Patty toward the field that most attracted her.

Counselors for disabled students at the precollege and undergraduate levels frequently discourage students with disabilities from pursuing a technical career because it is considered too demanding. Even before a young disabled student begins considering directions in higher education, he or she may be counseled out of mathematics courses and therefore will be poorly prepared to follow a technical curriculum.

All students who want to pursue a career in science or engineering need a strong background in mathematics. Teacher expectations that students with disabilities can do well in mathematics are important in moving young people towards their goal. Math coursework should be taken all through school as preparation for technical studies at the post-secondary level.

Parents of precollege students need to look closely at their children's course of study. Classes in "Consumer Math" may help with the grocery budgeting, but do not include the important algebra sequencing necessary to prepare for college.

Dr. James Slagle is a Distinguished Professor of Computer Science at the University of Minnesota. He has taught on the faculty of the Massachusetts Institute of Technology and Johns Hopkins University. The author of numerous papers, his subjects include artificial intelligence and pattern recognition. Totally blind since age 24, Dr. Slagle has used a braille computer terminal and various cassette recording devices during his educational career.

The student and his or her family need to persist in getting the right precollege education. If the rehab counselor is not familiar with requirements, a science teacher may be more supportive. Other people with disabilities who have become scientists or engineers can be the most helpful of all. Most students with disabilities have little or no opportunity to interact with science or engineering role models with disabilities. Also, the family of the student may not include scientists or engineers in their circle of friends or relatives, so the student has no informal mentors.

Out-of-school science programs can be extremely useful in stimulating interest in science for students with disabilities. Parents can also contact or visit museums, zoos, nature and science centers, botanical gardens and parks to get on mailing lists and find out what is available. A range of activities are available such as Science Fair projects, week-end classes at museums, behind-the-scenes tours of the aquarium and Scout camp-ins. Older students may participate in projects to clean up trails at state parks, mentor and shadow programs, and research opportunities. These kinds of experiences will open the way to lifelong involvement and literacy in science for today's youth.

Todd Blumenkoff is a Senior Research Scientist with expertise in organic chemistry. His interest in science began in third grade and continued throughout high school where he took many science courses. Mr. Blumenkoff uses a wheelchair and has spina bifida. In college he usually did lab work from his wheelchair. When working with such equipment such as NMR spectrometers that cannot accommodate the ferromagnetic characteristic of an ordinary wheelchair, he uses a wooden chair on casters, six inches higher than a normal wheelchair.

Kent Cullers is an Associate Research Scientist at NASA Ames Research Center, in California. His field is physics. As a scientist who is blind, he uses all available technology - computers to give him speech or braille output as well as personal readers. Because he keeps up with science literature via his technology, his lack of vision function does not limit him in his research activities at the Search for Extra Terrestrial Intelligence (SETI).

It takes time and lots of discussions to identify appropriate undergraduate and graduate science programs that offer first-rate education and meet the other needs of the student and family, such as accessibility, location and finances. Disabled Student Services Offices (DSSO) at colleges and universities are particularly useful in providing accommodations such as readers, interpreters and note takers, and insuring that classrooms and labs are accessible. It is best that students with disabilities contact the DSSO at their school before they enter college, if possible, and tell them what their needs are. Teachers, counselors and other mentors should not make any preliminary assumptions about what a student with a disability may or may not need. Each individual differs in access and adaptation needs, and some individuals with disabilities require none at all. The student is often the expert on what accommodations will work best and a meeting between student and professor should be set up in the beginning of a semester to discuss options and adaptations for classroom and lab work, and for taking exams.

Ralf Hotchkiss is a Senior Research Scientist in the Engineering Department at San Francisco State University. Since college, he has been designing wheelchairs and conducts workshops in third world countries on building wheelchairs from found materials. After he began his interest in wheelchair design, Mr. Hotchkiss was in a motorcycle accident and now uses his own wheelchairs to get around.

Ralph Guertin is a physicist who is deaf. He has taught at the undergraduate and graduate levels, worked in private industry and is now doing research for the MITRE Corporation.

Parents of students with disabilities can play an active part in finding scientists as role models for their children. School, library and community bulletin boards are sources of information on out-of-school science programs that may feature scientists at work. Relatives, teachers, ministers, co-workers or friends who work in laboratories or at colleges and universities can offer good suggestions on where to find science role models.

Students with disabilities might want to seek out an additional mentor in a particular area of science from the AAAS Resource Directory of Scientists and Engineers with Disabilities (Stern, Lifton and Malcom, 1987). The Directory is a source of role models for disabled youth. It lists approximately 1,000 scientists, mathematicians and engineers with disabilities who can share their coping strategies in education and career advancement, and can encourage students with disabilities to receive proper preparation to enter and succeed in technical fields. They can also direct students towards resources for financial aid, services for disabled students and innovative science programs.

Bruce Hilliam is Chair of the Department of Computer Science at California State Polytechnic University. A diving accident at age 16, caused a spinal cord injury and Mr. Hilliam uses an electric wheelchair to get around. Since the early 70s, he has been a strong advocate, having authored several articles on the rights of people with disabilities.

Robert Van Etten is a Rehabilitation Engineer. He consults with government and private agencies to design appropriate accommodations for people with disabilities in the home, at school and on the job. Mr. Van Etten has his own consulting firm, Adaptive Living. He is of short stature and uses platforms (sometimes from boxes and milk containers).

Michael Warshawsky was studying at Tufts University when he became spinal cord injured as a result of a diving accident. The Dean of his school encouraged Warshawsky to continue his studies and agreed to modify the university to accommodate his needs. Today, Warshawsky is a software engineer with the Raytheon Corporation in Bedford, Massachusetts.

The development of assistive technology for people with disabilities in the past decade and especially in the past three years, has made it particularly appropriate for science and engineering students with severe physical disabilities to function independently in the classroom and laboratory, and for engineers with disabilities in the workplace. Colleges and universities have the technical know-how to adapt classrooms and laboratories to accommodate students and can inform their faculty and students on appropriate ways to address special needs. But the student with a disability must push too.

A professional career in science or engineering takes four or five years of study at the minimum - more for a graduate degree. This requires financial planning and flexibility. A rehab counselor cannot always find funding for all of these years. A student may receive funding for some years and then needs to apply for grants, scholarships, or work-study funding. Co-op programs may be an excellent solution to getting work experience and saving money for the next semester. The important issue is to recognize a potential scientist or engineer and not allow stereotypes to get in the way of helping the individual to succeed.

References

Stern, V. W., Lifton, D. and Malcom, S. M. 1987. Resource directory of scientists and engineers with disabilities, 2nd edition. Washington, DC: American Association for the Advancement of Science.

Task Force on Women, Minorities, and the Handicapped in Science and Technology. 1989. Changing America: The new face of science and engineering. Washington, DC: National Science Foundation.

IV. DISABLED STUDENT SERVICE PROGRAMS: HOW THEY WORK, HOW THEY SUPPORT, AND HOW THEY CAN HELP THE STUDENT WITH A DISABILITY PURSUE SCIENCE/ENGINEERING AT THE COLLEGE LEVEL

Jane E. Jarrow, Ph.D.
Executive Director
Association on Higher Education and Disability

It is important to understand that the support services provided for students with disabilities in higher education are provided under a very different law than that which mandates services within the Special Education network. The authority of the Individuals with Disabilities Education Act (the IDEA, formerly P.L. 94-142) ends with the student's graduation from high school. After that time, students are entitled to freedom from discrimination on the basis of disability under Section 504 of the Rehabilitation Act of 1973 which can be paraphrased as follows:

No otherwise qualified person with a disability in the United States shall, solely on the basis of disability, be denied access to, the benefits of, or be subjected to discrimination under any (institution) receiving federal financial assistance.

The law does not require colleges and universities to set up separate courses or hire separate personnel to teach students with disabilities (as may be required under IDEA). Rather, it says that any program or activity, including educational opportunities, provided to any student must be available to all students, regardless of their disabilities.

What does this mean for students with disabilities who are seeking to enter the fields of science and engineering? It means that students cannot be prohibited from enrolling in courses for which they meet the academic prerequisites simply because someone has decided that they will not be able to perform the full range of job functions in the future. It means that students who choose to take courses in the sciences and who need specially modified equipment or assistance in order to participate in those courses have a right to expect the institution to provide such accommodation. It means that students who have need for disability-related accommodations in nonacademic areas (such as housing or transportation) have a right to expect that support services will be available through the institution to assure that these needs are met.

The biggest difference, however, between support services in elementary or high school and those provided in postsecondary education is not in the type of support provided, but in how that support is accessed. Within the special education system, the school district is obligated to identify students who have disabilities and are in need of additional support/services, and parents have a right to demand appropriate support and services for their children. **Under Section 504, a student is not considered disabled unless he/she chooses to self-identify to the appropriate institutional staff, and parents have no rights to request services.** The institution is not obligated to go out and seek qualified students with disabilities to include in their programming, nor is the institution obligated to provide support services for someone they know has a disability (by virtue of the visible manifestations of the disability, such as wheelchair use, or those who have been identified through the admissions process) if the individual does not request assistance through appropriate channels. Parents have no legal right to identify their child as being disabled to the appropriate school officials, nor to receive information about the support services or progress of the disabled student who is receiving such services. Indeed, by the time students reach higher education, they are no longer considered children, and any attempt to exercise their rights must be initiated by them!

Experience shows that this new responsibility for managing their own disability-related needs is often overwhelming to students with disabilities who have always had things done for them—and to them—throughout their prior educational careers. The single greatest threat to eventual success of students with disabilities in higher education seems to be lack of maturity and independence, rather than limited physical abilities or academic skills. Teaching such students to understand their disabilities, to identify their disability-related support needs, and to manage the provision of such support from a variety of sources should begin as soon as the student is ready to start shouldering some responsibility--**NOT** two weeks before he or she arrives on campus!

What kinds of support services are provided to students in higher education? Colleges and universities are required to provide access to auxiliary aids and services (adaptive computers, sign language interpreters, and the like), availability of adapted housing and transportation equivalent to the range of options available to nondisabled students, and academic support services that range from testing accommodations (extended time, use of a calculator, readers and scribes, and so on) to provision of materials in alternate media (such as large print or textbooks-on-tape). It is important to note the things that the institution is **NOT** required to provide:

- The institution is not required to provide either equipment of a personal nature (such as a wheelchair or hearing aids) or services of a personal nature in order to allow the student to participate in programming (such as attendant care or readers for study purposes). The institution must allow the disabled student to use such equipment or services as needed, but is not required to supply them.

- The institution is **not** required to provide free academic tutoring to students with disabilities **unless it provides free tutoring to all students on campus.** Although students with some disabilities may need tutoring in order to allow them to succeed, the institution may charge a fee for such services to students with disabilities if they charge for tutoring to nondisabled students who are in need of academic support.

One word of caution—access" means different things to different people. If a student is considering attending a college or university and will need to have either architectural access or programmatic assistance in place in order to succeed, we strongly urge that the student visit the prospective campus(es) in person to determine the nature and extent of accessibility available. Just asking questions over the phone is not likely to assure that the existence of the support matches the reality of the need!

V. PARENTS' CONCERNS AND EXPERIENCES

In most families, an adolescent's transition to adulthood is a stressful period. For families with children who have disabilities, the transition may be even more disruptive. The forms that the stresses may take and the ability to react to these stresses will vary from family to family, depending on the number of family members, the family's geographical location, their social and financial resources, and their personal values and beliefs (Brotherson, Backus, Summers, and Turnbull, 1986).

Parents may feel confused and frustrated as they gather conflicting or incomplete information in their search for new services and opportunities. Local school district task forces on transition find that parents are not well informed about work or higher education options (Montgomery County Public Schools, 1985). Early parental involvement in transition planning is essential.

Modrcin (1987) proposed several principles to serve as a guide for implementing the transition framework in a variety of settings. These principles can serve as guidelines to structure transition programs and services to higher education in a comprehensive and integrative manner. Briefly summarized, key propositions include: (1) program efforts must be individualized; (2) transition-oriented services must be anchored in the next progressive step in the transition effort; (3) transition-oriented services must begin early in the education and treatment process; (4) parents and other caregivers must be involved in the planning and development of transition services; and (5) an identified person must assume responsibility for working with the adolescent and overseeing the transition process.

The "identified" person referenced in principle number five may be a transition specialist, a professional person specially trained in education and related services (Kochhar, Hagerty and King, 1982; Baker and Geiger, 1988). Or, in many instances, it may be the parent, for it has been the parent who had been the constant factor in the child's development—from identification and diagnosis through early intervention and treatment, school programs and services, to the verge of adulthood. Therapists have changed over time. Doctors have come and gone. And a number of teachers have entered and left the child's life through the years. But the parent has been there throughout. In a very real sense parents, over time, become the real "case managers" for their children (Paul, 1981).

We now present the perspectives and thoughts of two parents who addressed the workshops held in Boston and Seattle-Tacoma.

Nora Wells, Boston

You have asked why undergraduate students with disabilities are underrepresented in the fields of science and engineering.

The answer would seem to lie before the question.

We need not ask why they are underrepresented at the college level until we have asked what experiences and encouragement they have had prior to college, specifically during the most impressionable years prior to secondary education.

There is a tendency in western culture to view our children by their diagnoses rather than by their abilities. We refer to the "cerebral palsy boy" rather than "the boy who has cerebral palsy." We tend to use the disability as if it were a given name: "The Cerebral Palsy Boy in sixth grade," not "Tommy Smith."

We also have an interesting tendency to expect less of children with a disability. "He's doing SO well," croons a teacher who does not have any direct classroom contact with my child. I have passed her in the hall many times when my older children were in the elementary school. At those times, we exchanged the standard community-related pleasantries. Now that my child with hearing aids is a visible member of the school community, this teacher praises his progress voluntarily and instantly—even during the year in which the classroom teacher is openly discriminating against him in class!

Statistics released within the past decade confirm that our experience is not isolated. The maximum expectation in an educational setting for a child with hearing loss is comparable with our minimum expectations for a child without hearing loss. It is such wonderful news that our child has a "C" average in a mainstream setting! But his peers with "C" averages are exhorted to try harder. This attitude is biased and condescending. It reinforces the self-fulfilling expectation of low achievement.

Studies also show that our children with hearing loss are roughly **three learning years** behind their hearing peers upon high school graduation. They may graduate on schedule from either specialized or local schools, but they are less educated.

These attitudes are deeply ingrained. We may vocalize understanding of each child as an individual, but we rarely cognitize this understanding. We talk about how wonderfully that little "CP Kid" is doing without ever understanding how well he could learn if we matched our expectations to his abilities.

The ultimate, of course, is to go beyond vocalizing and cognitizing. We need to internalize the concept that every child is an individual with a deep reservoir of untapped ability. The importance of this internalized realization cannot be emphasized enough.

Our preconceived biases are what block the child's chance to advance. He is doing so well [just look at that "B" in science!] that we are sure he has reached a fine level of understanding. **We need to look beyond the current achievement level and ask what are his actual potentials and is he being helped to actualize these potentialities?** We need to educate these students to their strengths and to stop viewing them by their weaknesses.

If we can achieve this internalized level of understanding that all children have potentials of which we may not yet be aware then we may proceed to ask why our children are underrepresented in the fields of science and engineering.

Jo Butts, Seattle-Tacoma

In the best of times, with every young person there is a crisis in graduating. It is even "more so" for young people with disabilities.

Often there are limited expectations for students with disabilities; they are put in a vocational track without the option of college education. Stereotypes of what a person with a disability cannot do get in the way of recognizing potential. Students may not know their own potential, they may be very capable but haven't been encouraged. As parents we need to have the same vision for our children who have disabilities as for our children without. We must try not to let "reality," the unavailability of services, etc., dim that vision.

We need to understand who or where is the barrier. Teachers or school counselors may discourage a student's interests, strengths. A student with LD may be counseled away from science because of reading level. There is need to begin in the elementary school. Transition is not an event, but a process. Society's views toward disabled persons may be compounded when bias related to gender and culture are add-ons to that of disability.

I know a young man with CP who is quadriplegic and also has a brilliant mind. Math and science are his strengths and his interest. He has barriers to overcome: society's view of what he can do; financial considerations—he will always need a full-time aide; and accommodations in schooling and job, housing, transportation. In postsecondary, realities are reasonable accommodations for those who are otherwise qualified.

Parent involvement—mixed messages: no entitlements; services come from many different sources; parents think there is a system, but that is a fallacy, there is no system, only isolated bureaucracies.

Muted realism—the right to strive for an unobtainable goal; maybe it is not unobtainable.

<u>References</u>

Baker, B. C. and Geiger, W. L. 1988. <u>Preparing transition specialists: Competencies from thirteen programs</u>. Vienna, VA: DISSEMIN/ACTION.

Brotherson, M. J., Backus, L. H., Summers, J. A. and Turnbull, A. P. 1986. Transitions to adulthood. In Summers, J. A. (Ed.) <u>The right to grow up: An introduction to adults with developmental disabilities</u>. Baltimore, MD: Paul H. Brookes Publishing Co.

Kochhar, C., Hagerty, G. and King, P. 1982. <u>The evolution of a commitment: Training agents for change in career/vocational education for the handicapped</u> (Policy Research and Resource Series No. 7). Champaign, IL: University of Illinois, Leadership Training Institute.

Modrcin, J. J. 1987. <u>Emotionally handicapped youth in transition: Issues and principles for program development</u>. Portland, OR: Research and Training Center to Improve Services for Seriously Emotionally Handicapped Children and Their Families, Portland State University.

Montgomery County Public Schools. 1985. Rights of passage. (Final report of the task force on the transition from school to work for Montgomery County students with disabilities). Rockville, MD: Author.

Paul, J. L. (Ed.) 1981. Understanding and working with parents of children with special needs. New York, NY: Holt, Rinehart and Winston.

VI. FACTORS ASSOCIATED WITH UNDERREPRESENTATION AND STRATEGIES TO OVERCOME BARRIERS TO CAREER ACCESS OPPORTUNITIES

Barriers to Career Access

In the first three workshops, small group sessions using the Nominal Group Technique process identified 382 barriers to career access in science and engineering for students with disabilities. Within each small group, identified barriers were ranked in terms of importance, and a total of 75 "most important barriers" emerged. There was considerable overlap among these barriers or factors associated with underrepresentation. Project staff developed an affinity diagram to combine and condense them into a summary list. This process resulted in 13 clusters which are summarized below.

1. **Attitudinal barriers**—especially lower expectations of persons with disabilities that tend to discourage development of the individual's abilities, e.g., through stereotypes, fear of differences, prejudice and discrimination, and patronizing.

2. **Lack of collaboration between education and industry**—this results in poor knowledge about future job opportunities, lack of employer understanding, and limited outreach services and activities.

3. **Poor knowledge about accommodations**—applies to both education and industry, and results, for example, in lack of physical access to curriculum materials, for example; assistive technology and adaptive equipment are neither widely known nor used.

4. **Steering students away from science and math**—early tracking in schools, generally poor academic preparation, and the public's poor knowledge of and attitudes toward the purpose of math and science.

5. **Lack of career guidance**—information on careers and academic counseling related to them.

6. **Poor self-images of persons with disabilities**—the lack of self-esteem leads to incorrect self-assessments and inflexible ideas about career possibilities.

7. **Physical barriers**—architectural barriers still exist; facilities, especially older buildings but even newer ones, are inaccessible.

8. **Cost $$$$**—more money is necessary for funding the materials, resources, staff development and support systems that are needed.

9. **Lack of self-advocacy skills**—many students fail to self-identify and request accommodations.

10. **Inadequate curriculum modifications**—inflexibility in adapting curriculum to meet the needs of persons with disabilities.

11. **Lack of contact with role models**—few role models are available and there is insufficient contact with them.

12. **Uninformed teachers**—have not been trained and don't know what to do; or, are not told ahead of time and can't plan adequately.

13. **Professors' resistance**—negative attitudes which emphasize disability; feel accommodation or modification equals "watering down."

In all five workshops, small group sessions using the Nominal Group Technique process identified 373 strategies to overcome barriers to career access in science and engineering for students with disabilities. Within each small group, identified strategies were ranked in order of potential effectiveness, and a total of 95 "most effective strategies" emerged. There was considerable overlap among these strategies. Project staff developed an affinity diagram to combine and condense them into a summary list. This process resulted in 14 clusters which are summarized below.

1. **Provide training in self-advocacy**—improve knowledge about disability, legal rights and responsibilities, and science and engineering careers; develop skills in using role models and mentors, interviewing, job search, and adaptive technology.

2. **Establish partnerships between educational institutions and industry**—improve employer understanding in recruitment and hiring, emphasizing employability of persons with disabilities and low costs of accommodation; market engineering and science to the schools; involve disability community in product design.

3. **Promote the use of technology**—match employer needs and employee skills; tax incentives for businesses; computer networks; better laboratory/computer facilities; remove architectural barriers; adaptive equipment; accessible curriculum materials; regional centers for high-tech modifications.

4. **Expand role models and mentorships**—AAAS resource group; public advertising; speakers' bureaus; starting in the middle schools; special emphasis on math and science teachers with disabilities.

5. **Training for educators**—better teaching methods for teaching science, including labs; adaptations in the classroom; use of notetakers and interpreters; include elementary and special education, vocational-technical, and college professors.

6. **Conduct educational awareness for educators, employers, persons with disabilities and the general public**—in regard to high performance levels of persons with disabilities, availability of assistive technology, opportunities in science and technology, and support organizations; improve political perceptions; answer questions.

7. **Provide effective family counseling and education**—remove attitudinal barriers of parents; begin in early childhood; connect parents with opportunities in science, mathematics and engineering.

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7. **Provide effective family counseling and education**—remove attitudinal barriers of parents; begin in early childhood; connect parents with opportunities in science, mathematics and engineering.

8. **Improve science and mathematics instruction**—more experiential learning; emphasize elementary grades; increase math and science requirements; learning style diversity; demystify science and engineering careers through increased direct contacts.

9. **Develop and disseminate good information on careers in science and engineering**—focus on careers not placement; visits to colleges and universities to see programs and research activities; job fairs, site visits, and networking.

10. **Early intervention to enhance youth awareness and skills**—science courses in elementary and middle schools; career education at elementary level; use hands-on experiences and after-school programs.

11. **Provide real work experience in science and engineering**—job shadowing for junior high students; internship programs for high school and college students; students as "scientists working on projects"; move teachers into industry for certification credit.

12. **Provide more assistance for students**—especially more assistance for students in mainstream classes.

13. **Use summer programs to increase awareness and visibility**—summer science and math programs; summer camp programs; disabled student service programs in colleges working with high schools.

14. **Improve transition from high school to college**—more and better trained counselors, e.g., in disability awareness and careers in science and engineering; disseminate information on colleges' support services; involve rehabilitation counselors.

VII. RECOMMENDATIONS

1. The National Science Foundation should encourage the dissemination and use of the workshop model as an effective approach to the study of issues involved in underrepresentation of students with disabilities. The workshop can be effectively used in local/regional demonstration projects which emphasize and/or include improving access into science and engineering careers students with disabilities. It can be particularly effective as a planning and coordination tool for needs analysis, problem assessment, strategy development, and for building networks for collaborative efforts between education and industry and between levels of the educational system.

2. The broadly stated clusters of barriers and potentially effective strategies to overcome them which were identified in this project should be the foci for future studies and demonstration projects concerned with the issues of access and underrepresentation. The National Science Foundation should encourage grantees to address these barriers and test these potentially effective strategies in future research and demonstration projects.