

The Diversity Programs' Graduate Bridge Program

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Introduction

This country needs more female and underrepresented minority graduate students in STEM fields. According to the National Science Foundation,¹ a citizenry informed in science and engineering is critical to maintaining and improving our nation's current standard of living. Higher education, particularly graduate education, is essential to meeting this goal; unfortunately, graduation rates for some minorities and women are underrepresented when compared to their presence in the population. This underrepresentation, which is even worse among engineering faculty, is of great concern to ASEE. Chubin and Slaughter² discuss in the September 2002 edition of Prism what they call the "stunted pipeline" that has resulted in the absence of minority faculty members in engineering education. They state that only 20% of the bachelor recipients are women and less than 12% were minorities in 2001. They challenge the engineering schools to produce more minority engineers, which will hopefully lead to more minority faculty.

In the April 2002 edition of Prism, Representative Vernon Ehlers, (R-MI), also makes a case for increasing the diversity in engineering.³ He states:

Diversity is essential in engineering, beyond simply addressing the human capital needs of the tech-driven economy. William Wulf, president of the National Academy of Engineering, has remarked that engineering is fundamentally a creative process, and like any creative process, benefits when its practitioners can call on a spectrum of backgrounds, viewpoints, and experiences. Viewed in this light, diversity is essential in order to maximize our national capacity for continued innovation and progress

The University of New Mexico (UNM) and its School of Engineering (SOE) are totally committed to increasing their diversity across the spectrum of their students. While SOE has great success in attracting minority students to its undergraduate program, its graduate student record is not as stellar. The SOE minority undergraduate enrollment for 2000-2001 was 55% minority (63 Native Americans, 468 Hispanics, 35 Afro-Americans, and 66 Asian Americans /Pacific Islanders out of a total enrollment of 1150). The Diversity Programs (DP) in the School of Engineering has contributed much to this success by offering students support in the form of scholarships (~\$300,000 annually), employment (DP employs about 12 students), structured study sessions, tutoring, advisement, a computer lab, and work skill development workshops. Unfortunately, this success has not been translated into its graduate school where the minority enrollment is under 12%. This trend is not unique to UNM. According to NSF, African American, Native American and Hispanics made up only 6%, 0.5%, and 5% of the U.S. science and engineering graduate student population respectively in 1997.¹

It has been the experience of the Diversity Programs that many minority students do not have the support structure that makes graduate school an integral part of their education. Either they are not encouraged or are ill prepared to continue onto a graduate education. To improve the minority graduate student enrollment at UNM and other universities, SOE conducted a graduate bridge program during the summer of 2002. The goal was to increase the interest among minority students in pursuing graduate degrees in engineering, math, or science. The program was designed to educate undergraduate and first-year graduate students on the skill set required to succeed in graduate school and to introduce them to the research areas of some SOE faculty. The program helped the participating students understand the difference between an undergraduate and a graduate education and introduced them to research areas in which they want to continue their education. In doing so, we hope to increase the chances of recruiting and retaining them as graduate students.

The graduate bridge program was intended for students majoring in STEM (Science, Technology, Engineering, and Mathematics) fields and consisted of a four-week term. Each weekday had 6 hours containing a blend of lecture and laboratory activities. The activities were divided into two tracks: technical and non-technical. The technical track consisted mainly of SOE faculty members making presentations on either their research areas or areas of expertise. The non-technical track consisted of the skill/information building activities.

The Diversity Programs and the Electrical Engineering Computer Engineering (EECE) Department in the School of Engineering were responsible for the Bridge Program. Chaouki T. Abdallah (Graduate Advisor for EECE) was responsible for obtaining the faculty and other guest speakers; Robert LaFarge, Director of the Diversity Programs, was responsible for the student recruitment and the fiscal aspects. The program was funded by NSF through the Minority Graduate Education at Mountain States Alliance (MGE@MSA), at Arizona State University.

Background

There's no question that the face of the American workforce is changing. The minority population in the United States, primarily the Hispanic population, is growing. The population changes from 1990 to 1999 include an increase of 13.4% for American Indians, 30.1% for Asian American, 12.1% for African Americans, 28.0% for Hispanics and only 6.9% for Whites.⁴ Although minorities have broadened their career choices in the past few years, they have not increased their numbers in science and technology. The current US workforce is comprised of 77% White, 4% Asian and 19% Minority, but these numbers do not hold for engineering professionals. The Bureau of Labor Statistics states that the engineering professional ethnicity breakdown includes 88 % White, 6% Asian and only 6% minority.⁵ The representation in engineering schools is dismal; there are barely 1,000 African Americans, American Indians, and Hispanics are among the 25,000 engineering educators in the nation's colleges and universities.² Not only is the American workforce changing, the size of the U.S. college age population is undergoing a change. After decreasing in size from 22 million in 1980 to 17.5 million in 1997, about 23%, the population started growing in 1997 and is expected to be 21.2 million by 2010 with a strong growth among minority groups.⁶ While the white college age population will experience growth until 2010, it is projected to decline afterwards. The minority population, however, will continue to rise. This trend presents quite a challenge to the U.S. educational

system if it is to educate these students who are traditionally underrepresented in Science and Engineering (S&E). Most of the strain will be on research universities who educate only 19% of college students but account for 42% of the B.S. and 52% of the M.S. degrees in S&E. A key challenge to undergraduate education will be producing enough qualified K-12 math and science teachers to meet the increase in not only student population but in retirement of experienced teachers. This is a topic that UNM and DP is much concerned about. UNM's ENLACE Program, through funding by the Kellogg Foundation, has created a Hispanic Teachers Pipeline that seeks to produce more Hispanic teachers by various methods, including mentoring high school and middle school students by champion teachers.

There is some mixed news in minority engineering graduate education. It increased 47.7% in the period from 1990 to 1999 in comparison to increasing only 14.7% for the non-minority. Minority received 15.5% of the total S&E PhD's awarded in 1999 as opposed to 8.5% in 1990. The percent of engineering Ph.D.s awarded to minorities increased annually, with the exception of 1998, when it decreased slightly. The largest number of engineering PhD's was awarded in electrical engineering and the largest number of science PhD's was awarded in psychology.⁴ Still, while underrepresented minorities compose 25% of the general population, they constitute only 9.3% of the student in graduate science and engineering degrees.⁶ If the ASEE concern for more minority engineering faculty is to be addressed, then a better pipeline that produces more minority graduate students must be created. There are numerous ways to improve the pipeline such as growing your own, considering your own graduates, poaching, reaching out, and target advertisements. Some experts believe that current faculty members must take a more active role in graduate student recruitment.⁷ This graduate bridge program brings the Diversity Program in the School of Engineering together with the faculty of the school to encourage the minority students attending UNM and other schools.

Program Description

The Graduate Bridge Program was meant to facilitate, or bridged, the transition of STEM undergraduate students into graduate schools by offering them some insight into graduate school and maybe matching them up with UNM faculty. The program was conducted for four weeks. The participants met for 6 hours a day (9:00 a.m. – 12:00 p.m. and 2:00 p.m. – 5:00 p.m.) in various lecture and laboratory settings. Some of the UNM students were allowed to attend half time to accommodate their work/school schedules. The feeling was that some exposure was better than no exposure.

The program had two tracks: technical and non-technical. The technical track had SOE and other UNM faculty lecturing on their research areas or their areas of expertise. The non-technical track had UNM lecturers discussing some skill that graduate students find useful, such as project management, leadership, or risk taking. The schedule is presented in Table I.

The rationale for this structure was based on Dr. Abdallah's experience as the graduate advisor for the EECE department. He noticed that the minority graduate students were missing two important ingredients that were necessary to succeed in graduate school: an exposure to the research being conducted in the department and the skills to conduct meaningful research.

Originally, it was intended to have an equal representation among the departments in the School of Engineering. The volatility of faculty's summer schedules precluded such a distribution. Most

of the presenters were from the EECE department. This favored the distribution of students since most of them were EE majors. Due to a last minute schedule change, the Chemical Nuclear Engineering Department did not have a representative. The Mechanical Engineering Department only had one member represented.

As the program was being developed, it was hoped that as a byproduct, faculty would be indoctrinated into the active recruitment of minority graduate students. This was partially realized. The entire participating faculty enjoyed their interactions with the students and a few actively recruited them. Most committed to the second program offered during the Christmas break, if their schedule allowed.

Table 1: Graduate Bridge Schedule

Date	Topic
June 10, AM	Introduction
June 10, PM	Introduction to Library for Engineering Research
June 11, AM	Mathematics & Engineering I
June 11, PM	The Ethics of Research
June 12, AM	Antennas I
June 12, PM	Risk Taking & Project Management
June 13, AM	Antennas II
June 13, PM	History of Technology
June 14, AM	Optical Communication Systems I
June 14, PM	Research Methodologies
June 17, AM	Other Applications of Optics in Engineering
June 17, PM	Research Methodologies
June 18, AM	Visualization & Computer Vision I
June 18, PM	Leadership
June 19, AM	Visualization & Computer Vision II
June 19, PM	Leadership
June 20, AM	Visualization & Computer Vision II
June 20, PM	Mathematics & Engineering II
June 21, AM	Networks I
June 21, PM	Mathematics & Engineering III
June 24, AM	Networks II
June 24, PM	Medical Imaging
June 25, AM	Antennas
June 25, PM	Data Analysis
June 26, AM	Water Resources Engineering
June 26, PM	Fluid Mechanics I
June 27, AM	How to get into Graduate School
June 27, PM	Fluid Mechanics II
June 28, AM	Scholarships
June 28, PM	Fluid Mechanics III
July 1, AM	Digital Imaging I

July 1, PM	Applications of Fluid Mechanics
July 2, AM	Digital Imaging II
July 2, PM	Visualization
July 3, AM	Optical Sciences and CHTM
July 3, PM	Research in Aerospace Structures
July 5, AM	The Context of Higher Education

Participants were recruited through the many channels that the Diversity Programs had at its disposal, including its own scholarship programs and its close ties to the student chapters of AISES, NSBE, MAES, and SHPE. Flyers were posted in all the engineering buildings. An announcement of the program was sent to the National Association of Minority Engineering Program Administrators (NAMEPA) list server and resulted in three non-UNM students attending the program.

Results

Because, the funding was approved in mid May, the recruitment was not as efficient as might have been the case earlier in the semester. By this time most of the students have jobs, internships or have summer school already lined up. As a concession to the late date, UNM students were given the option of attending only half the session in any manner they chose. As a result, there were 15 students in the program including three from outside of New Mexico. UNM students were paid an attendance-based stipend and the out of town students were housed in a nearby hotel and given a meal allowance. The UNM students bonded well with the non-UNM students not only in class but out class as well. They all went out together for lunch and other times.

The ethnic and gender breakdown of the students was: one Asian female, one Native American female, two African American females, two African American males, four Hispanic females, and five Hispanic males. Two participants were first semester graduate students; four were recent graduates of UNM; and the rest were upperclassmen. Most were either EE majors or interested in a graduate degree in EE.

Surveys

Surveys were conducted at the end of each week to determine students' reactions to each lecture. Needless to say, the survey responses to each lecture varied greatly. Most had a wide range of reactions that made it hard to formulate any meaningful conclusion for most lectures. For example, the comments for the June 10 *Introduction to Library for Engineering Research* lecture were:

- Everything was explained very well, but the subject was boring.
- Informative
- I would enjoy the lecture more if the tasks/examples were done at the same time as directions, the more interaction the better.
- Exercises were very good, but too many of them.

- Most of us already had the info that she gave, so personally it was boring and waste of time.
- She had command of subject.

While the comment for the June 11 *Mathematics & Engineering I* presentation were:

- The lecture was informative and well presented.
- He gave very useful, interesting, and practical information that all engineers could use in their career.
- Great presentation.
- I enjoyed the entire lecture.
- Instructor made it fun.
- Very cool.

These two examples are a good illustration of how most of the comments went. The variations in comments for a particular presentation were probably correlated with the students' academic standing.

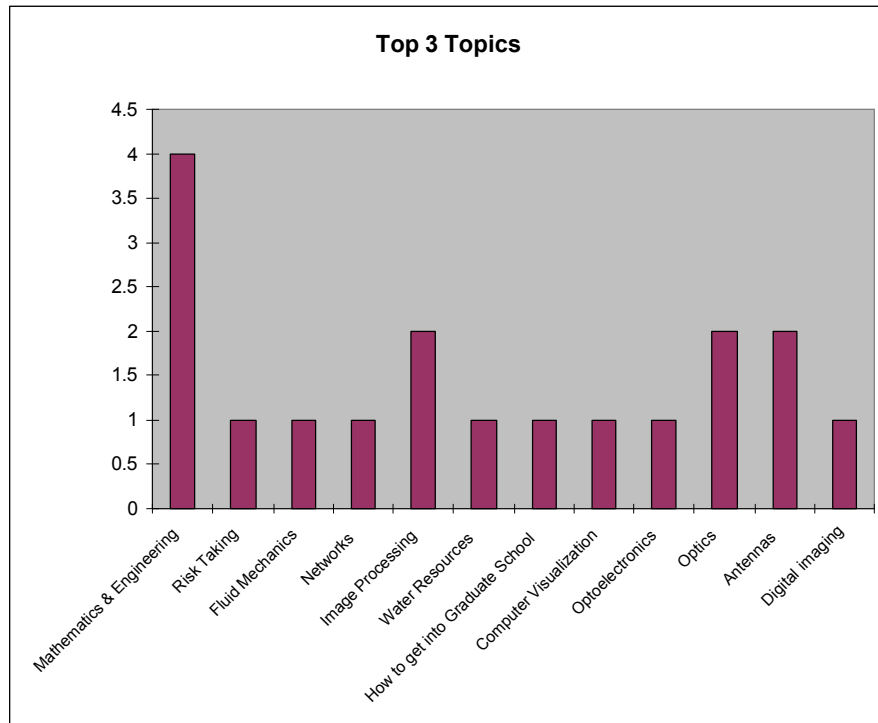
Final Survey

A survey of was conducted on the final day to gauge the participants' reaction to the overall program. The first five questions were concerned about the actual topics. The survey tried to determine which ones the students liked and which they did not. The students were also asked what other they would like to have been included or not covered at all and if they would have enjoyed more hands-on or laboratory experiences. The next four questions were concerned about logistics. The question asked the students if the program had changed their mind about graduate school. All ten questions and the students' responses are listed below (Note: (x2) denote two responses).

1. What were your three favorite topics?

Figure 1 shows the students' rating their top three topics.

Figure 1: Top Three Topics



2. What were your three least favorite topics?

- All mechanical engineering, although topics that included image processing was fun.
- Library lectures (x2)
- Antennas
- Fluid Mechanics (x3)
- Risk taking and
- Project management.
- Research methodology

3. Were there any missing topics that you would have liked to be included?

- Not in particular, maybe provide instructors from the business department.
- Include a lecture by a professor explaining his/her graduate studies, students, research area and expectations for RA's, fellowships and TA's.
- Include classes of studying for the GRE.
- Networking: Not enough information given.
- Some hardware knowledge.

- More topics in chemical, civil, and electrical engineering. We viewed mechanical, computer science, and some electrical engineering but not chemical and civil engineering.
- Robotics, controls engineering, thermodynamics, power plants

4. Were there any included topics that should not have been there, or should have not been emphasized?

- At times, lecturers did not specifically mention whether or not the information they were presenting was graduate student research.
- All topics I believe were divided evenly.
- Again, the library search and ethics lectures were very helpful, but were also too long. I feel 1 or 2 days at most.
- Mechanical engineering was covered in great detail (and not that many ME majors were in the class.
- More distribution of topics.
- Should move the antennas class in the middle of the session. Too complicated for the beginning of the session.
- Library stuff should NOT have been there. Most of us are already juniors, seniors and graduates and we are from this country. So we already know how the library system works.
- All of the topics were nice to have in order to have exposure to different areas.

5. Would you like to see more hand-on exercises and laboratory experiments (computer examples)?

- Yes, provide exposure to software i.e. Labview, Matlab, also more exposure to equipment i.e. oscilloscopes, multimeters.
- Visiting the labs was an excellent idea. I enjoyed seeing what people were actually researching.
- Yes, that would be very helpful to understand some topics in the lectures.
- I would have liked to see graduate students working in their labs in each of the SOE departments.

6. How would you like the schedule to be changed?

- The schedule was fine.
- The schedule did not seem as if it would need any changes.

- View some type (hands-on) of graduate research in every engineering field. I feel this will help to interest everyone that is in the program.
- Have program in a room where there are not any computers, so certain students don't get distracted.
- Six hours every day was a lot. (I went 3 hours only).
- Maybe evening classes so that those who work could attend all classes.
- Shove off ½ hours of each session if it is just lecture and not labs.
- Have the program earlier in the year e.g. late May.
- 10:00-12:00 & 2:00-4:00.
- 9:30-12:00 & 2:00-4:30.

7. Was the daily schedule too long, too short, or just right?

- I only attended half day, which I feel was just right for me. Although, I could have attended all day if I had the time, because some of the morning topics interested me.
- Just right. (X3)
- Too long. I went 3 hours. I liked the fact that if I missed one afternoon class, I could make it up with a morning class (vice versa).
- On some days it was long. I think reducing it by 1 hour a day or including more computer/lab examples would be nice.
- 4-5 hours a day would have been more pleasing.

8. Was the overall program too long, too short, or just right?

- Just right. (X2)
- A little long, maybe 2½ to 3 weeks would have been appropriate, but overall it was set up well.
- Move the program up one week, so it ends at the end of June and before the 4th of July holiday week.
- Overall it was right, 4 weeks were good.
- The program could have been a little longer.
- One month was just enough time. Any less and we would have been cramming information. With a month's time, we were able to move at a steady pace.

9. For out-of-town students only: How were the hotel accommodations? Would you rather have stayed at UNM dorm rooms?

- The hotel accommodations were great. But staying at the UNM dorms would not be a bad idea.

10. Are you more likely to go to graduate school now (if funding/re-location were not issues)?

- Definitely
- Yes, this provided great information in areas that I would have otherwise not have had any interest in.
- Yes. (X2)
- Yes, will be attending graduate school.
- Before I signed up for this program, I was totally in the dark about grad. School. I felt that I had to finish my undergraduate studies and just find a job. Now that this program is over, I have set another goal; to finish graduate school. This program was well worth my time and has honestly made a difference in my life. Robert Ibarra and Johann Van Reenen I feel “opened my eyes”. Thank you once again.

Conclusion

Though only a small amount of data is available, it points out that the UNM Graduate Bridge Program is a success. By exposing the participants to technical and non-technical information that is necessary for their success in graduate school, the program gave the students a good head start towards their graduate education. The students, particularly the undergraduates, were very appreciative. One student said it was one of the best experiences of his life. Others said it made graduate school a new priority in their lives. An additional benefit of the program is that the participating faculty are now very cognizant of the need to recruit minority graduate students. There was at least one recruitment of a non-UNM for the EECE department.

An anecdotal conclusion is that undergraduates are not very familiar with the research being conducted in their schools. When asked, the students mostly requested more technical presentations. They were very concerned about getting a true picture of the research being conducted by the faculty presenters.

A second two-week bridge program is being conducted as this paper is being written. It has about 25 participants with eight from other universities. Results from this program were used to restructure the program. Some of the non-technical presentations were moved to the beginning of the program, and other were eliminated or reduced. A GRE practice exam was added. Word of mouth has become a good recruitment tool. Even though the recruitment process started later than expected, more students enrolling in the program.

Another intent of the program is to produce a structure could very easily be copied at any university. As data are obtained, the program can determine the proper mix of technical and non-technical topics that optimize the participants’ enjoyment and exposure to the right information. The cost to other universities could be very minimal if faculty and students volunteer their time.

The important thing is to reach out to the minority students and educate them about the value of a graduate education.

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BIOGRAPHICAL INFORMATION

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Robert LaFarge has been a member of the technical staff at Sandia National Laboratories for 29 years. He has worked in the areas of flight mechanics, numerical analysis, range safety, robotics, and software engineering. He was the Director of the Diversity Programs in the School Engineering from January 2001 to January 2003 as an executive on loan to the University of New Mexico.

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