

*Sheila M. Humphreys
Department of Electrical Engineering and Computer Sciences
University of California at Berkeley
Berkeley, CA 94720*

Abstract

The Department of Electrical Engineering and Computer Sciences, University of California at Berkeley, has organized a program of undergraduate research during the past eight summers. Called SUPERB (Summer Undergraduate Program in Engineering Research at Berkeley), the program brings six to eight underrepresented minority students to Berkeley for a research experience. Individual faculty provide eight-week research projects and welcome students from other universities and colleges into their research groups. The goals of the program are to affirm the motivation of the students for graduate study while strengthening their qualifications. Based on evaluation of the program and annual tracking of the student participants, these goals have been met. About 75% of SUPERB alumni have attended or are attending graduate programs in engineering. In addition, other unanticipated positive effects have resulted. The Berkeley REU model differs from some others in ways which present interesting challenges.

Background

An NSF study several years ago concluded that undergraduate research is the most critical factor in predicting whether a student will pursue graduate study. Departmental concern about the diversity of our graduate student population led EECS students and faculty to seek funds to initiate SUPERB in 1990. The Berkeley campus provided funds for the first year of the program; NSF's Research Experiences for Undergraduates has funded the core activities of program since that time. The Chair of the Department serves as the Principal Investigator.

Student Population Served

One way in which the Berkeley EECS REU differs from many other is that it has always served underrepresented minority students and since 1997, first-generation college students. The students have come from both majority and minority institutions, as a result of widespread publicity. Historically Black Universities have been particularly well represented. Chicano students have come mostly from the California State University System or from other UC campuses. Since 1990, 15 women and 33 men have participated in SUPERB. The ideal SUPERB student at Berkeley has completed the junior year, with at least some upper-division technical coursework as a foundation for

research. However, sophomores are now applying in greater numbers and have succeeded as well.

Role of Graduate Student Mentors

Each SUPERB student is assigned a graduate student mentor, who receives a stipend of \$500 and provides daily guidance. It is notable that within the culture of the EECS graduate community, senior graduate students often supervise new graduate students in research groups. The SUPERB faculty mentor delineates the research project with the graduate student mentor; ideally, the project relates closely to the graduate student's doctoral research. The advantage of graduate student mentors in our REU is twofold; graduate students are more approachable than faculty and thus more likely to develop truly collegial relationships with undergraduate researchers, and their daily presence provides closer collaboration than would be possible with faculty. Indeed, the Berkeley REU model relies on the energy and commitment of the graduate student mentors. Graduate students, in turn, learn something about management of research.

Evaluation

The REU program has been evaluated in three ways: formatively, during the summer program, summatively, at the end of the eight-week period, and longitudinally, since the program's inception. Formative evaluation has led to short-term corrections, such as research mismatches, insufficient mentoring, or, logistical difficulties such as a need for equipment. Questionnaires administered at the end of the program, supplemented by interviews, provide a good picture of students' perceptions of the value of the SUPERB experience.

The program is perceived by students to have increased their motivation to aspire to graduate school. Students from smaller institutions with no Ph.D. programs were learning about research universities for the first time, and learning to feel comfortable in a new kind of academic environment. Some of the comments from students in 1997 attest to the way in which the program increased their confidence through exposure to the graduate school environment:

- I had always planned on attending grad school. SUPERB was nice because I learned more about the grad

school application process and I had the experience of doing research.

- I wasn't seriously thinking about grad school until I attended SUPERB.
- Now I have a firm understanding of graduate school.
- I planned on grad school when I came in, and the program simply reassured me that I'm on the right path.
- My experience in the SUPERB program and interaction with grad students has boosted my confidence level and desire to enter a graduate study.

The summer research experience appears to help students focus on their undergraduate coursework. In reply to the question "How will SUPERB affect your next academic year?" students gave these responses:

- I have to do a senior thesis next year so I will definitely do a research project.
- After doing work on this project, my interest in this subject has increased. Therefore, courses in this area are also more interesting.
- I have a better understanding of how to study. Also, I can motivate myself.
- My SUPERB project covered many subjects that I will take in the future, so I should be better prepared for them.
- SUPERB has given me an insight on Graduate School, so I will try to use the techniques I learned here at school.
- I have a good understanding of what subjects are of great importance and possible application.

When asked to cite "the most important aspect of the SUPERB experience," students cited the demystification of graduate student life:

What is the most important aspect of your SUPERB experience?

- Learning more about graduate student life and the application process.
- That I am now very serious about going to grad school.

- The chance to work with graduate students and do research. It gave me a chance to see what actually goes on at grad school.

- The entire grad school experience. SUPERB offered an invaluable insight into the life of grad students, both through the experiences and interactions.
- My mentors, the SUPERB and EECS staff, my fellow SUPERB members.
- The important highlights include: Gaining knowledge on the grad application process, fellowships, test. Another important aspect is learning what grad students do during their educational career.
- Besides learning so much in my area of interest, I had the chance to learn about very interesting areas of research. Also, the people involved in the program are very special. It was good to meet all of them.

Since 1990 a total of 48 undergraduates have participated in the SUPERB program. Of these, 15 have been women and 33 men. Nine of these students have enrolled in MS or Ph.D. programs in EECS at Berkeley, and at other graduate programs such as UCLA, and Stanford. One SUPERB alumna has already completed a Ph.D. in electrical engineering at Berkeley, and three students have received Master's degrees. Three more are within 18 months of receiving the Ph.D. in electrical engineering. Four have been awarded National Science Foundation Fellowships; one has earned an M.B.A. at Harvard Business School. The senior doctoral students graduated from Howard, North Carolina A & T, and Prairie View A & M, respectively, all Historically Black Universities. It is both interesting and gratifying that all the former SUPERB students who have enrolled at Berkeley have taken an active role in both formal and informal mentoring of succeeding cohorts of SUPERB students.

Future Challenges

The Berkeley REU model presents several challenges. Competition for students is more keen than in other engineering fields; students in electrical engineering and computer science are currently swamped with offers for lucrative summer employment. The \$3,000 NSF stipend for eight weeks, including lodging, does not match competing offers from industry. In fact, the EECS Department must raise funds to provide the \$500 increment in the student stipend from \$2500 to \$3,000. Given the limited number of slots (6), we struggle to recruit the most able students who will profit from the experience.

Despite NSF support, SUPERB is a costly program. The budget submitted to NSF for the SUPERB REU does not begin to cover expenses; the EECS Department matches the grant by paying all costs of research, staff time, administration, graduate student salaries, recruitment expenses during the year, and supplementary funds for social activities and industrial field trips.

The focus of our program on diversity is problematic. The passage in November 1996 of Proposition 209 presents us with a situation in which it is necessary to define the SUPERB program more broadly in order to preserve the intent and spirit of the program. SUPERB is an outreach (as compared with an admissions or hiring) program. Because the federal funds from the NSF REU program are not technically constrained by Proposition 209, the program may continue. However, the current political climate makes it very necessary to defend the program's focus on diversity both on and beyond the campus.

Faculty availability for programs like SUPERB can be unpredictable. Faculty in major research universities regard the summer as a time to catch up, travel to conferences, and concentrate on their own research. Hence, some of the faculty who would make the best SUPERB mentors are not available to serve during the summer.

The criterion for determining the success of SUPERB may be viewed broadly or narrowly. Our stated goal is to motivate students for graduate study by giving them a positive exposure to research. Secondly, the department wishes to attract them to Berkeley, and a total of nine students have matriculated at Berkeley. Competition for admission to the Berkeley EECS graduate program, however, is keen; competent SUPERB students who wish to attend Berkeley are disappointed if denied admission. Because of the internal overhead of the program, the only measuring stick for the success of the program for some people is "How many SUPERB students enrolled at Berkeley?"

Finally, there is a question about whether EECS will be able to continue SUPERB after the end of the current NSF REU grant. In the wake of anti-affirmative action legislation in California, it may be very difficult to sustain the program as now designed without the considerable external leverage and prestige from the National Science Foundation.