The Summer Undergraduate Program in Engineering Research at the University of California, Berkeley (SUPERB-IT Program)

FINAL EVALUATION REPORT

National Science Foundation Research Experiences for Undergraduates: Grant #0097289

April 1, 2001 – March 31, 2006

For more information, please contact:

SJB Research Consulting, Inc.
240 East 55 Street
New York, NY 10022

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ABSTRACT

"SUPERB is a vital program because it not only clears up the metaphorical fog that tricks people into believing that they can't undertake doing research, but at UC Berkeley especially, with the support of the staff, students are allowed to work side by side with Ph.D. candidates and sometimes professors on new cutting edge research."

The Summer Undergraduate Program in Engineering Research at the University of California, Berkeley in Information Technology (SUPERB-IT) offers a diverse group of students from across the country the opportunity to gain eight full weeks of research experience through the Department of Electrical Engineering and Computer Science (EECS). At the end of the 2001 – 2005 funding period, a retrospective study was conducted of the 30 student participants and a sample of faculty mentors over the course of those five years. The purpose of this external evaluation was to assess long-range outcomes of the undergraduate research program and experience.

The findings presented below are from the 25 of 30 SUPERB students who responded (83%) to an online follow-up survey and the seven faculty mentors who were interviewed.

- Almost 90% of the respondents (who were typically in their junior year) said the SUPERB program was their first opportunity to do research as an undergraduate.

- 84% said they felt more confident they that could succeed in graduate school,

- 80% realized they could go further in their career than they thought before SUPERB, and

- 76% agreed (52% agreed strongly) that they went from feeling uncertain about going to graduate school to becoming certain they would go because of SUPERB.

Each of the 25 respondents (100%) applied (or for most recent cohort, planned to apply) for admission to graduate school. This occurred among a group of students in which most were attending undergraduate schools with few or no research opportunities for students in their field and/or which do not grant doctoral degrees. Over half the students' parents had no higher than a high school diploma, including a few with only grade school education. Most were from populations typically underrepresented in EECS. Yet SUPERB students' academic and career paths show not only retention in their field, but also very high participation in graduate education.

- SUPERB students who applied to UC Berkeley's EECS graduate program were admitted at a higher rate than the EECS Department.'s normal rate of about ten percent. They had an "admit rate" of 27 percent (4 of the 15 applicants were admitted.)

- Of the 25 respondents, 23 have continued in the fields of engineering and information technology, a retention rate that is particularly strong for students often underrepresented in these fields.

- Eight earned a technical master's degree: six were working in engineering positions and two in computer science. An additional former SUPERB student worked in a computer science position and plans to pursue her MBA.

- Ten students are pursuing a Ph.D., three in electrical engineering, five in Computer Science, and two in another engineering field. Four are working towards a master's degree in electrical engineering.

Faculty mentors believe that SUPERB makes a difference in students' lives because of the combination of research, mentoring, training for graduate applications,

exposure to a first tier research enterprise, and the opportunity for meaningful contact with a network of faculty, students, and staff. Faculty identified the following benefits to students who participate in SUPERB:

- Student gain a much richer understanding of how research is conducted, including an appreciation of what it takes to do experimental research, how to problem-solve as a group, and how to present research findings.
- Participants benefit from having the research process "demystified," and realizing that they are capable of conducting research and going to graduate school.
- As students gain confidence in their ability to do research and pursue a graduate degree, they "realize they can go further than they thought." They are given the practical tools to complete the application process and seek paid fellowships for graduate school.
- Students obtain recommendation letters from UC Berkeley EECS faculty mentors, letters which can increase students' chances to get into graduate school, and start building a network for future career moves.

Graduate student mentors reported benefits as well: they learn how to organize and manage a research project and supervise and mentor students. Graduate student mentors found it gratifying to see students learn and develop confidence, and for some, being a mentor in SUPERB confirmed their interest in pursuing a tenure track position.

Although there are times when the SUPERB program leads them to recruit a superior candidate for UC Berkeley, faculty mentors' underlying motivation is to help talented undergraduates from underrepresented groups realize what is possible and continue their education with graduate studies. Images of Electrical Engineers and Computer Scientists are often not inviting, especially to people without a family history of involvement in higher education or EECS fields, and the SUPERB program "puts a human face" on disciplines within EECS. With their high rate of graduate school participation, SUPERB student "alumni" increase the diversity of the talent pool of EECS professionals nationwide. Faculty mentors experience great personal satisfaction in seeing a young adult change, and in helping SUPERB students accomplish things they did not imagine were possible.

Finally, the SUPERB program has developed an infrastructure and systems that make it easy for faculty to participate. It is one thing to want to bring in women and

students from underrepresented populations to do research, and quite another if the faculty has to go out and recruit the students.

Sustainability of SUPERB is important to UC Berkeley faculty. Towards that end, the full report includes a "ready-to-use" system for assessing short-term and long-range outcomes of the SUPERB program.

"I feel that SUPERB was the perfect package to help me succeed in research and realize my potential. It provided me with an understanding of what it was to do research, gave me connections to some of the top researchers in the field, helped me overcome deficiencies of my undergraduate institution, and helped me prepare for all aspects of applying for graduate school (including the GRE, fellowships, letters of recommendation, research experience, statement of purpose). Thank you so much for allowing underrepresented students from smaller schools to have this opportunity and for all that it provided for me."

The Summer Undergraduate Program in Engineering Research at the University of California, Berkeley (SUPERB-IT Program)

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EVALUATION REPORT

Research Consulting, Inc.

1. BACKGROUND

1.1 The SUPERB-Information Technology Program

As computing has permeated and transformed our everyday lives, the preparation of a globally competitive U.S. workforce - with critical knowledge and understanding of information technology - has become paramount. The Summer Undergraduate Program in Engineering Research at the University of California, Berkeley (UC Berkeley) in the field of Information Technology (SUPERB-IT) offers a group of talented undergraduate engineering students the opportunity to gain research experience through the Department of Electrical Engineering and Computer Sciences (EECS).

The SUPERB-IT program in EECS is funded by grants from the National Science Foundation Research Experiences for Undergraduates (REU) program. The EECS department at UC Berkeley has been funded to implement an REU program since 1991. The REU program's objective is to provide research opportunities, in compliance with California's Proposition 209, to students who have been historically underrepresented in the field for reasons of social, cultural, educational or economic barriers. SUPERB-IT was funded for the period 4/1/01/ - 3/31/06 by the NSF Engineering Directorate Grant # 0097289, seeks to affirm students' motivation for graduate study in electrical engineering and information technology, and strengthen their qualifications through strong faculty mentoring and challenging research projects. The Principal Investigators for the program were: Professors Richard Newton, Jan Rabaey and Shankar Sastry.

The program is open to U.S. citizens or permanent residents, typically after their junior year, that have completed some upper-division course work in Electrical Engineering and Computer Sciences (EECS). A minimum overall GPA of 3.0 is required with upward trends in grades being preferable. The program is open to students with or without prior research experience, but only to students who have *not* participated in SUPERB previously. Students who meet these criteria and are selected to participate in this research apprenticeship explore options for graduate study, gain exposure to a large research-oriented department, learn

about industry stakeholders and the social contexts for EECS, and are motivated to pursue graduate study. Each year, NSF's Engineering Directorate funds six undergraduates, selected in March by UC Berkeley from over one hundred applicants, to participate in Berkeley's eight-week SUPERB research apprenticeships. The six students are joined by 10-20 additional undergraduate researchers funded by other sources.

The long-term goal of the Engineering Directorate REU program is to increase the pool nationwide of students who attain graduate degrees in engineering and information technology. An additional benefit to UC Berkeley of conducting the program is the chance to recruit a small number of the SUPERB students to add very bright students who have been underrepresented in the pipeline for electrical engineers in its own graduate program.

1.2 Evaluation Objectives

At the end of the five-year grant period, a summative evaluation plan was developed to assess the program's longer-term effects from the perspectives of the students, and the faculty mentors. Although SUPERB students do complete evaluations at the beginning and at the end of their summer research program, they have not been asked to reflect on that experience years later, with the distance of time and likely new perspectives. While the annual surveys provide snapshots of students' perceptions at that time, the systematic and externally conducted summative evaluation of a five-year cohort, looking back to see if students actually did go to graduate school, and whether they continued their career in EECS, adds a new dimension to understanding the SUPERB program outcomes. Further insights were sought from the EECS faculty members who mentor SUPERB students. Faculty mentors are integral to the program and they have provided informal feedback to program staff but faculty had not previously been interviewed by an external evaluator.

The evaluation objectives were to:

- Learn whether students identified outcomes they attributed directly to the SUPERB program, from groups who participated in the SUPERB summer research experience from one to five years prior.
- Identify how many students pursued graduate degrees, where they studied, what degrees they are pursuing or have earned, and in what field of study.
- Determine how faculty mentors described their involvement with SUPERB students, and what benefits they identified for students as well as graduate student mentors, for the EECS department at UC Berkeley, and for graduate engineering education more generally.
- Assess how consistent the SUPERB program's anticipated outcomes were with the outcomes observed by faculty mentors and students' self-reported outcomes.

In addition to collecting the data reported here, the intent was to develop an easily replicated evaluation system that could be used in future undergraduate program assessments, including REU site programs funded by other branches of NSF or at other universities.

2. METHODOLOGY

2.1 Student Sample

The population of SUPERB students for 2001 – 2005 was made up of **30 students**. Across the five years, participants included: a mix of males and females; students from diverse racial/ethnic populations and varied economic levels; students whose parents had a wide range of educational levels, from grade school to Ph.D. All participants met the criteria described earlier for SUPERB students, including compliance with Proposition 209 which prohibits using race or gender exclusively in selecting students. Thirty percent of students in SUPERB were females, a proportion that is higher than that found in engineering (21%) or computer science (27%) baccalaureate programs nationally.[1] The SUPERB participants included 33% who were Hispanic/Latino and 27% who were African American, both populations typically underrepresented in EECS programs.

Table 1 Demographics of SUPERB Students: 2001 – 2005

	2001	2002	2003	2004	2005	Total (n = 30)
Gender						
Male	2	3	5	4	7	21 (70%)
Female	4	3	1	1	--	9 (30%)
Race/Ethnicity						
African American	2	1	1	3	1	8 (27%)
Asian American	--	1	---	---	1	2 (7%)
Hispanic/Latino	2	--	5	---	3	10 (33%)
White	1	3	--	2	--	6 (20%)
Other	No info (1)	No info (1)			Multiracial (1) Persian (1)	4 (13%)

[1] Science and Education Indicators: Chapter 2 Higher Education in Science and Engineering. National Science Foundation. 2006. http://www.nsf.gov/statistics/seind06/ Only 5.9% of graduate students in engineering and 5.6% in Computer Sciences re African American, Hispanic/Latino or American Indian.

While students demonstrated strong academic ability in order to be chosen for the competitive SUPERB-IT program, data in Table 2 reveal that few students had parents with graduate degree experience. For two students, both parents had not gone beyond grade school; another two had one parent with a grade school education; and, twelve students' parents had no more than a high school diploma.

Educational Level	2001 M	2001 F	2002 M	2002 F	2003 M	2003 F	2004 M	2004 F	2005 M	2005 F	Total M (27)	Total F(26)
Grade school	1	1	1						2	1	4 (15%)	2(8%)
High school diploma	1	2	2	4	4	4	2	2	2	2	11(41%)	14(54%)
Associate's degree	1	2			1		1	1		1	3 (11%)	4 (15%)
Bachelor's degree	1		2	1				1	3	3	6 (22%)	5 (19%)
Master's degree							1				1 (4%)	------
Ph.D.	1	1			1						2 (7%)	1 (4%)

Table 2 Mothers' (M) and Fathers' (F) Educational Levels

As part of the SUPERB application process, students were asked to identify their academic background, research interests, and career objectives. They were also invited to share aspects about
their background not reflected elsewhere in their application. These comments, which appeared in the open-ended 300 – 500 word Statement of Purpose section of the application, revealed diverse motivations for seeking the SUPERB research opportunity.

Some students' Statement of Purpose comments focused sharply on their interest on specific research topics and/or the opportunity to have a research experience. Students said they wanted the SUPERB research experience because it was not available at their undergraduate institution, they wanted to learn about research and/or they hoped to better prepare themselves for graduate school.

"Since I am obtaining my undergraduate degree from a non-research institution, I feel the experience the SUPERB-IT program will give me is the bridge I need to eventually transition to a research oriented institution."

One female commented that her undergraduate institution has a small electrical engineering department and because of its size, faculty emphasized the fundamentals rather than specialized electives on topics of interest to her.

Other students used the statement to also share personal experiences that motivated them to apply, including obstacles they overcame or sources of inspiration. For instance, four students commended their parents as role models for their strong work ethic and dedication to education. In these instances, the parents' formal education did not go beyond high school, but their values and knowledge beyond the classroom were cited as being highly motivating to the students. One of these students emphasized her mother was a role model because she worked in a non-traditional occupation, albeit not engineering. For another student, the limitations of financial means resulted in her attending a state-funded school in the Midwest that did not have the kind of program she wanted. The SUPERB program offered an opportunity to carry out research in a specialized field of great interest. Five students wrote about growing up in other countries with poor educational systems, societies "governed by prejudice," and no access to a computer. The personal statements reveal that diversity within the SUPERB program is manifested in many ways.

SUPERB students came from 13 states and the territory of Puerto Rico, including AZ, CA, FL, ID, IN, MA, MN, NC, NJ, NM, NY, OH, and WA. At least one student from California participated in the SUPERB program for each of the five years studied here: in 2003, three of the six SUPERB students were from California.

SUPERB-IT students were from undergraduate programs at 25 colleges or universities across the country. Four institutions had more than one student over the five-year period: University of New Mexico: University of Puerto Rico; University of California, Santa Cruz; and, University of California, Berkeley. The first of these two schools as well as Howard University are minority-serving universities, and Mills College is a woman's college.

The majority of students participating in SUPERB were from colleges and universities not in the top tier, and therefore would typically be less likely to attend graduate school in a top-tier university. Eight students were attending universities considered top tier: State University of New York, Binghamton; University of California Los Angeles; University of New Mexico, University of California, Santa Cruz; Northwestern University; and University of Maryland College Park.

Other students were attending universities which do not grant Ph.D.'s (such as, Boise State University, University of Puerto Rican, North Carolina State University) or are not research institutions (e.g. University of Toledo, Ohio Northern University) or from smaller or teaching institutions (including, Mills College, Augsburg , Rose-Hulman Institute of Technology, Skidmore College, Seattle University, Diablo Valley Community College.)

Table 3 Undergraduate Colleges Attended by SUPERB Students

2001	2002	2003	2004	20005
U of Puerto Rico	CSU Fresno	Arizona State U	Calif St Polytech U	Boise State University
SUNY Binghamton	UCLA	San Diego State U	Northwestern U	Rose-Hulman Inst of Tech
U of New Mexico	Augsburg	UC, Santa Cruz	Ohio Northern U	UC Berkeley
No. Carolina SU	Skidmore	UC, Santa Cruz	U of Cincinnati	U of Maryland, College Park
Howard U	Seattle U	UC Berkeley	U of So. Florida	U of Puerto Rico, Mayaguez(2)
Mills College	U of Toledo	U of New Mexico		Diablo Valley College

Data Collection

For this summative evaluation of SUPERB-IT, the ideal way to contact and collect data from the 2001 – 2005 former participants was to use an online survey. For many of the former SUPERB students, email addresses and telephone numbers had been updated as former participants got in touch with faculty mentors or SUPERB program

staff. Email contact information for eight students was found by using online search engines. A few more students were contacted via the permanent address they listed on their original application, typically through their parents. Every effort was made to find current contact information for the 30 SUPERB participants.

The online survey created for this evaluation was sent to all SUPERB students. When the survey was first sent, six were returned because the e-mail address was incorrect. For those students, follow-up was done using the students' permanent telephone number on their original application. Every non-respondent was sent a second request to complete the survey. All those who still did not respond were sent personal emails and, if needed, received a telephone call. For two students, conversations with parents ultimately led to written surveys sent to the students, who completed and returned them for data entry by the evaluator. As a result of these multiple follow up methods, 25 students completed the surveys, a response rate of 83 percent.

The development of survey items was done collaboratively by the SUPERB Project Director and SJB Research Consulting, Inc. Items were created to address the key evaluation questions. The online survey was entered into the SurveyMonkey.com system. Wherever it was appropriate, the online survey randomly arranged the closed-ended items within a series that used the scale - "strongly agree" to "strongly disagree" - so the order varied from one student to the next. In addition, a few items were negatively worded to try to prevent response bias in student answers. The exact items students were asked appears in Appendix A at the end of the report.

In addition to data collected specifically for this study, the original student application forms were reviewed to obtain demographic and other data referred to throughout the report, and findings from the online survey of students administered at the end of the SUPERB experience were examined as well. Relevant comments from the 2005 graduate student mentor surveys provided additional insights, which are presented later in this report. Prior assessment results reported by the SUPERB Project Director provided an important context for carrying out this study and interpreting findings.[2]

[2] Humphreys, Sheila. Evaluation of SUPERB Program, UC Berkeley. 2006.; S.M. Humphreys. "Summer Undergraduate Program in Engineering Research at Berkeley," Conference Proceedings, ASEE/IEEE Frontiers in Education. Nov. 1998.

2.2 Faculty Sample

Each SUPERB student had both a faculty mentor and a graduate student mentor. Over 50% of EECS faculty members have served as SUPERB-IT mentors since the program's inception in 1991. Although they are asked for feedback each year through informal channels as well as an online survey, this study marks the first time a sample of faculty mentors was interviewed by an external evaluator. Each faculty mentor responded to a common set of questions, and was given an opportunity to speak in-depth about their experience with SUPERB. Each interview was recorded, transcribed, and reviewed to capture accurately what faculty said.

Seven faculty mentors were interviewed by telephone in April 2006. The first interview was a pilot test of the interview guide. Since the guide did not undergo major change, the data from that interview are included as one of the seven in the report findings. Some faculty members had been involved with the SUPERB program for the five-year duration of this grant period, and others for one or two years. The faculty interviewed included the current Chair of the EECS Department.

The interview questions, created collaboratively by SUPERB Project Director and SJB Research Consulting, Inc., can be seen in Appendix B.

3. STUDENT FINDINGS

3.1 SUPERB Provides First Research Experience

Over 70 percent of the students, most[3] having just completed their 3rd year of undergraduate work, ***had their first opportunity to do research as an undergraduate*** during their summer-long SUPERB program.

As seen in Table 4 below, the vast majority of SUPERB students (92%) agreed they had a research experience that taught them about cutting-edge research beyond what was used specifically in their particular project. In addition, 80 percent of the students discovered that they enjoy doing research, and 88% felt they gained a realistic understanding of how researchers in their field tackle problems. Also of interest is the intensity of students' reactions, with over half "strongly" agreeing the SUPERB program improved their understanding of and interest in research. One of the three students who felt they did *not* gain a realistic understanding of how a researcher tackles problems also noted that SUPERB was not his first research experience, i.e. he might have *begun* the program with a realistic picture of what research is like. The other two students were not satisfied with their research experience, with one deciding she did not wish to do work that was largely research.

Table 4 Learned about Research

Indicate how much you agree or disagree that the statement describes YOUR experience with or reaction to the SUPERB program.	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree	Mean
Learned about cutting-edge research, beyond what used in own project.	12 (50%)	10(42%)	2 (8%)	1 (4%)	--------	4.42
Discovered that enjoy doing research.	13 (52%)	7(28%)	4 (16%)	1 (4%)	--------	4.28

[3] There was one sophomore and one senior.

Gained realistic understanding of how researcher tackles problems.	13 (52%)	9(36%)	---------	3 (12%)	--------	4.28

Consistent with the finding that 92% of students reported they learned about research beyond their own project, the same percent of students saw how their eight-week research project fit into a larger body of research. One faculty mentor described ways she tried to develop in students an appreciation for research experiments, from formulating research questions to making presentations. She met with students every week to ask them what they saw in the literature that was relevant to their project, and offered suggestions for additional reading.

On the other hand, although 60 percent of the students thought their research project could be realistically completed during their eight-week SUPERB program, 22 percent felt the summer-long time frame for their projects was not realistic and 16% were uncertain. This finding was consistent with the results from the annual SUPERB end-of-program evaluations for 2001 – 2005. The finding could very well reflect variability in the scope or feasibility of the assigned projects, diverse mentoring styles by faculty or graduate student mentors, amount of student preparation time with readings and briefings before the research could begin, and and/or unpredicted glitches in the methodology (including equipment problems) or surprises in the outcomes. More likely, the combination of student inexperience - given 89% were doing their first research project – with any of the above factors would take time away from conducting the research project.

Table 5 Feasibility of Research Project[4]

Indicate how much you agree or disagree that the statement describes YOUR experience with or reaction to the SUPERB program.	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree	Mean
Research project could *not* be realistically completed during summer.	2 (8%)	4(16%)	4 (16%)	11 (44%)	4 (16%)	2.56
Did *not* understand how	1 (4%)	-------	1 (4%)	12	11 (44%)	1.72

[4] In Table 5, both items were stated in the negative to help prevent response bias. For the data analysis, the data were reverse coded.

research project fit into larger body of research.				(48%)		

In their individual open-ended comments, some students emphasized that their research experience taught them the importance of asking questions, and having the confidence to ask those questions.

> *"In research, it is always good to ASK questions. Do not assume things, and never think your question is silly. The question-asking exercise will help you develop good research and critical thinking skills in the future."*

> "*I saw the importance of asking questions and being 100% clear on the issues at hand and the solution being pursued. This is a fundamental practice in graduate school."*

SUPERB students are required to write a technical report describing their research projects, and to present their project at a SUPERB Poster Session at Berkeley, which attracts an audience of faculty, staff, graduate, undergraduate, and some high school students. SUPERB students are coached by their graduate student and faculty mentors on presentation skills. At the end of each summer, reports for all the SUPERB students are published in one bound document and copied onto a CD, both distributed to the participants and to NSF.

One faculty mentor observed that in his field, the time from research to publication is lengthy. Thus, eight weeks is too short a time period to result in a study that merits publication. However, some SUPERB students provided useful data or software, and were acknowledged in a published paper.

At the time of the evaluation, five students reported they had co-authored a paper or presented findings at a conference, related to their SUPERB research project. Here is how the five SUPERB students described their publications.

- Topic Term Identification for Context Question Answering (2006 Midwest Computational Linguistics Colloquium)
- Mankoff, J., Dey, A.K., Hsieh, G., Kientz, J., Ames, M., Lederer, S. Heuristic evaluation of ambient displays. CHI 2003, ACM Conference on Human

Factors in Computing Systems, CHI Letters 5(1): 169-176. 2003. http://home.cc.gatech.edu/julie/uploads/17/660-mankoff.pdf

- Efficient Pitch-based Estimation of VTLN Warp Factors, with David Gelbart (SUPERB grad student mentor). Published in the Proceedings of Eurospeech 2005.
- SUPERB research paper was accepted for presentation at the Sigma Xi Annual Student Research Conference, was presented at the Annual Florida-Georgia Louis Stokes Alliance for Minority Participation (FGLSAMP) expo and is awaiting publication in the UC Berkeley Scientific Journal and Pittsburgh Undergraduate Review
- Design and Verification of Iterative Decoders for LDPC Codes

Another student, in his narrative remarks at the end of the survey, referred to a poster presentation he did on his SUPERB research at the Society of Hispanic Professional Engineers' National Technical and Career Conference, and a verbal report he delivered at a Mexican American Studies Conference.

3.2 Impact When Return to Undergraduate Institution

Once students returned to their undergraduate institution, many found their coursework to be more relevant and meaningful. Nearly two-thirds of students made connections between their SUPERB research and what they were learning in their coursework. In a few instances, faculty mentors helped their SUPERB student identify courses to take in the last year of undergraduate work, which would likely contribute to students seeing connections more explicitly.

Close to three-fourths of the students indicated they talked with their professors at their home institution more than they used to before the SUPERB program about the professor's own research. Over half of the students felt more confident that they could do well in class. Forty percent of students continued to do research related to their SUPERB project and/or began research at their own campus.

Table 6 Impacts on 4th Year of College

Which statement(s) best describe your experience when you returned to your undergraduate program, after the SUPERB experience in the summer?	Choose all that apply.

Item	Yes, this is what happened for me.
I talked with professors more about their research.	18 (72%)
I saw connections between my coursework and SUPERB research.	16 (64%)
I was more confident I could do well in my classes	14 (56%)
I continued to do research related to my SUPERB project	10 (40%)
I initiated research at my own campus.	9 (36%)

A comment by one particularly articulate student captured the value of having this intense research experience:

"SUPERB is a vital program because it not only clears up the metaphorical fog that tricks people into believing that they can't undertake research, but at UC Berkeley especially, with the support of the staff, students are allowed to work side by side with Ph.D. candidates and sometimes professors on cutting edge research.."

3.3 Impact on Graduate Education

Encouragement to Pursue Graduate Degrees

For most students, the chance to participate in the SUPBERB research experience opened their eyes to the possibilities and realities of graduate school. Daily involvement in research, with mentoring by a graduate student and faculty member, took their abstract images of "research" and "graduate school" and made them realistic and attainable. The sessions led by the SUPERB program staff, e.g. on financial aid packages, graduate fellowships, the application process, and GRE preparation, filled a gap in students' knowledge, and gave them practical information needed to apply to graduate school.

> *"Prior to SUPERB, I did not know anything about the Ph.D. I imagined it just involved taking more classes. My experience in the program exposed me to the more interesting reality of Ph.D. research, and prepared me for the complicated application process".*

"As it was stressed in some of the early SUPERB meetings ---- the more you can prepare and the earlier you can prepare for graduate school, the greater the experience in graduate school."

The figures in Table 7 reveal that most respondents felt the SUPERB research experience increased their confidence in their ability to do research, and made them realize they could succeed in graduate school. They saw firsthand how skills in research were a critical component of successful graduate studies. Three-fourths of the students agreed (52% agreed *strongly*) that they went from feeling uncertain about going to graduate school to becoming certain they would go because of SUPERB. Eighty percent reported they could go further in their careers than they realized due to their experience at UC Berkeley.

"Having gone to a small undergraduate university, I was timid about my abilities as an engineer. SUPERB showed me that my abilities were at least equal to my peers at larger and traditionally thought of as superior universities."

Table 7 Impact on Graduate Education

Indicate how much you agree or disagree that the statement describes YOUR experience with or reaction to the SUPERB program	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree	Mean
I felt a sense of accomplishment at the end of my SUPERB experience.	17 (68%)	7(28%)	----------	1 (4%)	--------	4.60
The SUPERB experience made me more confident I could succeed in graduate school.	12 (48%)	9(36%)	2 (8%)	2 (8%)	--------	4.24
As a result of SUPERB, I realized I could go further in my career than I thought beforehand.	11 (44%)	9(36%)	4(16%)	1 (4%)	--------	4.20
I went from being uncertain to being certain that I wanted to go to graduate school because of SUPERB.	13 (52%)	6(24%)	4 (16%)	1 (4%)	1 (4%)	4.16

As illustrated by the following comment from a 2003 SUPERB student, now a doctoral student in computer science, it was more than the research experience that made the difference.

"I got my first experience in the 'research world' at SUPERB. At my undergraduate institution, they never really exposed the undergraduate students to research that the faculty and the graduate students do. So I learned about the difference between the master's track and the PhD track, and the emphasis of research. I became immersed in research 'lingo' and I met other researchers. I also learned how to give a research talk and actually had my first experience doing so. I realized that research was something that I really could do. I also began to understand that you adjust your research to your own interests and passions. Since then, I have been able to do just that in my graduate program. They also made it a big point to have faculty and graduate students come talk to us and spend time with us to help us understand how to be a successful graduate student. Also, my faculty advisor sat down with me at the end of the program and, according to my interests, pointed out schools across the country that I might be interested in. This really really, really helped me in the application process (I'm at one of the schools on his list now)."

Making Graduate School a Reality

In addition to being encouraged to attend graduate school, 16 participants identified specific ways their SUPERB experience directly helped them get into graduate school. The most frequently cited was the weekly series of workshops that provided detailed information on how to choose and apply to graduate schools. These sessions helped participants understand the graduate school application process, provided insights into the admissions committee decision processes, gave students assistance in preparation for the GRE, and taught them about fellowships and other financial support. In fact, some students commented they had no idea that fellowships were a possibility for them. The SUPERB program staff stepped them through deciding which graduate schools to apply to, how to complete applications, and obtain letters of recommendation. For students, many in the first generation of their families to be attending college, receiving specific guidance in the graduate school and fellowship application process, including information on sources of financial assistance, was of critical importance as the following comment from a 2005 end-of-SUPERB survey makes clear.

"Before SUPERB, I was not sure I wanted to pursue my Ph.D. Also, I was unfamiliar with the process of applying to graduate school. Now that I have that information, I plan on receiving my Ph.D."

Table 8 SUPERB Increases Students' Knowledge about Graduate School

Did any of the following aspects of your SUPERB experience help you get into graduate school?	Percent choosing each response. Students could choose all that apply.
Weekly sessions on how to apply to graduate school	81%
Letter(s) of recommendation	75%
Advice from a faculty mentor	75%
Advice from SUPERB staff	75%
Advice from graduate student mentor	69%

Faculty mentors introduced students to fields they were not aware of, provided career advice, helped them choose which graduate schools to apply to, and many wrote letters of recommendation. Two students emphasized that through the SUPERB program, they discovered a field that they plan to pursue for their career: one in automatic speech recognition and the other in human-computer interactions. Students were grateful they could submit as part of their application to graduate schools, letters of recommendation from their faculty mentors at UC Berkeley, which strengthened their credentials.

> *"As a working student, I desperately needed to find a job that summer in order to stay alive; I could not afford to do research as an unpaid volunteer. But the SUPERB program's free room/board, along with the living stipend, allowed me to focus entirely on the research project. This was the first time in my life that I was able to pursue an intellectual interest with such commitment. When I then learned that I could continue doing this in grad school (and get paid -- I was shocked to learn that Ph.D. students get fellowships), I was*

determined to make it happen. Now, I look forward to mentoring other students one day; and eventually, my ambition is to become a professor."

Graduate Education Experiences

Every one of the 25 respondents applied for admission to graduate school (or, for the most recent participants, planned to apply). Admission to UC Berkeley was sought by 15 students, with an additional four planning to apply in the future. Of the 15 who already applied, four were admitted to UC Berkeley, of whom two were enrolled in the program at the time of this survey, and two who were to enroll in the fall of 2006. In other words, SUPERB students had an "admit rate" of 27 percent (4 accepted of the 15 applicants) which is notably higher than UC Berkeley's normal rate of about ten percent.

Table 9 Progress toward Graduate Degree

Degree	2001	2002	2003	2004	2005	Total
Is in a Master's degree program or has completed Master's degree, is now working full-time	2	3	2	1	2	10
In a Ph.D. program	2	2	2	2	5	13

Students are planning to earn their graduate degree in either electrical engineering (n=8) or another engineering field (n=2), computer science (n=9), and business (n=1). All of the students seeking a Master's Degree (n=8) are in Electrical Engineering. The students in the doctoral programs include eight Computer Science majors, four Electrical Engineers, and one student pursuing another kind of engineering degree (not identified by the student.) Eight students have already earned a MS and are employed in an EECS-related position.

Listed below are the academic institutions where SUPERB students have enrolled for their graduate degrees. One student plans to obtain an MBA but does not intend to go to graduate school for a few more years.

Table 10 SUPERB Students Accepted to/Attending Graduate Schools

Name of Graduate School	Degree and Field
Georgia Institute of Technology (2 students)	Ph.D., Computer Science
Current: Columbia University; Future: Georgia Institute of Technology	Current: MS; Future: Ph.D. Computer Science
University of Maryland, College Park	Ph.D., EE
Columbia University	MS, EE
Northwestern University	Ph.D., Other engineering field
Michigan State University	Ph.D. in Computer Science
Texas A&M University	MS, EE,
University of California. Berkeley (1, graduated,2 current, 2 accepted for fall 2006)	MS, EE, graduated Ph.D., Comp. Sci MS, EE//MS, EE//Ph.D., EE
University of California, Los Angeles	MS, EE, graduated
University of California, Santa Barbara	Ph.D., Computer Science
University of California, Santa Cruz (2 students)	Ph.D., Other Engr.//MS, EE
University of Wisconsin, Madison	MS in Electrical Engineering

3.4 Diversity

The SUPERB program is designed to provide opportunities to undergraduates from populations underrepresented in engineering and computer science. From the perspective of the students who participated, the opportunities were more than scholarly. For almost all of them, meeting people from diverse backgrounds was of great importance to them. A review of the open-ended comments suggests that "diversity" was seen as not only race, gender, and income but also being with graduate students and faculty at a top university, and meeting students from across the country.

For most students, their experiences at UC Berkeley contrasted sharply with their undergraduate environment. One student contrasted the SUPERB experience at UC Berkeley as follows.

"*My undergraduate institution was a tier-4, unknown institution that I went to mostly because it was all I could afford, since I had to pay for school on my own. There were no research experiences there for undergraduates....Thank you so much for allowing underrepresented students from smaller schools to have this opportunity.*"

To see whether students felt the environment during their SUPERB program was welcoming, students were asked two explicit questions about whether they had observed or experienced racism or sexism. Over 90% of the students did not observe or experience racism, and over 80% did not observe women and men being held to different standards.[5] A few students described how meaningful it was for SUPERB to serve students from underrepresented groups.

"Thank you so much for allowing underrepresented students from smaller schools to have this opportunity and for all that it has provided to me."

"My ultimate goal is to become a Professor of Electrical Engineering and to encourage other African-American youth to pursue a career in Engineering."

Table 11 SUPERB Program Diversity

Indicate how much you agree or disagree that the statement describes YOUR experience with or reaction to the SUPERB program	Strongly Agree	Agree	Uncertain	Disagree	Strongly Disagree	Mean
Meeting people from diverse	15	9(36%)	----------	1 (4%)	--------	4.52

[5] For the few who felt "uncertain" or did observe racism or sexism, there were no further comments in the open-ended section to explain their rating.

backgrounds was a very important aspect of the SUPERB program for me.	(60%)					
While in the SUPERB program, I did not observe or experience racism.	16 (64%)	6(24%)	2 (8%)	1 (4%)	--------	4.48
In the SUPERB program, I did not observe women and men being held to different standards.[6]	11 (44%)	9(36%)	4(16%)	1 (4%)	--------	4.20

Networking and establishing good relationships with graduate students, faculty, program staff, and other SUPERB students proved to be an important benefit for participants. For instance, when asked how the SUPERB program could be more beneficial to undergraduates in future programs, one participant advised students:

"Network as much as possible, meet faculty members for which you have interest in their work. It's never too early to start building the communication link."

In the year-end evaluation for 2005 participants, another student expressed gratitude for the opportunity to be part of a group of SUPERB students.

"I think the academic part of the research experience is great but the social interaction between such a diverse group of talented students is even better. We as students, pointing to similar goals, can relate profoundly, help, and learn from each other."

3.5 Starting Careers

Eight SUPERB students obtained their Master's degree, and nine are working full-time in electrical engineering or computer science positions. They described their positions as follows:

[6] This item was reverse coded for this chart, so that data are reported in the same direction throughout study.

- Engineering manager, a position related to degree work computer science. … "helping carry out tools used for testing purposes." [SUPERB in 2001]
- Systems Analyst at Deloitte who feels her Master's degree will serve as a "career advancer."
  [SUPERB in 2001]
- After getting his M.S. in electrical engineering from UC Berkeley, started a job as a Digital Signal Processing engineer at 2Wire in San Jose, CA at the end of July, 2006. [SUPERB in 2001]
- An Electrical Design Engineer Consultant who works on general Electrical Engineering areas and in Power Electronics. He reports that the position overall is directly related to his studies in electrical engineering. He earned a Master's degree in electrical engineering from the University of Wisconsin. [SUPERB in 2001]
- He is working in a Signal Integrity Pathfinding position at Intel after earning a Master's Degree at Columbia University. [SUPERB in 2003]
- He is currently working as a Design Engineer, and earning a Master's Degree in electrical engineering from the University of California, Santa Cruz . [SUPERB in 2003]
- He currently helps maintain and support three electronics packages that will be used in an aerospace application. He pursued an electrical engineering degree from UCLA . An electrical engineering background is necessary for this position.
- She is working in the field of computer science as a Software Engineer as of July 2006 [SUPERB in 2002]
- She is a Software Architect, work that is somewhat related to her degree in electrical engineering inasmuch as it deals with computers. She is planning to pursue a graduate degree – likely an MBA - in a few years. [SUPERB in 2004]

3.6 Lasting Outcomes

Over 75% of participants said they are still in touch with someone from the SUPERB program. Half indicated they found someone from the SUPERB program who has become a mentor to them, and half said they have support from other SUPERB students via e-mail. Almost one-third said they found a faculty mentor or graduate student role model through the SUPERB program.

Students were asked to describe what they learned or discovered in SUPERB that continues to affect them today. The question was open-ended so results reflect students' own words. The exact statement from each respondent appears in Appendix C. **Of the 25 students, 22 identified a positive lasting impact**.[7] A content analysis of all comments reveals the most frequently mentioned outcome[8] was that doors to graduate school were opened by the research experience.

Table 12 Lasting Outcomes Identified by SUPERB Students (N=23)

Outcome	# Identifying Outcome
Learned how to conduct research in EECS field (e.g. how to formulate research questions, test hypotheses, and present findings) AND discovered that enjoyed/was good at conducting research.	19 (83%)
Learned from UC Berkeley faculty and graduate students - who served as role models and/or mentors -	9 (39%)
Increased confidence that could succeed as an engineer, improved confidence in own abilities	8 (35%)
Realized could succeed in graduate school, discovered what doctoral studies are like, persuaded to attend graduate school	8 (35%)
Obtained the practical information that helped them apply to graduate school, find financial aid opportunities	5 (22%)
Make good contacts at UC Berkeley and beyond, developed good networks	3 (13%)
Found an area of specialization that changed their career path	2 (9%)

For most of the SUPERB students, the research experience was a revelation. The experience showed them the process of conducting research, they were capable of carrying out research, and that – by extension – they were able to succeed in graduate school.

When faculty mentors were asked what *they hope students learn* through their SUPERB experience, their responses virtually paralleled the long-lasting impacts

[7] Two students did not comment, and one student did not have a positive research experience.

[8] Students' comments often identified more than one outcome. Table 10 shows the number of times each outcome was mentioned.

students report. Faculty wanted students to: (1) gain a deeper understanding of research; (2) realize that graduate school is an achievable and sound goal; and (3) develop an understanding of the "culture" of Electrical Engineering and Computer Science.

One professor defined "success" for the SUPERB students as gaining both the research and technical knowledge as well socialization to the graduate school experience, understanding the process of what graduate school might be like.

> "*Undergraduate programs are largely not research or project-based. To have an experience that is outside the classroom is important. The 8-week period is a sampler, we cannot expect a lot of results, students are relative beginners.....the value of the snapshot experience is to see how things work in the next step of education, graduate education PLUS whatever else they can learn of a practical, hands-on nature that would not typically learn in classroom."*

Some students had a "transformational" educational experience (Armstrong, Doyle & Bennett, 2003) that is, they report that the SUPERB program changed their life. The reasons for the significant changes, in addition to the intensive research experience, are: (1) students could focus on their project without the distraction of having to work; (2) students had frequent interactions with extremely talented graduate students and faculty; (3) gave student a mentor who was a role model and inspiration; (4) provided connections to top researchers in the field; and, (5) earned a compelling letter of recommendation from a UC Berkeley faculty member

> *"My SUPERB experience provided me with the confidence to apply to top programs in my field...My graduate mentor taught me much more than research methods. At a university such as Berkeley the quality of Ph.D. candidates is unmatched. His guidance and mentorship continues to serve as a model of how I would like to live my life. He is the most intelligent and balanced person I know ...SUPERB has permanently changed my life!!!"*

> *"I can say my experience with SUPERB is the sole reason I got where I am today. My faculty mentors in SUPERB were highly motivating, allowing me to work independently and realize my potential in research that I could not have gotten from my undergraduate institution...It provided me with an understanding of what it was to do research, gave me connections to some of the top researchers in the field, helped me overcome deficiencies of my*

undergraduate institution, and helped me prepare for all aspects of applying for graduate education (including the GRE, fellowships, letters of recommendation, research experience, statement of purpose)."

3.7 Advice to Next Generation of SUPERB Students

The SUPERB program asks each student to evaluate the program after their experience is completed. A major purpose for this evaluation is to assess how effective the program was for each student, and to hear their recommendations for what would have made the experience better for them. Many of the responses have been used in formative evaluation, i.e. as a way to improve the program.

In this five-year assessment, the emphasis is on how the program makes a difference for students in their academic and career choices as well as in their personal and professional development. Hence, former SUPERB students were asked for their advice to make the program more beneficial to the next group of undergraduates. Their responses were often student-to-student advice on maximizing the benefit of this opportunity. Their comments appear in Table 12. The two recommendations most often given were to:

- Be deliberate in building relationships with faculty, both faculty mentors and other faculty, as well as with graduate students. The potential for increasing learning and future professional networks is invaluable.

- Ask questions, and become aware that inquiry is a constant companion to research.

In addition, a few students suggested SUPERB students should:

- Enjoy the experience, and nurture relationships with other SUPERB students.

- Take advantage of the six-week GRE preparation course, especially given that the GRE score is used as a filter in graduate admissions at UC Berkeley.

Table 13 SUPERB Participants Advice to New SUPERB Students
What advice do you have to make the SUPERB program more beneficial to undergraduates participating this year?

1. Be deliberate in building relationships with faculty, including faculty mentors *and* other faculty, and with graduate students.

It would have been beneficial to have more personal interaction time with current graduate students. We had a graduate student assigned to coordinate extra-curricular events, but maybe one or two more graduate coordinators would have been great. That way, we would have gotten a chance to really get to talk to current students outside of the lab setting.

Be sure to make the most out of your summer. Try to establish a good relationship with your faculty advisor, at least let her/him know what your interests are. This way he/she can later provide you advice in your graduate application process. This will also be helpful for your advisor in case you ask him/her for a letter of recommendation. If you are not sure of your interests (like I was), (and even if you are) make sure you talk to different faculty in your field and graduate students about their research projects

Anything to increase interaction between faculty and students. Perhaps weekly or bi-weekly scheduled meetings by the SUPERB staff.

I advise them to keep in touch with graduate student mentors, faculties, and any other students to get advice from them about graduate school.

To future SUPERB students: Learn as much as you can while at Berkeley. Network as much as possible, meet faculty members for which you have interest in their work. It's never too early to start building the communication link.

Please continue to encourage students to make enough contact with their advisor so that they can request (and get) a strong letter of recommendation from them. This was the most important outcome of the SUPERB experience for me.

2. Ask questions.

I would advise students to take heed to the overused saying, 'no question is a dumb one' because what I have found is a measure of one's intelligence is relative from one person to the next. It is very common to find people who are really experienced in certain things because of their continual exposure, but novices in others. The moral of the story is to be yourself and to allow your education to work for you by means of adding onto the knowledge that you already possess.

Take advantage of all offerings and ask many questions.

Don't be afraid to ask questions. Ask questions about other projects that mentor, professor, or other people are doing in your area.

3. Have fun, build camaraderie with other SUPERB students

Most important, have fun! And make sure you get together with the other "SUPERB"s. These are people you surely will see in the future and it is always good to know people scattered around the country.

Make friends with the other undergraduates

Remember to have fun too, a work-life balance is important.

Program should engage students in other activities besides research, GRE prep classes and workshops. Life is not about work, work, work. Take the students out on a social trip like mountain climbing, a trip to Alcatraz etc. Students tend to interact more freely at social events.

4. Take advantage of GRE examination preparation

Devote more time studying for the GRE examination.

The GRE course should remain a component of the program--it's really important

Take the GRE prep course if they offer it.

As it was stressed in some of the early SUPERB meetings ---- the more you can prepare and the earlier you can prepare for graduate school, the greater the experience in graduate school.

5. Individual suggestions

I would offer a few more visits to UC system schools. Not every participant is going to be able to get into Berkeley but if the develop a network while they are in the area then maybe they can still get into a top program in California.

Likewise, perhaps a vital skill that would be needed at some point in a student is presentation skills, and as future scientists/engineers, there would be a point where they would be asked to review research papers not in their field of study. So here is my suggestion. Instead of too many workshops, have weekly sessions were 1 or 2 students are assigned a research paper not in their field or in their field but not in the area of interest, and ask them to present it to all SUPERB members in a matter of 20 minutes. This simple exercise builds their oral presentation skills, public speaking skills and gives students the opportunity to think outside the box. I had this exercise while at MIT for the MIT summer research program and I found it very valuable. This should be incorporated in SUPERB as well.

Be more involved in the research the students are doing - I remember a few students finished several weeks before the program ended, while others were working up to the morning of the poster session. I know some students really enjoyed the projects they were given (such as myself) but others felt like they didn't have a useful project.

In addition to the above, a few students made suggestions for program improvement. Three suggested that students need to be steeped in the research literature and understand the research question more deeply before they begin the project. This relates to the short duration of the program.

"*It's impossible to jump straight into your research project without any preparation. Spend the first couple of weeks doing nothing but reading the required texts and getting familiarized with your research environment. If you can determine your project prior to arriving,[that is] even better.*"

Two students suggested it would be helpful to increase the program length from 8 weeks to 10 weeks, particularly so students can take the first two weeks to become familiar with the material and clarify the research goals. This recommendation has also been made by some students in the post-SUPERB evaluation form.

> *"10 week will be better than 8-week program so that we have more time to accomplish and get deeper results. Most of the engineering projects take many weeks just to get familiar with the material, the goal of the whole research, and to define our own project."*

> *"A vital skill that would be needed at some point in a student is presentation skills, and as future scientists/engineers... to review research papers not in*

their field of study. [Why not] have weekly sessions where 1 or 2 students are assigned a research paper not in their field or in their field, but not in the area of interest, and ask them to present it to all SUPERB students in a matter of 20 minutes. This simple exercise builds their oral presentation skills, public speaking skills and gives students the opportunity to think outside the box."

3.8 Case Studies

Another way to examine the impact of the SUPERB program is to look at brief case studies of individual students, to understand what the program meant in various and distinct situations. The following are four examples – taken from various forms and surveys submitted to Berkeley by participants - of how the SUPERB program made a difference.

Her goal was to attend graduate school to study communications and signal processing, and to become a research and development engineer. She feels that because of the research experience and the confidence she developed through the SUPERB program, she was accepted to not only to U.C. Berkeley but also to Stanford, Princeton, and other top-tier universities. She chose to attend UC Berkeley, and graduated in 2006 with her Master's Degree. She began her job as a Digital Signal Processing engineer at 2Wire in San Jose, CA at the end of July, 2006, a position that directly related to her field of study in college, and

One SUPERB student pointed to his Chicano heritage, and the lessons he learned from his hard-working parents about a work ethic and how "education impacts opportunity." After a four-year period of service in the U.S. Navy, he pursued undergraduate studies in electrical engineering. During the SUPERB program, he impressed his faculty mentor and has been accepted to Berkeley's doctoral program in electrical engineering.

This student graduated from a high school in Ethiopia, and had never seen a computer until he arrived in the United States. He is the first in his family to attend university. When he returned for his last year of undergraduate work, after the SUPERB program, one of his professors wrote, "I can't begin to tell you [his] being out there has done for him. He was so polished and professional [in presenting his research]." After completing his undergraduate work, he hoped to pursue graduate studies and maintain a strong connection with industry. He is currently employed as a software engineer, and continues to be mentored by his Berkeley graduate student mentor as he pursues his goal of

4 FACULTY MENTOR FINDINGS

4.1 Goals for SUPERB Program

Faculty expectations for the SUPERB program are that it will: (1) give undergraduates an intensive eight-week mentored research experience; (2) give students a sense of engineering practice, and how academia interacts with industry and other stakeholders; (3) encourage students to consider graduate school, and (4) provide them with the knowledge, tools, and confidence to pursue graduate education; and thereby (5) increase the pool of underrepresented students who go to graduate school in EECS fields. The eight-weeks in the SUPERB program was described as "an immersion" experience.

In the interviews with faculty, they consistently felt that students who participate in SUPERB:

- Gain a much richer understanding of how research is conducted, including an appreciation of what it takes to do experimental research.
- Benefit from having the research process "demystified," to see it as a group trying to solve a problem by systematically trying and assessing different strategies.
- Learn how to present results of research by making PowerPoint presentations to their peers, graduate students, and faculty, as well as a written report at the end of the 8-week experience.
- Learn what graduate school would be like, and see how a top university challenges its students.
- Gain confidence in their ability to do research and pursue a graduate degree: students "realize they can go further than they thought."
- Obtain recommendation letters from UC Berkeley EECS faculty mentors, letters which can increase students' chances to get into graduate school.

Individual faculty reported ways they worked directly with SUPERB students. One of the most important is to define, with the graduate student, discrete research projects that can be accomplished during the eight weeks a SUPERB student is on campus. The student should know upfront what the project involves, and what the expectations are. Unlike students who are at UC Berkeley for a year or more, the SUPERB students do not have the luxury of time to be involved in multiple facets of research. SUPERB students should be working on a research project that will give them a sense of accomplishment at the end of the 8-week period, while understanding how their piece fits into the research of the lab as a whole.

Faculty mentors help SUPERB students in the following ways, although each:

- Hold regular meetings with SUPERB students, helping to keep them aware of important articles and research related to their work.
- Provide one-on-one feedback on student's presentation prior to oral presentations or poster sessions.
- Provide opportunities to show how researchers from academic centers relate to other stakeholders, especially those in industry.
- Help students understand the social context in which engineering and technology must function, how the work in their academic disciplines can affect society.
- Work with students to help them identify courses they should take in their last year of undergraduate school to position themselves well for graduate school.

4.2 Experience of Graduate Student Mentors

Faculty mentors were unanimous in their recognition that UC Berkeley graduate student mentors benefit from their involvement in the SUPERB program as well. Ideally, graduate student mentors will achieve the following benefits, although the extent of the benefit will vary according to the graduate student's prior experiences supervising undergraduates. It is worth noting that the 2005 end-of-summer survey results provide an identical picture of benefits.

- Gain experience with how to organize and manage a research project, identifying what realistically can be achieved in a relatively short time span.

- Learn firsthand how to supervise and mentor undergraduates, e.g., determining the "right" level of supervision needed throughout the eight weeks for that particular project and student.

- Accomplish some portion of their own research agenda due to help from SUPERB students.
  In some cases, a particularly talented SUPERB student's research project will provide results the graduate student would not otherwise have obtained.

- Feel "energized" by the spirit of the undergraduates who have a fresh look at what is involved in the research project, and who appreciate the opportunity to be working at the UC Berkeley.

At the end of the summer, graduate students who were SUPERB mentors are given an online survey. They are asked what gave the most satisfaction as well as what direct benefits they experienced.

Each of the five graduate students in 2005 found the most satisfaction in being a SUPERB mentor was in seeing their students' progress.

> *"Seeing the student have an 'AHA' moment when something really clicked. Also, seeing the student make real progress and contribute to a team effort."*

> *"Hearing my student speak intelligently about a difficult subject that he had no knowledge of beforehand."*

Two of these five graduate students also identified benefits for themselves. One learned about project/schedule management, and the other obtained practice in teaching, experiences expected to be helpful when he becomes a professor and is responsible for providing advice to graduate students.

Most graduate student mentors have opportunities to work with UC Berkeley undergraduates but in the case of SUPERB students, they have greater responsibilities. They have to take charge, define the project, and help the student succeed. Graduate students are encouraged by faculty to make sure the student has a good time, and enjoys the SUPERB experience. Some graduate students mentor more than one SUPERB student. Two graduate students turned down opportunities to work in industry so they could mentor a SUPERB student. One SUPERB student, once back at his college, invited his graduate student mentor to be a guest speaker at his college. According to the faculty mentor, this proved to be a positive professional development experience for both the graduate student and the undergraduate.

According to a faculty mentor who has been involved in the SUPERB program for the five-year grant period, when the program "operates" at its best, it is not only the students that benefit but the graduate students and faculty as well. Graduate students gain valuable experience when they assume responsibility for designing their projects and finding the resources – e.g. software, publications – to get ready for their student. The SUPERB program provides graduate students with a "wonderful

mentoring opportunity." Some graduate students find this experience confirms they would like to become faculty, and some who were graduate student mentors are now faculty at other universities.
A bonus for faculty and graduate student mentors is that most SUPERB students are "a breath of fresh air" since they are excited to be at Berkeley, and their enthusiasm is contagious.

4.3 Reasons SUPERB Important

Although there are times when the SUPERB program leads them to recruit a superior candidate for UC Berkeley, faculty say their underlying motivation is to help talented undergraduates from underrepresented groups realize what is possible and continue their education with graduate studies. A number of professors recalled students who had not considered graduate school before their UC Berkeley experience. There is great satisfaction in seeing a young adult change, and in helping SUPERB students accomplish things they did not imagine were possible. As one faculty mentor commented,

"*SUPERB is not just another undergraduate research program but it is a program combined with a social mission, which makes it incredibly rewarding to faculty.*"

SUPERB students see that engineering projects typically involve group meetings with a bunch of people discussing problems and potential solutions. Students learn the important lesson that they can do this kind of work, or as one faculty mentor stated:

"*There is no magic associated with being in this field.*"

Helping undergraduates from underrepresented groups to persist in electrical engineering and information technology, to earn their baccalaureate degrees, and to increase future participation in graduate school and the workforce is seen as an important outcome of the SUPERB program. In fact, since the majority will not be accepted by UC Berkeley, faculty mentors believe in the broader mission of SUPERB.

All of the SUPERB students who participated between 2001 – 2005 earned their Bachelor of Science degrees. As mentioned earlier, the acceptance rate for SUPERB

students who applied to UC Berkeley's graduate school in EECS (27%) was almost three times greater than the typical rate of ten percent. Further, of the 25 survey respondents, 23 have continued in the fields of engineering and information technology.

4.4 Benefits to University of California, Berkeley

A common theme in the faculty mentor interviews is that the SUPERB program benefits UC Berkeley, even though most students are not admitted to the EECS graduate program. The reasoning is that:

- It is important for UC Berkeley to provide people who are underrepresented in the fields of Electrical Engineering and Computer Science with an opportunity to attend graduate school. They see a serious need to expand the pool of potential electrical engineers and computer scientists to include women, people of color, and students from low-income households who may be the first in their family to attend college. This is viewed as a national concern so even though most SUPERB students do not continue graduate work with UC Berkeley, they do continue in their field and pursue graduate degrees, an important outcome that addresses an urgent national need.

- Because UC Berkeley is a "tough place," with very smart students, the learning environment is different than the undergraduate experiences of most of the SUPERB students. During their eight week research project, they gain broader perspectives and new experiences as do the graduate student mentors.

- Typically, out of close to 1,000 US applicants to their EECS program, UC Berkeley accepts approximately ten percent. Yet, as mentioned earlier, the SUPERB students' acceptance rate is 27%. The SUPERB program is therefore viewed by faculty as an excellent recruitment vehicle for identifying top talent among undergraduates that faculty mentors might not otherwise meet. As one professor explained, Berkeley faculty must be proactive in recruiting top candidates who are most underrepresented. The pool is relatively small, and the best graduate schools compete for the top students.

Faculty hope the SUPERB program is an important link in the chain of events that keeps students studying and working in fields related to electrical engineering and information and technology.

All faculty mentors want the SUPERB program to continue. When asked what they would do to attain the diversity outcomes described above if there were no SUPERB program, most said they would try to recreate SUPERB. Even when pushed by the interviewer to dream up an alternative approach, they did not have a model they felt would achieve their goals any better than the SUPERB program. One of the attractive features of SUPERB is that it has an infrastructure and systems that make it easy for faculty to participate. It is one thing to want to bring in women and students from underrepresented populations to do research, and quite another if the faculty has to go out and recruit the students. With SUPERB, they can fulfill what they see as an important mission without spending considerable time otherwise required for successful recruitment and decision-making about candidates.

As appreciated as the SUPERB program is, it takes money to operate, and to pay for students and graduate student mentors. One faculty member commented that the SUPERB program is one important vehicle to help UC Berkeley to serve students from a broad range of economic levels.

Another factor pointed to by faculty mentors is that images of Electrical Engineers and Computer Scientists are often not inviting, especially to people without a family history of involvement in higher education or EECS fields. The SUPERB program is one way to "put a human face" on disciplines within EECS. Students, starting no later than middle school, and their families need to know these fields are not "dry" or daunting. They need to see EECS fields address real-life concerns, like efficient use of energy or the ethical dimensions of technological advancement. Undergraduates and potential graduate students need to feel welcome in electrical engineering, computer science and other engineering fields. Too often, these fields are seen as cold, distant, mechanical, and mathematical. Young people need to see that it is people in engineering and technology fields that can solve major societal problems, such as addressing the energy crisis and using engineering to improve health.

One faculty member emphasized the need for more encompassing educational

reform, to make STEM fields exciting to students, akin to the national initiative during the Sputnik era. It will require attention to primary and secondary education, and a shifting in values that shows invention and discovery are as thrilling as being good at football, and reveals that quick success is usually just that, fleeting.

5. CONCLUSIONS

Statistics from the American Society for Engineering Education (ASEE) demonstrate that the demand for engineering talent in this country exceeds the supply. An obvious solution -- to increase the talent pool by enrolling and graduating more women, African-Americans, American Indians, and Hispanic-Americans – has been discussed and acted upon in numerous ways. Yet, the situation today is not greatly changed from a decade ago (Grose, 2006.) Women, African-Americans, and Hispanic-Americans as well as students who are first-generation Americans or who come from low income households are particularly underrepresented in the fields of electrical and computer engineering.

The foundation of the SUPERB program is the eight-week research experience. However, the program also incorporates a number of strategies identified as successful by researchers and policymakers seeking to increase the number of students who have long been under-represented in engineering and computer science. These include:

- Removing the "mystery" from engineering, revealing the importance of problem-solving as a team to discover solutions to difficult problems.
- Increasing students' confidence, which is particularly important for those who are women and under-represented minorities as well as students who come to the United States from other countries and those who are the first in their family to attend college or consider graduate school.
- Building community by bringing together a group of people for an intensive experience that deepens their identification with a field of study and the people who work in that field. Students can start to envision themselves as electrical engineers or computer scientists.
- Providing explicit instruction and actionable strategies that foster academic success, retention, and transition to the next academic level, such as teaching students about the graduate school application process and the steps for attaining fellowships.
- Creating explicit links with external organizations and internal research centers that emphasize the human aspects of technology.

This study demonstrated that students and faculty alike agree that positive outcomes results from the *combination* of the above components of the SUPERB program. The high proportion of students who graduated from their undergraduate

degree program and continued with graduates studies in EECS disciplines provides quantitative evidence that the program has been successful. The comments from students, graduate students and faculty mentors reveal why so many students reported lasting benefits, a phenomenon not very common with educational interventions.

One limitation of the evaluation findings is there is a competing hypothesis. Students selected for SUPERB were strong performers at their undergraduate institution so they may have found alternative opportunities to obtain research experience. It is even possible that because they were high achievers and motivated, they may have found other avenues to learn about graduate school, and gain admission. Further, there are so many intervening variables over time, such as academic and personal events that occur in the last year of undergraduate work, that it becomes more difficult to isolate how much influence SUPERB can have.

However, the most powerful argument that SUPERB made a difference is students' own reflections over time, their firm personal statements linking the SUPERB experience with specific, positive outcomes. The unique combination of features in the SUPERB program provided opportunities difficult to find elsewhere: research experience; mentoring from top faculty, academic staff, and graduate students; sessions by academic staff that guide each student in graduate school preparation and application; and, an intensive experience at a top-rated program. The high acceptance rate to UC Berkeley's EECS program, particularly from students otherwise unlikely to even have the confidence or knowledge to apply to Berkeley, is also persuasive evidence supporting the benefits of participating in SUPERB. Given the small numbers that make up the base of women and underrepresented minorities in EECS fields, the 25 respondents who participated in SUPERB and who have continued in EECS could have a cascading impact as examples of success, and role models for upcoming generations.

It is also possible that the evaluation methods used to evaluate SUPERB contributed to its success. Aside from the informal feedback that the Project Director obtained each year by careful observation and an openness to suggestions for improvement, the SUPERB program has created a series of online surveys for students at the start and finish of the SUPERB experience as well as for graduate students at the end of

the summer program. In 2006, the evaluation expanded to include a follow-up online survey as well as interviews with a sample of faculty mentors. Each of these assessment instruments is available online and can be easily modified, if necessary, to ask new questions.

Based on the findings from this study, including faculty mentors' strong endorsement of the SUPERB program, the program developed by UC Berkeley's EECS Department should continue as an effective way to open the pipeline for students underrepresented in electrical engineering and computer science. Further, given the slow progress nationwide in increasing participation and the compelling need to attract and retain the widest possible talent for EECS, other institutions might benefit by examining the SUPERB program and evaluation model employed at UC Berkeley.

6. EVALUATION PLAN AND TOOLS FOR FUTURE EVALUATIONS

One of the major goals for this study was to develop an easy-to-replicate strategy for future SUPERB and REU program evaluations. The following plan, with readily available assessment instruments, is designed to be used by SUPERB staff in the future. The evaluation approach and tools could also be adapted to assess related programs designed to bring under-represented people into the fields of engineering, computer science or science.

Database

Each of the assessment tools is available online: the surveys are collected using SurveyMonkey.com.
If UC Berkeley would grant each student who completes the SUPERB program a permanent Berkeley e-mail address, it would greatly facilitate the collection and analysis of evaluation data.
Going forward, the SUPERB participants should be required to complete the following surveys, to enable comparisons across cohorts and longitudinally.

Students

An online application to the SUPERB program. This letter includes useful information that should be retained on an Excel spreadsheet or a simple database that includes the student's name, address, college, permanent address, phone number, email addresses, race/ethnicity, gender, parents' educational level, and language spoken at home. The data for email addresses and phone numbers should be updated annually, with a request to former participants to keep the information current. The time to put a system in place to keep track of former SUPERB students would be less than that required to track students down years after their SUPERB experience.

Pre-SUPERB Student Survey This survey asks questions that can be used for formative assessment as the program rolls out each summer, and as a baseline for summative assessment, against which progress of students can be measured at the end of the program and years later.

Post-SUPERB Student Survey This survey provides immediate feedback on perceived

efficacy of the program, and is also useful for benchmarks to be used in outcome evaluation started at one year after program completion.

Follow-up Student SUPERB This survey was developed for this evaluation. Ideally, there would be a core set of questions asked each year for comparison with prior years, and a few new items relevant to the most recent implementation of SUPERB. Since this was the first long-term assessment of the SUPERB program, the questions focused on the research experience, preparation for graduate school, and whether participants persisted in their field and went to graduate school. It would be useful in future evaluations to ask students whether other features of SUPERB, such as visits to the IBM Almaden Research Center, or involvement with any of the National Science Foundation-funded UC Berkeley research centers, such as the Center for Hybrid and Embedded Software Systems (CHESS) and its Center for Information Technology Research in the Interest of Society (CITRIS), which seeks out solutions to societal problems, have any longer-term impact.

Graduate Students

This survey is completed by graduate students at the end of the SUPERB experience. The purpose is to assess the experience from the graduate students' perspective, e.g., how s/he benefited, and what could be done to strengthen the program. Questions about SUPERB students' performance and learning could be compared with student perceptions of their own performance and learning.

Faculty Mentor Interview

Faculty mentors were interviewed by telephone, allowing for a set of structured questions as well as the opportunity to explore topics in greater depth. The interview data provided opportunities to find out benefits to students, graduate students, faculty, UC Berkeley, and the higher education community nationwide. Faculty had the chance to make recommendations for improvement and suggest alternative or supplementary strategies to bring more underrepresented students into the EECS pipeline.

Timeline for Annual Evaluations

Applications due January

Candidates chosen by mid-March.

Data from Application can be entered into database.

Pre-survey for students completed online early June

Post-survey for students completed in August or September

Post-survey for graduate mentors in August or September

Follow-up survey for former SUPERB students sent early May, at least one year after the completion of the SUPERB program

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APPENDIX A:
QUESTIONS ON STUDENT APPLICATION FOR SUPERB-IT PROGRAM

Statement of Purpose

Berkeley has a long-standing commitment to promoting access to graduate education for diverse populations. This commitment involves reviewing applicants' achievements within the context of their life experiences. You are invited to share aspects about your background that have not been reflected elsewhere in your application. This may include information regarding your achievements in spite of economic, social, or educational disadvantages.

Briefly describe your academic background, research interests, and career objectives in the space provided below. Please limit your statement to 300-500 words.

Program Description (From Web Site)

SUPERB-IT in EECS is a program funded by a grant from the National Science Foundation Research Experiences for Undergraduates (REU) Program, and is administered by the EECS Center for Student Affairs. Over 50% of EECS faculty have served as SUPERB-IT mentors.

Project Director: Dr. Humphreys

Goals

The Summer Undergraduate Program in Engineering Research at Berkeley - Information Technology (SUPERB-IT) in the Electrical Engineering and Computer Sciences (EECS) Department offers a group of talented undergraduate engineering students the opportunity to gain research experience. The program's objective is to provide research opportunities in engineering to students who have been historically underrepresented in the field for reasons of social, cultural, educational or economic barriers. SUPERB affirms students'

motivation for graduate study and strengthens their qualifications through strong faculty mentoring and challenging research projects.

Eligibility

The program is open to U.S Citizens or permanent residents who are juniors and have completed some upper division course work in Electrical Engineering and Computer Sciences (EECS). A minimum overall GPA of 3.0 is required with upward trends in grades being preferable. The program is open to students with or without prior research experience, and students who have not participated in SUPERB previously.

Expectation

SUPERB participants are required to attend orientation and complete the entire eight-week program. Each participant is required to give an oral presentation and submit a written report describing the results of his/her research.

Awards

SUPERB-IT participants spend eight weeks at UC Berkeley during the summer (June 10 - August 3, 2007) working on exciting ongoing research projects in information technology with EECS faculty mentors and graduate students. Students who participate in this research apprenticeship explore options for graduate study, gain exposure to a large research-oriented department, and are motivated to pursue graduate study.

SUPERB-IT participants receive a $3,750 stipend, room and board on campus in the International House, and up to $600 for travel expenses.

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APPENDIX B: Tool-Kit for SUPERB Program Director

Student Survey

1. Read each statement below carefully, and indicate much you agree or disagree that the statement describes YOUR experience with or reaction to the SUPERB program.

	Strongly disagree	Disagree	Uncertain	Agree	Strongly agree
I learned about cutting-edge research in engineering beyond those used in my own research project.	○	○	○	○	○
I did not understand how my research project fit into the larger body of research.	○	○	○	○	○
In the SUPERB program, I observed women and men being held to different standards.	○	○	○	○	○
Meeting people from diverse backgrounds was a very	○	○	○	○	○

important aspect of the SUPERB program for me.					
While in the SUPERB program, I did not observe or experience racism.					
The SUPERB experience made me more confident I could succeed in graduate school.					
I went from being uncertain to being certain that I wanted to go to graduate school because of the SUPERB program.					
I felt a sense of accomplishment at the end of my SUPERB research experience.					
As a result of SUPERB, I realized I could go further in my					

career that I thought beforehand.

The research project I was assigned could not realistically be completed during the 8-week summer program.	○	○	○	○	○
Because of my SUPERB experience, I gained a realistic understanding of how a researcher tackles problems.	○	○	○	○	○
I discovered that I enjoy doing research.	○	○	○	○	○

2. Did the SUPERB program provide your first opportunity to do research as an undergraduate?

Yes	No
☐	☐

3. Which statement(s) below best describes your experience when you returned to your undergraduate program, after the SUPERB experience in

the summer. (Check as many as apply.)

- ☐ I talked with professors more about their research.
- ☐ I was more confident I could do well in my classes.
- ☐ I asked more questions in classes.
- ☐ I saw connections between my coursework and SUPERB research.
- ☐ I was equally motivated before and after SUPERB to do well in my classes.
- ☐ I continued to do research related to my SUPERB project.
- ☐ I initiated research at my own campus because of SUPERB.
- ☐ I was more motivated to do well in my classes.
- ☐ Other (please specify)

4. Did you apply (or do you have plans to apply) to graduate school?

Yes	No
○	○

5. Did you obtain (or do you plan to obtain) a Letter of Recommendation from your SUPERB faculty mentor?

Yes	No
○	○

6. Did you apply (or do you plan to apply) to the University of California, Berkeley for graduate school?

- Yes, I am currently a graduate student there.
- I will be studying there in the fall of 2006.
- Yes, but I decided to go elsewhere.
- Yes, but I was not accepted.
- No, but I plan to apply in the future.
- No.
- Other (please specify)

7. What is the name of the graduate school you are attending (or will be attending?)

8. Did any of the following aspects of your SUPERB experience help you get into graduate school? (Choose as many as apply)

- Advice from graduate student mentor.
- Weekly sessions on how to apply to graduate school.
- Letter(s) of recommendation
- Advice from staff.
- Advice from faculty mentor.
- Other (please specify)

9. In which field of study do you plan to earn your graduate degree?

- Electrical engineering
- Other engineering field
- Computer science
- Business
- Law
- Other (please specify)

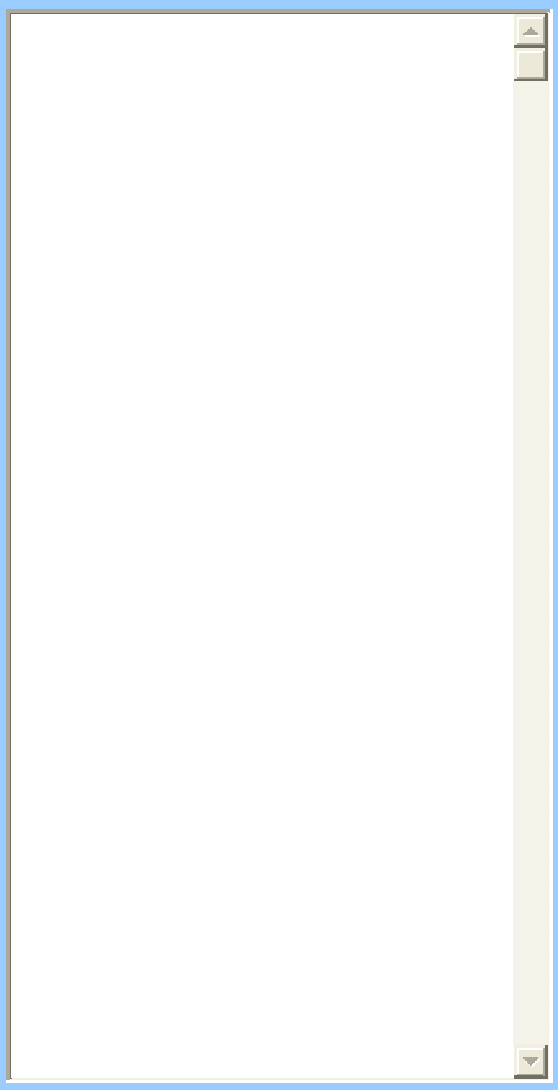
10. Which degree(s) will you pursue? (Check all that apply)

- Master's of Science
- MBA/Law degree
- Ph.D.
- Other (please specify)

11. If you are working full-time, which field are you in? (If NOT, please skip to question 13)

- Electrical engineering
- Other engineering field
- Computer science
- Management of engineering work
- Other (please specify)

12. If you are working full-time, what is your position, and how does it relate to your field of study in college?



13. Are you still in touch with anyone you met through the SUPERB program? (Check as many as apply.)

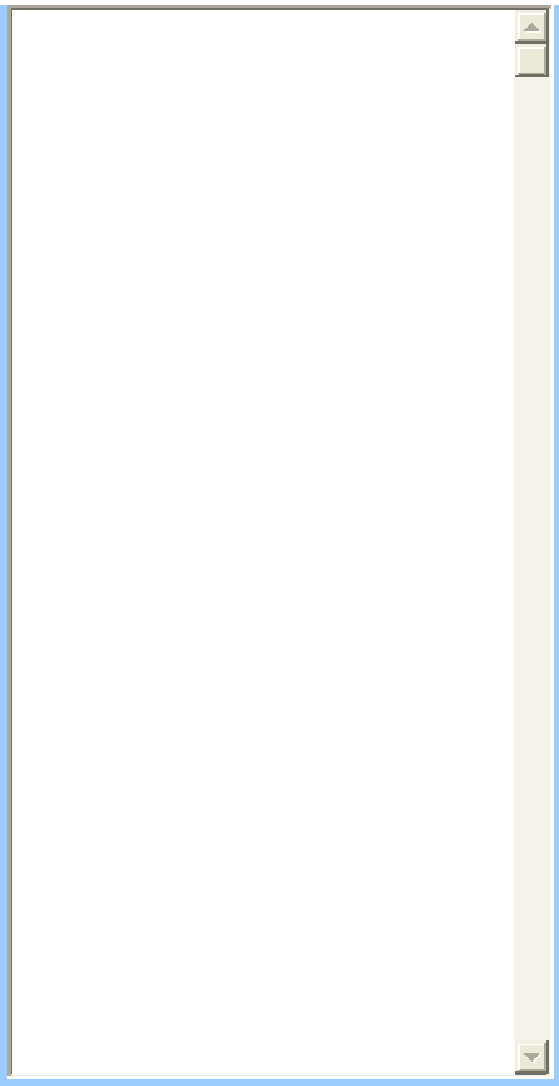
- ☐ Yes, faculty mentor.
- ☐ Yes, graduate student mentor.

- [ ] Yes, staff for SUPERB program.
- [ ] Yes, other SUPERB students
- [ ] I was at first, but am no longer in touch.
- [ ] No.

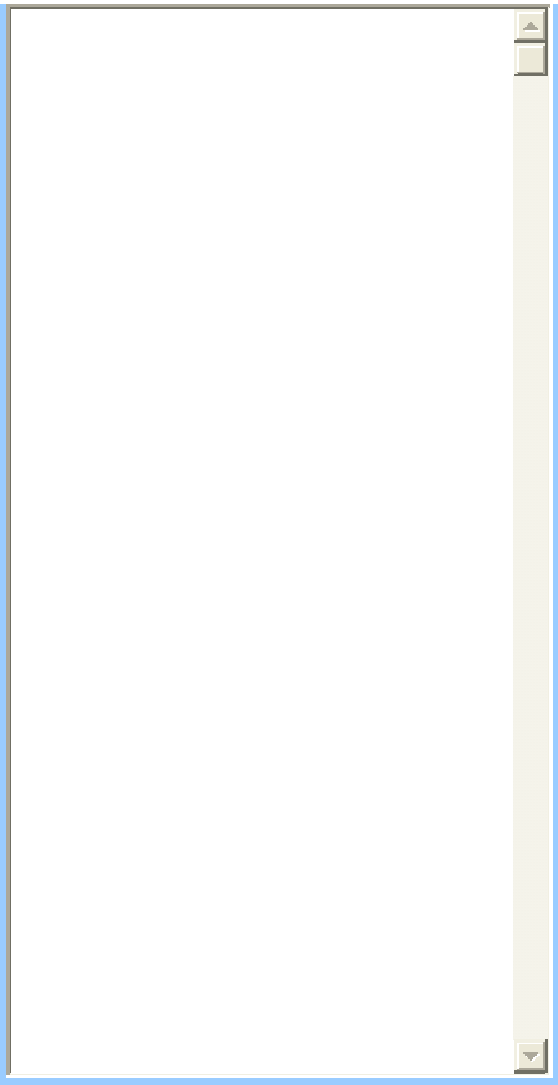
14. If you are still in touch with someone from the SUPERB program, how has this network been helpful to you? (Check as many as apply)

- [ ] I found a role model.
- [ ] I found someone who has become a mentor to me.
- [ ] I have support from other SUPERB students via e-mai.
- [ ] Other (please specify)

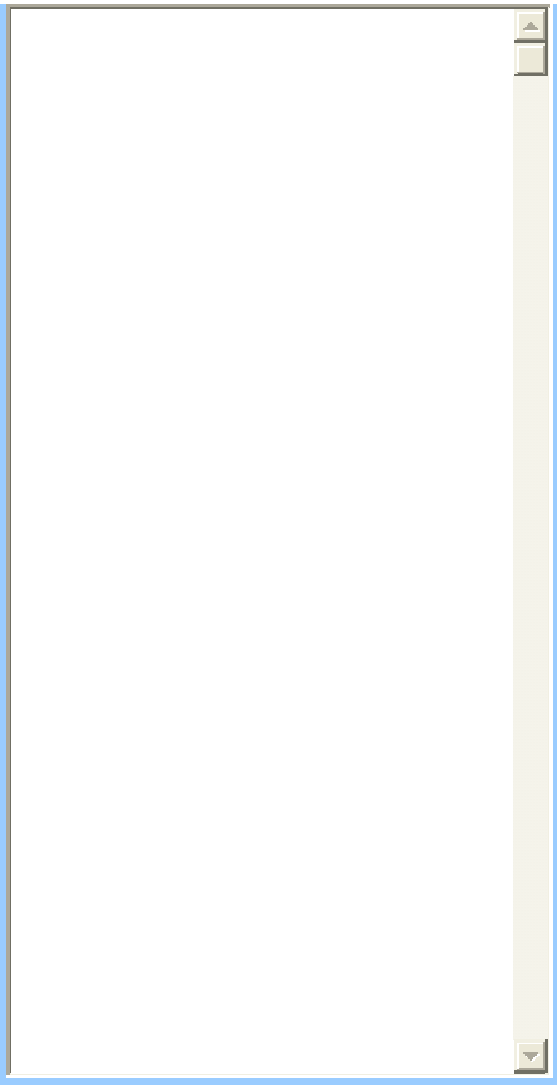
15. If you were a co-author or author of any papers, including a conference paper, as a result of your SUPERB experience, please name the paper(s) and/or give the URL(s).



16. Now that some time has passed since your SUPERB experience, please tell us what you learned or discovered in SUPERB that has continued to affect you today. This is an important question so please be specific and provide examples.



17. What advice do you have to make the SUPERB program more beneficial to undergraduates participating this year?



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3. Online Survey Completed by Graduate Student Mentors

1. How much time per week did you spend mentoring your SUPERB student? If you had more than one student, please average the time per student.

*** 2. How involved was your Faculty Research Advisor in mentoring your SUPERB student?**

3. Did your Faculty Advisor attend the Poster Session?

4. How many times did your student meet with your Faculty Research Advisor, individually or in your group?

1-2 times	3-5 times	Weekly	More than weekly
○	○	○	○

5. How do you rate the program balance of student's time for research and time allocated for outside activities, such as the GRE sessions, weekly meetings, field trips, etc?

*** 6. What did you find to be the most challenging aspects of mentoring your SUPERB student? (Check all that apply):**

- ☐ Defining an undergraduate research project

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- [ ] Getting the student up to speed on their project in the early weeks
- [ ] Student's level of motivation
- [ ] Project management
- [ ] Other (please specify)

*** 7. Did you attend the SUPERB Graduate Mentor training before your student arrived?**

*** 8. Did you attend the mid-program Graduate Mentor's Meeting?**

*** 9. In retrospect, how do you rate information given to you about SUPERB?**

*** 10. What training do you suggest for SUPERB mentors? (Check all that apply):**

- [ ] Understanding of SUPERB program goals
- [ ] Guidance on the amount of mentoring students need
- [ ] Understanding the student's academic background

- [ ] Determining what students are capable of in research
- [ ] Defining a good research project
- [ ] Adjusting the project to the student's preparation
- [ ] Pacing the student's progress
- [ ] Prior TA experience
- [ ] Other (please specify)

11. Did you discuss your student's graduate school plans? (Check all that apply):

- [ ] Where to apply
- [ ] Relative competitiveness of graduate programs
- [ ] Role of GRE in admission
- [ ] Letters of recommendation
- [ ] Research interests for graduate school

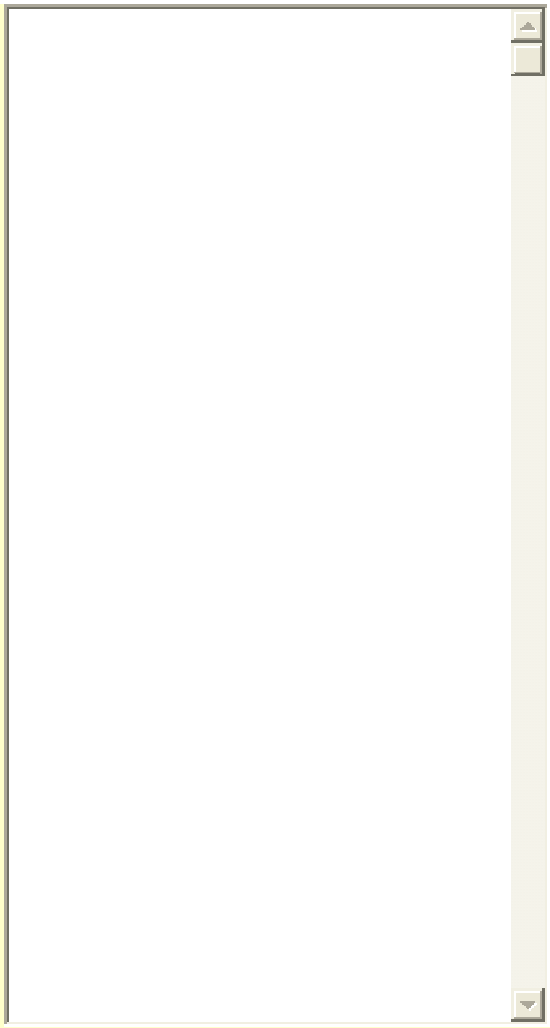
12. Will your faculty advisor write a letter for your student?

*** 13. Please rate your SUPERB student(s) on the following**

	very high	high	medium	low

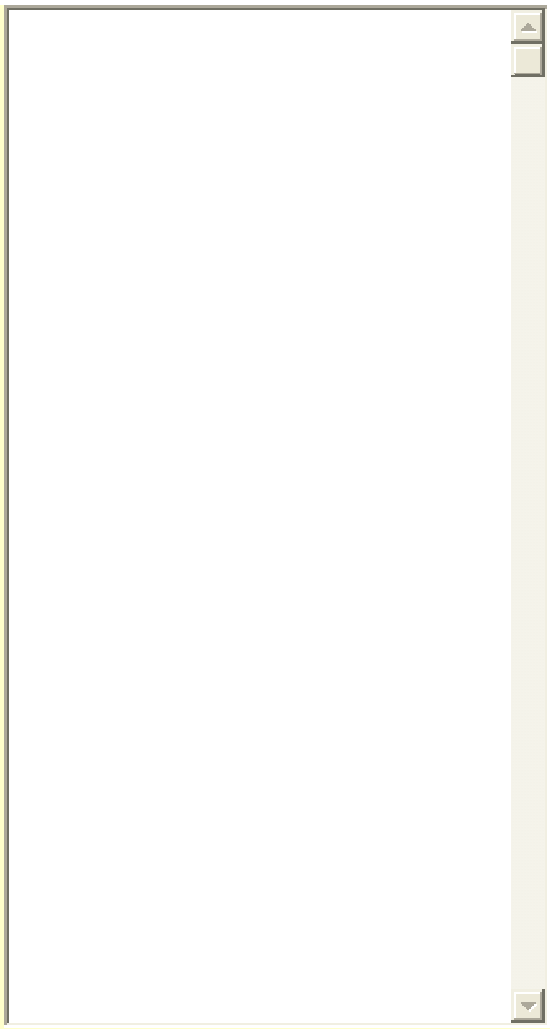
Level of preparation for the specific research task upon arrival				
Level of comfort with the research process in general upon arrival				
Level of comfort with the research proces in general upon completion				
Level of confidence in their ability to work in a graduate research lab				
Level of preparation to perform well in Graduate School				
Ability to succeed in graduate school at Berkeley				
Ability to succeed in graduate school in general				

*** 14. What aspect(s) of mentoring a SUPERB student gave you the most satisfaction?**



15. What did you gain from this experience?

16. What suggestions do you have for improving the program?



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2. Faculty Mentor Interview Guide

How many years have you been involved in the SUPERB program? How many students?

Have you kept in touch with or heard from any of the SUPERB students? Are any at UCB? Where are they?

What kind of contact continues – with you, with grad student? Do you know if they continued with the research when they went back to school? Do you know if the SUPERB

How would you define "success" in this program? For instance, is it for students getting into grad school, recruiting students to UC Berkeley for grad school, helping students from under-represented racial/ethnic groups move ahead in STEM fields, clarifying goals, building confidence, keeping students in STEM fields – whether academic or otherwise?

Has your SUPERB student (s) been an author or co-author on any publication relating to this research, including informal publications? Were any papers published as a result of the SUPERB program? [If yes, how many, how helpful.]

Do you think SUPERB participation had any impact on students' understanding the process of what grad school might be like?

What level of supervision do students typically need? How much from him versus graduate student? Does it start out more intensely and then become more routine? [expectations]

How much time over a summer do you spend on the SUPERB program? Do you believe the time YOU put in is well spent? Is there a benefit to you as a faculty member?

How about the graduate student mentors? Are there ways they benefit from the SUPERB program experience? [If no response, ask to see if Do SUPERB students help them accomplish needed research tasks? Is that a significant motivation for their participation?

Is SUPERB used by faculty to screen prospective graduate students?

How do SUPERB students compare to UCB undergraduates in the conduct of research?

What do you see as the mission for the SUPERB program? [Probe to see if feel it is global – to diversity the national pool of talented undergrads – or local – to diversify UC Berkeley's own pool? Or both?] Do you think that is exactly the right mission or do you have suggestions for change?

What does UCB get out of the SUPERB program? If there were no SUPERB program, what could UCB do to increase diversity in STEM fields?

What could be altered or improved in the SUPERB program?

APPENDIX C: OPEN-ENDED C

OMMENTS

What Students Learned or Discovered in SUPERB That Had Lasting Impact

Note: Each section below contains one student's description of what s/he learned or discovered as a result of the SUPERB experience, an impact that continued to affect them when this survey was conducted. Because a student could make more than one point in the statement, the four most common impacts are color-coded for ease of identification.

- **First hand research experience (such as, how to formulate research questions, test hypotheses, and present findings) AND realization that student enjoyed/was good at conducting research. [*Any time research is mentioned, that part of statement is underlined*]**
- **Learning from UC Berkeley faculty and graduate students.**
- **Increased confidence that could be successful in graduate school.**
- **Practical information on application to graduate school, financial assistance options.**

1. I can say my experience with SUPERB is the sole reason I got where I am today**. My faculty mentors in SUPERB were highly motivating, allowing me to work independently** and realize my potential in research that I could not have gotten from my undergraduate institution. **Not only did they introduce me to a field of computing about which I am passionate (Human-Computer Interaction, which didn't even exist at my undergraduate institution), but they provided me with great career advice and a boost to my confidence level. They helped me decide which graduate schools to apply to and wrote me letters of recommendation. Also, we were able to co-author a conference paper together, which gave me an advantage in applying for graduate schools. I ended up joining the Ph.D. program at the school where they got their Ph.D.'s from, Georgia Tech, and am even working with their Ph.D. advisor there which is working out extremely well.** My undergraduate institution was a tier-4, unknown institution that I went to mostly because it was all I could afford, since I had to pay for school on my own. There were no research experiences there for undergraduates. Without my participation in the SUPERB program, the research experience it provided, and the network that I was able to build, I do not think I could have gotten where I am today, which is one of the top schools in Human-Computer Interaction. I am finishing my third year of my Ph.D. and am getting close to the thesis proposal stage, have several major conference publications, and am funded on an NSF fellowship. I feel that SUPERB was the perfect package to help me succeed in research and realize my potential. It provided me with an understanding of what it was to do research, gave me connections to some of the top researchers in the field, helped me overcome deficiencies of my undergraduate institution, and **helped me prepare for all aspects of applying for graduate school (including the GRE, fellowships, letters of recommendation, research experience, statement of purpose).** Thank you so much

for allowing underrepresented students from smaller schools to have this opportunity and for all that it has provided for me.

2.My SUPERB experience provided me with the confidence to apply to top programs in my field. I was able to present the research I completed during SUPERB at 3 conferences after completing the program. Two were poster sessions, Society of Hispanic Professional Engineers National Technical and Career Conference and the Boise State University Undergraduate Research Conference. The other was an oral session at the Mexican American Studies Conference in Boise, Id. The trip to UC Santa Cruz introduced me to an area of electrical engineering research that I am strongly considering for graduate studies. Meeting UCSC's diversity recruiter has proved valuable as I begin the graduate admissions process. **My graduate mentor taught me much more than research methods. At a university such as Berkeley the quality of PhD candidates is unmatched. His guidance and mentorship continues to serve as a model of how I would like to live my life. He is the most intelligent and balanced person I know.** Most importantly I was able to visit the area. I know that success in grad school will depend greatly on how I adjust to the local culture and I absolutely fell in love with the Bay area. SUPERB has permanently changed my life!!!

3. I discovered the essence of engaging in research especially at a young stage in college. My experience with SUPERB has brought me far with research as I have come to present several of my research projects both SUPERB and non SUPERB projects. **I have had the opportunity through SUPERB to work with some of the best minds in research while contributing and learning from each other. In terms of graduate school, I got valuable information which I intend to use when applying to graduate school.**

4. I learned how to do research, when I was an undergraduate student I never realized how important is to do research in electrical engineering and I never had the opportunity to do research as an undergrad, but I think having some experience in doing research as an undergrad is a must, if you are going to grad school

5. Since my SUPERB experience I have been more aware of the different areas in my field and which interest me the most for graduate school. The SUPERB program showed me how to approach a complex topic and complete a research project out of it. It was definitely a challenge that made me grow as a researcher and as a person.

6. It gave me confidence and drive to further my education and pursue research in my field.

7.I realized that the life of a researcher is very hard and work intensive**. I saw my graduate mentor working in her lab 6 days a week from 8am to 10pm. For my SUPERB research I had to work almost like her.** However, this experience helped me get a better understanding of how to do research and how to succeed in graduate school. **Sincerely, the SUPERB experience was an intense one but it was fulfilling and it strongly convinced me to pursue graduate studies.**

8. What I learned in SUPERB is that I don't want to do research for a living. It was very disorganized, and I was never exactly sure what was going on. Very interesting!

9. Research experience, and be able to do a project outside of class assignment.

Graduate school application process, and some inner sights of admission committee.

10. The main thing that I took away from my SUPERB experience was the feeling that I was capable of doing research at a top institution. **It gave me the confidence to apply to the best graduate schools, and I'm happy to say that I was accepted to U.C. Berkeley, Stanford, Princeton, U. of Illinois at Urbana-Champlain, University of Washington, etc**. **My faculty mentor became my research advisor, and my 'grad student mentor' was actually a staff engineer at the Berkeley Wireless Research Center, and he remains a very supportive friend to this day. Additionally, throughout the program I've had the pleasure to know Sheila Humphreys, and I remain involved with WICSE, Women in Computer Science and Engineering.**

11. I learned valuable lessons in research that I continued to exercise throughout my research experiences, such as how to write papers and prepare poster presentations.
12. Most importantly, I learned what research is all about, and as a result, I am certain to continue to grad school.

13. Research takes a lot of patience, but getting results and publishing is still key to succeeding.

14. I got my first experience in the 'research world' at SUPERB. At my undergraduate institution, they never really exposed the undergraduate students to research that the faculty and the graduate students do. So I learned about the difference between the master's track and the PhD track, and the emphasis of research. I became immersed in research 'lingo' and I met other researchers. I also learned how to give a research talk and actually had my first experience doing so. I realized that research was something that I really could do. I also began to understand that you adjust your research to your own interests and passions. Since then, I have been able to do just that in my graduate program. **They also made it a big point to have faculty and graduate students come talk to us and spend time with us to help us understand how to be a successful graduate student. Also, my faculty advisor sat down with me at the end of the program and, according to my interests, pointed out schools across the country that I might be interested in. This really really really helped me in the application process (I'm at one of the schools on his list now).**

15. I discovered that I would like to do research at a big university. This was caused by being in a big lab working on my project and hearing the grad students talking about their projects and trying to solve problems. It seemed very exciting.

16. Prior to SUPERB, I did not know anything about the Ph.D. -- I imagined it just involved taking more classes. My experience in the program exposed me to the more interesting reality of Ph.D. research, and prepared me for the complicated application process. Most importantly, though, the SUPERB program got me started in a specific research project (automatic speech recognition) which I am continuing to work on to this day**. Looking back, the SUPERB program truly changed the course of my life. Without it, I would most likely never been able to be involved in undergraduate research, and subsequently would not have gone to graduate school. As a working student, I desperately needed to find a job that summer in order to stay alive; I could not afford to do research as an unpaid volunteer. But the SUPERB program's free room/board, along with the living stipend, allowed me to focus entirely on the research project.** This was the first time in my life that I was able to pursue an intellectual interest with such commitment. **When I then learned that I could continue doing this in grad**

school (and get paid -- I was shocked to learn that Ph.D. students get fellowships), I was determined to make it happen. Now, I look forward to mentoring other students one day; and eventually, my ambition is to become a professor.

17. Here is a list of things I learned while at Berkeley and still I need to remind myself from time to time: * In research, it is always good to ASK questions. Do not assume things, and never think your question is silly. The question-asking exercise will help you develop good research and critical thinking skills in the future. You will ultimately be able to think and answer your own questions. * **You will learn a lot from your faculty advisor.** But one thing to always keep in mind, is that even thought they are experts in their area, they are not almighty, do not assume they know everything, and also do not be afraid of them. * An advisor's role is that, to advise you, they are not tutors. While is good to ask questions, its also a good exercise to do your own research before asking questions to your advisor.

18. SUPERB is a vital program because it not only clears up the metaphorical fog that tricks people into believing that they can't undertake doing research, but at UC Berkeley especially, with the support of the staff, students are allowed to work side by side with Ph.D. candidates and sometimes professors on new cutting edge research--stuff that is talked about in the present media in terms of technological advances.

19. Throughout SUPERB, I saw the importance of asking questions and being 100% clear on the issues at hand and the solution being pursued. This is a fundamental practice in graduate school.

20. Networking is important.

21. The more experience in writing research papers and in doing research, I feel I continually increase my abilities to enhance my abilities.

22. Having gone to a small undergraduate university, I was timid about my abilities as an engineer. SUPERB showed me that my abilities were at least equal to my peers at larger and traditionally thought of as superior universities. My self-esteem improved because of SUPERB.

23. Graduate school is competitive. Preparation for graduate school is important. Saw another example of how graduate school requires significant amount of daily time. **However, some grad students had significantly different paces and time contributions from the average. Understand that faculty take on a lot of roles, from getting funding, teaching, and activity contributing to research. Graduate students also contribute to the funding in addition to topical roles.**