

7. CENTER DIVERSITY—PROGRESS AND PLANS

The NSEC based at Harvard University is committed to increasing the diversity of the science and engineering workforce, and to making science and engineering accessible to a broad audience. NSEC faculty participants are dedicated to increasing participation by members of underrepresented groups and to giving these scientists and engineers the resources and guidance needed to succeed in each stage of their careers so as to become leaders in both education and research. Our strategic plan for increasing diversity builds on connections we have made through various programs, and seeks to increase our impact by developing new partnerships, both internally and externally. The recently released reports of the Task Force on Women Faculty and the Task Force on Women in Science at Harvard present several opportunities for leveraging NSF and University support to increase participation of women and underrepresented groups in science and engineering.

We have identified five broad goals that will be accomplished through a variety of initiatives: (1) to intensify the recruiting, support, and professional development of a more diverse group of graduate students and postdoctoral researchers; (2) to increase the diversity of faculty participating in the NSEC; (3) to strengthen recruiting and mentoring of members of underrepresented groups through our joint REU programs; (4) to mentor pre-college students as they consider careers in science & engineering; and (5) to develop long-term partnerships with predominantly female and minority-serving institutions.

Goal 1: Recruiting, Professional Development, and Support of a Diverse Group of Graduate Students and Postdoctoral Researchers

Graduate students and postdoctoral researchers are at crucial stages in their careers. Their experiences in terms of professional development, mentoring, and access to facilities and other opportunities have a significant impact on their career choices. Our goal is to leverage NSF and University support to recruit graduate students and postdoctoral researchers from underrepresented groups in science and engineering, and to provide resources to the students that will empower them to become educational and research leaders.

Strategy 1: Recruiting. Many of the strategies in place in the REU program to recruit highly qualified undergraduates to the summer program have been shared in recruiting of graduate students and postdoctoral researchers, including publicizing the graduate program and postdoctoral positions at conferences and on websites that reach a large population of underrepresented minorities. The Director of Educational Programs **Kathryn Hollar** coordinates with the Director of Graduate Admissions in DEAS and the Graduate Program Administrator in Physics share resources in these efforts.

More directly, we are using the REU program as a method to recruit students to our graduate programs. Since 2005, 8 former REU students have been accepted into graduate programs at Harvard, including 3 minority students and 3 women.

Strategy 2: Professional Development and Mentoring. The NSEC has developed a program of professional development for NSEC-affiliated graduate students and postdoctoral researchers through the research exchange seminar and the AP298r course. Postdoctoral researchers and graduate students also have the opportunity to participate in

our educational programs, including developing mentoring and project management skills through our REU program and experience in presenting to K12 classrooms through connections with our GK12 and RET programs, and engaging the public at the Museum of Science, Boston.

The NSEC will also work in concert with the Division of Engineering and Applied Sciences, the Chemistry and Chemical Biology Department, the Physics Department, and the University administration to leverage support for more professional development opportunities for graduate students and postdoctoral researchers. We will use some of our funding to support these professional development activities and for travel support. An example of one such activity, a visit by Dr. Virginia Valian, is discussed below.

Strategy 3: Support. The NSEC supports several postdoctoral researchers from underrepresented groups each year through prestigious postdoctoral fellowships. Past and present Postdoctoral Fellows are listed in *Section 8—Education*. In the future, we will continue this valuable form of support, and also work collaboratively with the MRSEC to offer opportunities for women and minority postdoctoral researchers and graduate students to form a community in which issues unique to underrepresented groups can be addressed.

Goal 2: Increase Diversity of Faculty Participating in NSEC

One of the major challenges facing the science and engineering community is to increase the diversity of the faculty ranks. The collaborative and interdisciplinary nature of the research of the NSEC provides a supportive environment that effectively integrates young scientists and engineers into a vibrant scientific community at the beginning of their academic careers. The NSEC also provides access to cutting-edge instrumentation facilities, which are a valuable resource at an early career stage. Furthermore, several NSEC Faculty have leadership roles at Harvard—e.g., **Narayanamurti**, Dean of Physical Sciences and DEAS, and Friend, Chair of the Chemistry and Chemical Biology Department and Associate Dean of FAS—and are committed to making progress in this key area. Taken together, the NSEC at Harvard is ideally positioned to play a leading role in diversifying the faculty in science and engineering at Harvard.

Strategy 1: Partnership with Radcliffe Institute. As discussed in Section 9, we partnered with the Radcliffe Institute this past year.

Strategy 2: Leadership and Focus in Faculty Hiring. The sciences and engineering at Harvard are experiencing a period of rapid growth, and faculty in the NSEC are in leadership roles at Harvard that can influence the recruitment and support of new faculty. The highly collaborative environment of the NSEC and the availability of world-class instrumentation also provide an ideal opportunity to develop the careers of new faculty. Junior faculty at Harvard contribute significantly to each research cluster within the NSEC. One recent example, is **Xiaowei Zhuang** who has played an important role in developing new directions in the NSEC. Close interaction with senior faculty helps new faculty to develop stronger individual research and educational programs. Senior faculty in the NSEC who are also in leadership positions at the department and university level include:

Professor **Cynthia Friend**: Chair of Chemistry and Chemical Biology
Professor **Robert Westervelt**: Member of Diversity Committee, Physics Department
Professor **Howard Stone**: Associate Dean of Academic Programs, DEAS
Professor **Venkatesh Narayanamurti**: Dean of Physical Sciences, Dean of DEAS

These faculty and others have a strong commitment to increasing diversity, as evidenced by participation in this dialogue at a national level. For example, **Cynthia Friend** co-chaired the recent workshop on *Building Strong Academic Chemistry Departments through Gender Equity* at NSF in Arlington, VA, January 19–21, 2006 (<http://www.chem.harvard.edu/groups/friend/GenderEquityWorkshop/resources/pdf/Recommendations.pdf>).

Goal 3: Strengthen Recruiting and Mentoring of Underrepresented Groups through the REU Program

NSF support for the REU programs of the NSEC and allied programs in Materials Research provides core funding for a growing undergraduate research program that includes substantial funding from Harvard. These joint programs, which now support over 45 students each summer, share a common infrastructure for recruiting, providing community and professional development activities during the program, intensive mentoring during the summer and post-program, and program evaluation and tracking. Connections made through our REU program's focus on diversity also serve as critical building blocks for our strategic diversity plan.

Strategy 1: Recruiting. A special initiative spearheaded by **Howard Stone** recruits and engages excellent students from Historically Black Colleges and Universities (HBCU) in our summer REU programs. This recruiting effort has expanded to include universities with predominantly Hispanic enrollments, and primarily undergraduate institutions that serve women. Faculty and staff have visited Morgan State University, Howard University, Morehouse College, Spelman College, Florida Agricultural and Mechanical University, the University of Puerto Rico (Rio Piedras and Mayaguez campuses), Sweetbriar College, and Texas Prairie View Agricultural and Mechanical University. At these recruiting visits, we discuss not only the opportunities available at Harvard, but also the characteristics of a strong application for a research experience program. Former REU students at these institutions often lead discussions on the summer research experience. Additionally, faculty and staff recruit at professional and research conferences and career fairs for underrepresented groups, including the joint annual conference of the National Society of Black Physicists and the National Society of Hispanic Physicists; the National Society of Black Engineers, a National Conference on Hispanics in Engineering, and New England Board of Higher Education Minority Career Fair at MIT. To reach a wider audience of applicants for our REU program, we partner with the Graduate Admissions Offices of various departments, including DEAS and Physics, to distribute materials advertising our program at these conferences and career fairs. Attendance at these conferences aids us in recruiting students and in following up with past REU alumni (Figure 7.1). In 2006, we have recruited at least 3 very talented students from these conferences to our REU program



Figure 7.1. (*Left*) Postdoctoral Fellow Dr. Mark Bray delivers an invited talk at NSBP, and (*Right*) chats with former REU student Branden Reid. Branden has been accepted to Harvard's Ph.D. program, as well as several other prestigious institutions.

In addition to these recruiting visits, we also advertise on many websites and listservs that are resources for underrepresented groups. REU participants report that the internet is an important resource for finding summer programs; therefore, we also advertise on web sites and listservs that target underrepresented groups in engineering, such as the Faculty for the Future website (www.engr.psu.edu/fff/), and the Women in Engineering Professional Advocates Network (WEPAN). These efforts resulted in an increase in applicants to the joint programs from 247 in 2004 to 346 in 2005.

Through the National Research Centers Educators Network (NRCEN), **Kathryn Hollar** has also made many connections with minority-serving institutions and organizations. The NRCEN is developing a plan for sharing information on resources for diversity across the network of NSF Centers.



Figure 7.2. Dr. S. Allen Counter, well-known neuroscientist and explorer, and President of the Harvard Foundation for Intercultural and Race Relations, addresses REU participants and mentors at a luncheon.

Strategy 2: Mentoring and Professional Development.

The summer REU program includes many community-building and professional development activities for both REU participants and mentors, including a workshop on presentation skills, a luncheon on applying to graduate school, and weekly presentations by faculty on research and ethics. An intimate luncheon hosted by the Harvard Foundation for Intercultural Affairs gives

students from underrepresented groups a unique opportunity to interact with a small group of faculty (Figure 7.2). This luncheon has resulted in many instances of mentoring that have extended beyond the summer program, and will continue to be an integral part of our plan for minority students.

Through our REU program, we strive not only to develop a supportive community for students from underrepresented groups, but also to encourage our *entire* community to approach issues of diversity in science and engineering thoughtfully and proactively. To this end, **Cynthia Friend** garnered additional university support for an extensive visit by Dr. Virginia Valian, an acclaimed author and analyst of gender stereotypes for the summer 2005 REU program. In this intensive workshop, REU students, graduate students, postdoctoral researchers, faculty, University administrators, and staff had a unique opportunity to examine and discuss the effects that gender stereotypes have on the success of women in science and engineering. We anticipate that this workshop will have a long-term impact on how our faculty, graduate students, and postdoctoral researchers approach interactions with colleagues and students, and increase awareness of intrinsic biases in the academic culture.

In 2005 we chose to discuss with our undergraduate participants and their mentors some of the ethical dimensions of the implicit assumptions about gender that affect the advancement of women scientists and engineers. Professor Virginia Valian, author of *Why So Slow? The Advancement of Women*, was invited to speak with our REU students and their mentors. Because of the potential impact of this topic on a wider audience than our community of REU/RET participants and mentors, we were able to garner additional support from the Faculty of Arts and Sciences, the Graduate School of Arts and Sciences, the Radcliffe Institute to bring her for an entire day of workshops on gender equity for university administrators, faculty, staff, REU participants, and graduate students and postdoctoral researchers. Her visit also included a public talk that filled a 250-seat auditorium (Figure 7.3).

Dr. Valian met with REU students in the morning and again in the afternoon. During the morning session, she led the REU students in a discussion on how to seek out a “circle of advisors” of different backgrounds and expertise to help them define and realize their goals. Students were asked to take this discussion back to their laboratories and engage their mentors in a discussion on this topic.

In the afternoon, Dr. Valian led students in an exercise on how to effect change at their home institutions. Prior to Dr. Valian’s visit, we asked REU participants to perform an informal study of the gender of colloquium or seminar speakers in their home department or at a potential graduate school, and compare the percentage of women speakers to data on the percentage of tenured women in the broad discipline of their chosen department. As students shared results, participants were surprised at the low numbers of women in certain fields. This realization led to a discussion of how to advocate effectively for change, including the importance of gathering data and proposing action.

Many students reported conversations with their mentors following the workshop. Two participants, Krystal Barker of Bowdoin College and Hillary Smith of Bryn Mawr College, have communicated that this workshop has had a significant impact that they have been inspired to share with others (comments and names used with their permission):

“I want to thank you for inviting Dr. Valian to speak with us as well as giving us the opportunity to attend her workshop and presentation. I was especially enlightened at the steps to contact others and to make a change on university and college campus not so much however for women but for African-Americans.



Figure 7.3. Clockwise from top left: REU students discuss strategies for changing the culture of science and engineering during an afternoon workshop, audience members listen as Dr. Valian relates the results of her research on gender and advancement, Dean Barbara Grosz makes a point during a workshop for administrators as Dean William Kirby listens, Professor **Cynthia Friend** introduces Dr. Valian. Center: Dr. Valian explains the concept of “a circle of advisors” to REU students during the morning workshop.

I am the president of the African-American Student Organization at Bowdoin for this year. We have a large number of bright black students but no representation in the faculty especially in science. What is also depressing is that a lot of blacks drop out of science because they feel they are unprepared and cannot handle the field. Also, it is not a nice situation to attend classes and lectures with no people who look like you do. So I am working with my organization and others to bring about some change. We are inviting faculty and also alumns in science. I am passionate about the advancement of blacks especially in science and business. So this talk was useful for me and my organization. Thanks.”

–*Krystal Barker, NSEC REU participant*

Hillary Smith was motivated by the workshop to share her insights with the physics community: “The Virginia Valian talk was definitely something that got me thinking. Going to a womens' college, I have been to lots of gender discussions, and it is something we talk about in the department a lot. But the Virginia Valian workshop was something that sparked a conversation between me and Dr. Burns. We talked about gender issues in science over lunch a few times, and even talked to some other folks at the Rowland. It was an issue that I realized some people are not even well aware of, let alone attempting to change.” In January 2006, Hillary traveled to the *American Association of Physics Teachers* Winter 2006 meeting to give a talk, “Five inexpensive ways to involve more women in undergraduate physics.” Her goal was to make “people aware of how small changes in the way a department or school operates can have a huge impact on attracting women to science.”

Strategy 3: Post-Program Mentoring and Tracking. The relationships developed during the program extend past the summer; mentors provide guidance and support as students apply to graduate school, and also include students in the process of writing and submitting papers that are based on their summer work. Students are encouraged to present their work at local and national conferences, and funds are available through the REU/RET Site in Materials Research to support travel for mentors and REU participants to national conferences.

Goal 4: Introduce *Pre-college Students* to Science and Engineering Programs through Summer Camps or Year-round Programs

We continue to expand our repertoire of activities for pre-college students and teachers, focusing on collaborations that effectively impact schools and students that have high need or significant achievement gaps between student groups.

Strategy 1: Increase Collaboration with Cambridge Public Schools at the High School Level. In 2005–2006, Cambridge Rindge and Latin School offered a new course, “Research Seminar in Science, Technology, and Design,” for advanced students. This innovative course is part of the *Cambridge Science Initiative*, which seeks to provide extraordinary opportunities for *all* students and teachers in Cambridge Public Schools through partnerships with universities, industry, and other community partners.

This involvement builds on a relationship and infrastructure already established through short-term assistance on science fair projects, including project mentoring and judging.

Strategy 2: Strengthen Collaborations with Cambridge Middle Schools, Parents, and the Community. As discussed below in *Section 8—Education*, NSEC Faculty participate in Project TEACH (The Educational Activities of Cambridge-Harvard), which brings each 7th grade class from CPSD to Harvard for a college awareness and science presentation day. The Cambridge Public School District is an urban district that is over 60% minority, with 37% of students enrolled in a free or reduced lunch program.

In October 2005, we participated as partners with Cambridge Public Schools in a Community Science Day at Cambridge Rindge and Latin School. This large event is part of the Cambridge Science Initiative, which seeks to engage the community in science education.

Strategy 3: Develop Connections with Urban Schools through RET. Our RET program recruits teachers from local urban schools to participate in the Center’s research and educational activities for 6–8 weeks during the summer. We encourage many follow-up activities with teachers, including classroom visits and field trips to Harvard. As we continue to build research and educational programs in close partnership with CPSD, we will integrate our RET teachers and their students into these activities.

Strategy 4: Pursue Internal Partnerships. A new partnership with the Crimson Summer Academy at Harvard (www.crimsonsummer.harvard.edu) gave us an opportunity to collaborate with a program that already has tracking and follow-up during the school year. The Crimson Summer Academy is a 3-week summer program for financially-disadvantaged students recruited from public and parochial schools in Boston and Cambridge. The program, which admits 30 new rising sophomores each year, includes intensive academic activities during the summer and mentoring during the school year, with the goal of preparing these students for college and beyond. During their second summer in the program, Crimson Scholars participate in Career Exploration Field Experiences during the 6-week program. Students choose 3-week Career Exploration track to participate in over the summer.

The NSEC co-hosted a Career Exploration module for Crimson Scholars in conjunction with our joint Research Experiences for Undergraduates (REU) Programs,



Figure 7.4. (Left) REU students share strategies for selecting an undergraduate major and institution, as well as tips for obtaining scholarships. (Right) Professor **Eric Mazur** gives a presentation on *Stopping Time* to REU and Crimson Summer Academy participants.

which recruits students from diverse backgrounds and institutions. This half-day included: a luncheon and panel discussion with REU students, graduate students,

postdoctoral researchers, and faculty on preparing for a career in science and engineering; lab tours; a faculty research presentation; and a reception for all participants (Figure 7.4).

These four initiatives, natural extensions of established relationships, are examples of how we will continue to develop science education partnerships that engage students, teachers, and parents.

Goal 5: Develop Long-term Research and Educational Collaborations with Predominantly Female or Minority-serving Institutions

We will build on the connections we have made with predominantly minority-serving institutes through our REU program to develop research and educational collaborations. This connection will be strengthened by extending the visit to include a series of guest lectures in core engineering classes and a research seminar for students. We continue to build on the connections we have made with predominantly minority-serving institutes through our REU program to develop research and educational collaborations. For example, **Howard Stone** visits Morgan State University (one of the HBCUs) each year to recruit students for our REU program. The summer of 2006 will mark the fourth consecutive summer that **Stone** will host at least one student from Morgan State. The interactions have been productive and beneficial. Two of the Morgan State Students are coauthors on papers and have presented the results of their research at the APS Division of Fluid Dynamics Annual Meeting. This connection will be strengthened by extending **Stone**'s visit to include a series of guest lectures in core engineering/physics classes and a research seminar for students. **Stone** is in the process of exploring and planning this possibility.

Our goal over the course of NSF support is to formalize these research and educational partnerships with predominantly female and minority-serving institutions by facilitating the exchange of educational strategies and developing research collaborations. We will use these partnerships as a foundation to pursue participation by Harvard in several of the established programs of NSF, including Alliances for Graduate Education and the Professoriate, the Louis Stokes Alliance for Minority Participation, and Partnerships for Research and Education in Materials.

8. EDUCATION AND HUMAN RESOURCES

Current and Planned Activities

Center participants continue to be actively involved in programs that engage the public, teachers, students, and young scientists and engineers in the excitement of scientific discovery and increase awareness of the impact of scientific research on their daily lives. Our broad goals are to increase public engagement in and awareness of advances in nanoscale science and engineering, and to promote career advancement for a diverse group of young scientists who represent the future of science and engineering. We continue to enhance and expand existing programs and collaborations that address the needs of a diverse population (http://www.nsec.harvard.edu/pages/education_mos.htm). Our educational initiatives at the pre-college, undergraduate, graduate, and postdoctoral levels include embedded diversity initiatives and strategic collaborations whenever possible to encourage individuals from underrepresented groups to pursue careers in science and engineering.

Public Presentations—Holiday Science Lecture for Children

Howard Stone, Postdoctoral Fellow Dr. Daniel Blair, Daniel Rosenberg (Harvard Science Center demonstration staff), and Educational Programs Director **Kathryn Hollar** developed the fourth annual interactive Holiday Lecture, “*It’s Elementary, My Dear Einstein*,” that was held December 11, 2005. This children- and family-friendly science presentation is modeled after the Christmas Lectures first presented by Michael Faraday at the Royal Institution. This year’s lecture was attended by over 250 children and adults. Demand for the lecture exceeded lecture hall capacity, and we have rescheduled an encore presentation for April 22, 2006.

This presentation was also adapted for the 12th annual Saturday Science Conference, which is organized each year by the Harvard Foundation for Intercultural and Race Relations (Figure 8.1). The conference hosts over 100 elementary, middle and high school children from the Boston and Cambridge schools.



Figure 8.1. Professor **Howard Stone** demonstrates Brownian motion with the help of volunteers from the audience at the 12th annual Saturday Science Conference hosted by the Harvard Foundation for Intercultural and Race Relations.

Community Engagement—K12 Students, Teachers, and Parents

In addition to events on the Harvard campus that engage the public, faculty, postdoctoral researchers, and graduate students also participate in off-site public science events such as science fairs and community science days. For example, at the first annual *Science in the City* celebration at Cambridge Rindge and Latin School in October 2005, several faculty, postdoctoral researchers and graduate students shared their research with interested citizens of Cambridge in small venues (Figure 8.2).



Figure 8.2. Dr. Tomasso Baldacchini demonstrates some of the unique properties of black silicon to attendees of *Science in the City*.

Public Engagement—NISE-Net

The NSEC based at Harvard is also providing scientific support for the newly awarded NSF Nanoscale Informal Science Education Network (NISE-Net). Professor **Robert Westervelt** is the chair of the NISE-Net scientific advisory board, and Professors **George Whitesides** and **Eric Mazur** also serve as advisors to NISE-Net. Education coordinator **Kathryn Hollar** has also participated in planning public forums on nanotechnology, which will occur network-wide in May 2006, and in planning and recruiting for workshops for graduate students and postdoctoral researchers (also in May).

Pre-College Activities—Project TEACH

NSEC faculty share their enthusiasm for science through Project TEACH (The Educational Activities of Cambridge and Harvard). This early college awareness program is a joint effort of the MRSEC, the NSEC based at Harvard, and the Harvard Office of Community Affairs. Coordinated with the Cambridge Public Schools, Project TEACH brings each 7th grade class (approximately 400 students) from the Cambridge Public School District to Harvard University throughout the school year. During the visit, students receive information about college admissions, and learn about college life from Harvard undergraduates. The class visit culminates in an interactive science presentation by a NSEC faculty on his or her research and its societal benefits. The Cambridge Public School District is an urban district that is over 60% minority, with 37% of students enrolled in a free or reduced lunch program.

RET Program

The NSEC, in collaboration with an REU/RET Site in Materials Research and Engineering, hosted 5 teachers in 2005. These teachers work with faculty, postdoctoral researchers, graduate students, and REU participants on research or science curriculum projects. Teachers commit to 6–8 weeks during the summer, and are invited for a second summer to refine educational modules that are developed as a result of their research experience.



Figure 8.3. (Left) RET participant Bryan Menegoni (l) demonstrates biology modules to RETs Aaron Osowiecki and Christina Talbot at the end of summer poster session. (Right) Christina Talbot shares a module on soft lithography with teachers at the University of New Hampshire.

RET participants also attend weekly seminars on research topics and on research ethics. The integrated nature of RET and REU activities, particularly the faculty seminars during the summer, provide ample opportunity for teachers to explore development of small classroom modules based on seminar content.

In addition to weekly afternoon research and ethics seminars that were part of the REU/RET program, RET participants met weekly over lunch to discuss informally their research projects and how to best relate their summer research project to their curricula. The summer research experience for teachers culminated in a poster session. Teachers took these posters back to their classrooms to give students an introduction to scientific research, and to emphasize that science and engineering careers are accessible, interesting, and that science and engineering profoundly affect everyday life. These posters have also served as the basis for talks at regional and national conferences for teachers and faculty (Figure 8.3). Materials developed by teachers can be accessed at our website, www.eduprograms.deas.harvard.edu/RET.htm. Participant and project information can be found in Table 8.1.

Table 8.1: NSEC RET Participants, 2005

RET Participant Subject/School	Project Title
Bryan Menegoni <i>Environmental Science, Biology, Chemistry</i> (Marblehead High School, MA)	<i>Promoting Conceptual Understanding in the Classroom: An Examination of Interactive Engagement Pedagogies</i>
Aaron Osowiecki <i>Physics</i> (Boston Latin School, MA)	<i>Transformers: "More Than Meets the Eye"</i> <i>Looking at Transformers in the Classroom</i>
Christina Talbot <i>Physical Science</i> (Memorial High School, NH)	<i>Soft Lithography Made Simple and Inexpensive: Bringing New Technology to the Introductory Chemistry Lab</i>

This program also enriches our collaboration with the Museum of Science, Boston. Christina Talbot and graduate student Logan McCarty led a workshop on soft lithography during the Nanotechnology Symposium for teachers at the Museum of Science, Boston in

November 2005, which served over 80 teachers in the Boston metropolitan area. This module was further disseminated at a workshop for teachers at the 2nd Annual Nanotechnology Conference, sponsored by the NSF Center for High-Rate Manufacturing, which reached over 70 teachers from New Hampshire. At least 2 more presentations by RETs are planned for summer 2006.

Undergraduate Activities—REU Program

The NSEC has increased the number of REU participants by substantial supplemental funding from the Division of Engineering and Applied Sciences (DEAS), Harvard College, and the Rowland Institute at Harvard (Frans Spaepen, Director). An NSF-funded REU/RET Site in Materials Research (PI **Cynthia Friend**) has also allowed us to expand our professional development opportunities for participants, including an ethics component.

Figure 8.4 shows the demographic make-up of the 9 REU participants who were fully or partially funded through the NSEC. Of these students, 3 were from underrepresented minority groups in science and engineering, and 5 were female. Three of the students identified themselves as first-time college-goers or from economically disadvantaged backgrounds. Of the 9 participants, 5 were rising sophomores, 3 were rising juniors, and 1 was a senior. Three of the students were from institutions without major research facilities, including one student from a community college. REU participants funded in part or in full by NSEC are shown in Table 8.2.

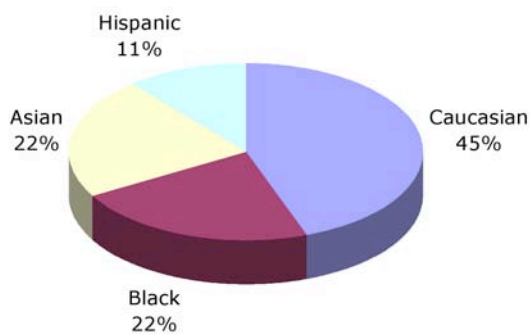


Fig. 8.4. Demographics of students receiving NSF support through NSEC.

Table 8.2: REU Participants, 2005

REU Participant/Institution	Project Title
Jonathan Aguilar /Harvard University	<i>Dielectrophoretic Manipulation of Particles with a Modified Atomic Force Microscope Tip</i>
Krystal Barker /Bowdoin College	<i>Waveguides Fabrication by Two-Photon Absorption Polymerization</i>
Allan Chu /Harvard University	<i>Nanowire Manipulation via CMOS-Controlled Dielectrophoresis</i>
Clarmyra Hayes /Harvard University	<i>Dielectrophoretic Manipulation of Micron and Nanoscale Objects with a Modified Atomic Force Microscope Tip</i>
Rachel Hillmer /University of Illinois-Urbana-Champaign	<i>Exploring the Casimir Force Using AFM Techniques</i>
Christina Lu /Brandeis University	<i>Fabrication and Characterization of Metallic Nanodisks</i>
Edwin Macomber /Bristol Community College	<i>Micro Engineering Design of Two-Dimensional Cardiac Tissue</i>
Emilio Nanni /University of Missouri-Rolla	<i>Surface Enhanced Raman Scattering Using Laser Nanostructured Silicon</i>
Darry Saunders /Elizabeth City State University	<i>Superconducting Zinc Nanowires</i>

The enhanced infrastructure provided by the REU/RET Site Program has allowed us to expand the program of professional development workshops, faculty seminars, and social and cultural activities that are designed to create community among participants and research advisors. These activities continue to include mentor training prior to the program start; weekly faculty-led research and ethics seminars; professional development workshops, including written and oral presentation skills workshops; large and small group discussions on applying to graduate school; and various athletic and social events during the summer.

One goal of our REU program is to develop essential skills in communicating effectively with scientists and the public. In collaboration with the Museum of Science, Boston, we hold a presentation skills workshop for REU students (see Figure 8.5). During this workshop, students receive guidelines from the staff of the Current Science & Technology Center at the Museum of Science, Boston, on how to present complex scientific concepts, then observe postdoctoral fellows and graduate students during a presentation and coaching session led by Museum of Science Staff. REU participants then see the final presentations at the Current Science & Technology Center at the



Figure 8.5. (Top Left) Dr. M.J. Morse of the Museum of Science, Boston, demonstrates various presentation styles to REU students. (Bottom Left) Postdoctoral Fellow Nicholas Geisse is coached after his presentation as REU students listen. (Right) REU participant Edwin Macomber presents at the end of summer REU Symposium.

Museum of Science, Boston. This format is very effective in increasing the confidence of these young scientists and engineers in discussing science with their peers and mentors, and demystifies the process of receiving constructive feedback. The workshop is followed by evening practice sessions in the week prior to the final symposium. An added benefit of the workshop format is that two presentations for the public were developed and given at the Museum of Science, Boston.

In addition to the end-of-summer research symposium, mentors are encouraged to seek out opportunities for their students to participate in professional meetings. This type of early exposure to the professional life of an academic is essential in encouraging young scientists and engineers to continue in academia.

Mentoring an REU student is a valuable professional development opportunity for a graduate student or postdoctoral researcher, allowing this population to explore effective models for project management. To enhance this experience for mentors, we have

implemented a series of program preparation sessions with REU mentors. New mentors participate in a series of luncheons in which faculty and other experienced mentors share strategies for mentoring undergraduate students, including planning a realistic project, modifying project goals, effectively managing time, and motivating students to work independently and as part of a team.

Graduate Activities—Course and Seminar Development

In addition to the mentoring and professional development activities embedded in our other educational programs, graduate and advanced undergraduate students participate in AP298r, *Interdisciplinary Chemistry, Engineering and Physics*, an interdisciplinary graduate survey course of ongoing research at the Center. NSEC Postdoctoral Fellows and graduate students also participate in the biweekly *Research Exchange seminar*. These activities are discussed in **9. Outreach and Knowledge Transfer**.

Postdoctoral Fellowships for Members of Underrepresented Groups

We have established Center fellowships to encourage the participation of women and minority groups in science and engineering. These Fellows are integrated into the research and educational community of the NSEC, and connections with faculty and institutes across the university are facilitated through this program. Access to research facilities and educational and professional development opportunities helps develop a strong pool of well-prepared researchers for faculty positions and the scientific community. These Postdoctoral Fellows include: Vidya Ramaswamy (Advisor: Michael Aziz; now at General Electric); Amy Prieto (Advisor: **Hongkun Park**; now a faculty member at Colorado State University); Laurie Calvet (Advisor: **Marc Kastner**, MIT; now in postdoctoral position in Paris, France); Heather Tavernier (Advisor: **Moungi Bawendi**, MIT); Mark Bray (Advisor: **Kevin Kit Parker**). Applications for new Fellows are solicited each spring.