



## **ROSE-BUD (Rose Building Undergraduate Diversity) MAPS (Mentoring and Professional Skills)**

### **Dr. Carlotta A Berry, Rose-Hulman Institute of Technology**

Dr. Carlotta A. Berry is an associate professor of electrical and computer engineering at Rose-Hulman Institute of Technology. She received her Ph.D. from Vanderbilt University, her thesis was on the development of an enhanced human-robot interface for a mobile robot. Her master's degree in control systems is from Wayne State University. She has two bachelor's degrees; one in mathematics from Spelman College and one in electrical engineering from Georgia Institute of Technology. She worked for several years as a manufacturing controls engineer for Ford Motor Company and Detroit Edison before returning to graduate school to pursue her PhD. She has been an active member of the American Society of Engineering Education (ASEE) and the Institute of Electrical and Electronics Engineers (IEEE) since 2004. Her research interests include multidisciplinary educational robotics, human-robot interfaces and identifying strategies to increase enrollment and retention of women and minorities in engineering. She is the co-founder of the first multidisciplinary minor in robotics at Rose-Hulman. She is currently the director of the minor. She is also co-PI of the Rose-Hulman building undergraduate diversity (ROSE-BUD) program funded by an NSF S-STEM grant to increase the recruitment, retention and development of underrepresented populations in electrical and computer engineering. She has approximately 20 peer-reviewed publications with two in the Computers in Education Journal. She also recently published a book on Mobile Robotics for Multidisciplinary Study.

### **Dr. Deborah Walter, Rose-Hulman Institute of Technology**

Dr. Deborah Walter is an Associate Professor of Electrical and Computer Engineering at Rose-Hulman Institute of Technology. She teaches courses in circuits, electromagnetics, and medical imaging. Before joining academia in 2006, she was at the Computed Tomography Laboratory at GE's Global Research Center for 8 years. She worked on several technology development projects in the area of X-ray CT for medical and industrial imaging. She is a named inventor on 9 patents. She has been active in the recruitment and retention of women and minorities in engineering and currently PI for an NSF-STEM grant to improve diversity at Rose-Hulman.

## **ROSE-BUD (Rose Building Undergraduate Diversity)**

### **MAPS (Mentoring and Professional Skills)**

#### **Abstract**

This paper will discuss a program developed in the department of Electrical and Computer Engineering (ECE) at XXX to increase the recruitment, retention and development of women and under-represented minorities. ROSE-BUD was established in 2009; it was funded by an S-STEM grant from the National Science Foundation. The goals of the program are to provide scholarships, improving the infrastructure for advising and mentoring, and teach professional development skills to prepare students for careers in engineering. The program is open to students from all demographic backgrounds. Although, there is a special emphasis on recruiting underrepresented populations in electrical and computer engineering (e.g., women, African-American, Hispanic, and Native American). The ROSE-BUD program creates a strong sense of community as well as identity within the ECE department early in the students' academic career. There are several components of this program including networking/social activities, mandatory internships, co-ops or research experiences, technical speakers, as well as panels on topics such as study skills and time management. Lessons learned in the first 3 years of this program as well as the assessment of the programming will be discussed. These results will be used to guide the creation of an institution-wide diversity program entitled ROSE-BUD MAPS (Rose building undergraduate diversity mentoring and professional skills) program.

The MAPS program will be an extension of the on-going and successful ROSE-BUD (Rose Building Undergraduate Diversity) scholarship, mentoring and professional development program. The establishment of the ROSE-BUD MAPS program will facilitate the growth of the ROSE-BUD program into a university-wide program that will be used to meet the diversity and student development goals of the institute as well as provide a model to other institutions with similar goals. A map is a tool used to help the user navigate through unknown territories. Although, engineering school prepares students for the technical aspects of their future career, it does not typically address the personal and professional development needs. ROSE-BUD MAPS is innovative because it attempts to develop the person as well as the technical professional. This

program will contain three components including a mentoring and professional skills workshop, mentoring program and professional meeting experience. This program will not only increase the retention, graduation and placement rates among our students, but also enable them to become leaders among their peers and in their professional career. In conclusion, this paper will present the activities that have been implemented as well as establish the goals for future activities to insure the long-term sustainability of the program at the institution.

## **Introduction**

Underrepresented minority (URM) populations in engineering and sciences generally include women (in some disciplines), African Americans, Hispanics, and Native Americans. The lack of diversity among the Science, Technology, Engineering, and Mathematics (STEM) fields is a well-known national dilemma. Government agencies, industrial employers, and educational institutions are all active in various ways to improve the representation of URMs in the STEM fields. The ROSE-BUD Scholarship program was designed, not only to recruit, but to retain students by creating a sense of community, building formal and informal networks, and to develop them through the mentoring and professional development activities. These activities will not only improve the overall climate for minorities on campus but also change the face of the profession to be on par with society at large. The key to this program is that students are not only given the financial incentives to apply and attend XXX, but more importantly, they are given the skills and support to succeed at XXX and in their future career. As the ROSE-BUD scholars mature in the program, they are becoming campus leaders and mentors among their peers. All students benefit from exposure to people with diverse views, experiences and cultures. It has been shown in the literature that this exposure in STEM fields improves team dynamics, communication skills, system design, and problem solving. With the proper nurturing environment, minority students will not just survive but thrive and go on to successful careers and as alumni return to recruit and support the next generation of students to STEM.

**ROSE-BUD Scholarship Goals** The goal of the ROSE-BUD program is to broaden the participation of financially needy, academically qualified underrepresented populations in Electrical and Computer Engineering (ECE). This is of particular benefit to the ECE department because it has some of the lowest rates with respect to the enrollment of women and minority

students. Institutions that do not have the infrastructure or funding to create institutionalized Women in Engineering or Minority Engineering programs must identify innovative techniques to recruit, retain and develop a diverse set of students. However, the advantages of these types of universities (small student-teacher ratio, individual advising, student leadership opportunities, faculty mentoring/interaction) can have a positive impact on the retention and development of all students, particularly women and minorities. The ROSE-BUD program can identify of techniques for the recruitment, retention and development of URPs in STEM fields at small universities.

This goal is achieved by providing scholarships, improving the infrastructure for advising and mentoring, and offering a professional development program to prepare students for careers in engineering. Although, there is a special emphasis on women and underrepresented minorities, based upon government guidelines the program is open to students from all demographic backgrounds.

**ROSE-BUD Mentoring Goals** The goal of the ROSE-BUD MAPS program is to develop graduates who are able to function effectively within a multi-cultural workplace and world. The program consists of three key components: the MAPS workshop, mentoring program, and professional meeting experience. This program will not only increase the retention, graduation and placement rates among our students, but also enable them to become leaders among their peers. The MAPS program will be the keystone in a larger effort to improve the infrastructure for building networking and mentoring opportunities for undergraduate students across multiple disciplines from multiple backgrounds on campus. It will also specifically target practical skills necessary to function effectively on diverse teams and prepare for professional careers. The workshop will highlight the benefits of diversity among students, faculty and staff as well as the skills necessary to excel in these relationships. After completing the workshop, participants will become mentors and mentees on campus. They will also be allowed to apply for travel grants to attend a professional conference or meeting with their advisor or mentor. The specific objectives of the ROSE-BUD MAPS program are to:

- *Offer a two-day mentoring and professional skill workshop to prepare students for careers in engineering;*

- *Improve the infrastructure for advising and mentoring across multiple disciplines in a multi-cultural community;*
- *Increase the opportunities for students to attend professional meetings and internships.*

The establishment of the ROSE-BUD MAPS program will facilitate the growth of the ROSE-BUD program into a university-wide program that will be used to meet the diversity and student development goals of the institute

## Motivation

The motivation for the S-STEM scholarship program is to recruit students to pursue and succeed in a STEM profession. Our particular focus is on the recruitment and retention of female and minority populations in ECE because of the historically low participation rate nationwide and particularly at XXX. Our belief is that the S-STEM scholarship program combined with the unique environment at XXX is particularly conducive to a high chance of success for these students and therefore a good use of resources. The foundations for this program were designed based upon literature that states, the most successful programs for women and minorities provide “strong financial support, create a successful learning environment, access to role models and faculty mentorship, and ensure existence of peer support” [1-4].

The job gap in Electrical and Computer Engineering – the difference between the number of engineers needed and the number of engineers graduating – is predicted to be one of the highest among the STEM professions. The professional organization for electrical and electronic engineers made a forecast for 2008 in eight categories likely to affect this profession. These categories were technology, energy, climate change, work force, employment benefits, immigration, infrastructure and the economy. Two of the discoveries concerning the work force were the issues of off shoring jobs and phased retirement. The problem with the increased off shoring of technical fields is that the fear of not being able to find a job may affect the number of U.S. students willing to take a chance and enroll in these majors. Also to compound the supply and demand problem is the fact that nearly 40% of senior electrical engineers and shift supervisors in the electric power industry will be eligible to retire in 2009. The growth of science and engineering degrees increased by an average of 1.5% between 1980 and 2000 but this was less than the 4.2% growth of science and engineering occupations. This shortfall was made up by the immigration of science and engineering workers. In ECE this problem is further compounded by the loss of students to other engineering majors such as biomedical and mechanical [5-6]. The Bureau of Labor Statistics calculated that the total job openings for several professions based upon growth and replacement from 2006 to 2016. It should be noted from Table 1 that ECE was in the top four to experience a shortfall [7].

**Table 1: Job Gap Predictions, National Employment Matrix**

**Bureau of Labor Statistics, 2006 - 2016 (numbers in thousands) [7]**

	Employment				Change		Total job openings due to growth and net replacements
	#		%		#	%	
	2006	2016	2006	2016			
Total, all occupations	150,620	166,220	100	100	15,600	10.4	50,732
Engineers	1,512	1,671	1.0	1.0	160	10.6	505
Civil	256	302	0.2	0.2	46	18.0	114
Computer	79	82	0.1	0.0	4	4.6	28
Elec & Electronic	291	306	0.2	0.2	15	5.0	82
Electrical	153	163	0.1	0.1	10	6.3	45
Electronics, except comptr	138	143	0.1	0.1	5	4.7	37
Industrial	201	242	0.1	0.1	41	20.3	89
Marine and Naval	9	10	0.0	0.0	1	10.9	3
Material	22	22	0.0	0.0	1	4.0	6
Mechanical	226	235	0.1	0.1	9	4.2	58

A diverse workforce in any industry allows the company to tap every available resource, maximize potential, and remain competitive. Some of the benefits of this workforce include customer match, global business environment, retention/morale, government business, recruiting, and innovation/problem solving. Over the next decade, the U.S. labor force will be more diverse due to the growth rate of Hispanics and the decline of white, non-Hispanics in the workforce. By 2012, the number of Hispanics will surpass the number of blacks in the workforce [8].

Nationally ECE compared to other engineering disciplines has a lower enrollment for women. Women have the largest percentages in bioengineering, chemical engineering, and industrial engineering (39%, 35%, 32%). With regard to underrepresented minorities, ECE is only slightly higher than the other engineering disciplines at 14%. If the current trend of population growth continues, by 2020 Hispanic Americans and African Americans will comprise 17 and 12.8 percent of the US population, respectively. This trend indicates that there will be a need for the engineering profession to develop solutions to problems for a more diverse society as well as find methods to draw more diverse students into the engineering workforce [9, 10]. In addition, as systems engineering becomes more prevalent for engineers of the future, it will become more important for engineering students to work effectively on multidisciplinary and multicultural teams [9,10]. Therefore, one of the aspirations of the engineer of 2020 should be to effectively recruit, retain, and nurture underrepresented groups into the profession. To show the investment

of electrical engineers to broadening the participating of women, in 1993 the IEEE Technical Activities Board passed the following resolution:

“Resolved that the IEEE actively encourages participation of women in all its activities and requested that the IEEE Board of Directors establish a mechanism to encourage greater participation of women, especially students, in engineering [11].”

Gandara, et al. [12] found that the more highly effective minority engineering programs and/or universities were typically smaller in size. However, these smaller programs also may not be able to reach a critical mass of students, particularly financially needy students. The other challenge for these small schools was that they also may not have the resources and diversity of course work and faculty to be effective. Thus, many small recruitment and retention programs must define whether their ultimate goal is to produce survivors or leaders in order to focus efforts [12, 13]. Female engineering alumnae at the University of Missouri-Rolla felt that their success was partially based upon the small school environment which allowed them to develop relationships with people with common goals and interests. Additionally, this small environment allowed them to take leadership roles in student organizations [12].

### **ROSE-BUD Program Scholarship Methodology**

The ROSE-BUD (Rose building undergraduate diversity) program was established in 2009 through a five-year \$600,000 grant from the NSF S-STEM program. The specific objectives are to provide scholarships for academically talented and students with demonstrated need for financial support as identified by the federal government. In addition to providing scholarships, the program prepares students for careers in engineering by: (1) improving the infrastructure for advising and mentoring underrepresented minority and transfer students, and (2) teaching professional development skills. The ROSE-BUD program offers student scholarships for up to \$8000 per year for 4 years. This amount will total over \$540,000 in scholarships over the lifetime of the program. The opportunities for students to apply are limited to those who are interested in either Electrical or Computer Engineering. The students are required to maintain a minimum of a 2.75 GPA and attend at least 1 professional development or networking activity each quarter. These may include technical speakers, career development seminars and upperclassmen mentoring. All students are also required to complete at least 2 internships, co-



ops or research experiences by the time of graduation. By the end of the 2012-2013 school year, there will be 21 students who have received the ROSE-BUD scholarship and many more who were impacted by the activities.

The advising and mentoring network will provide academic, career, and peer mentors by placing the students in a cohort with other students in the program and matching them with an advisor in the ECE department. The development of the student teams creates a sense of community among the underrepresented students. This is important because based upon focus groups with female students on campus, they stated that they would like to have a place to offer guidance and support when dealing with male students as well as ways to connect with other students in the discipline as soon as they arrive on campus. Therefore, each ROSE-BUD scholarship recipient are placed with a faculty advisor who provides mentoring. These faculty members will be provided with specialized training concerning diversity and the special need of women and minorities in STEM education. This training will summarized the literature and best practices concerning underrepresented populations in STEM education. The advisors will be selected based upon their expressed interest in improving the diversity in the department. The advisors for the scholarship recipients will be selected from this subset of the faculty. However, an effective faculty mentor does not necessarily have to be the same race and gender as the student. These cross-cultural or cross-gender mentors must be invested in the overall success and retention of the student. As the program grows it will not be possible to match an entering freshman with a same-ethnicity and same-gender advisor. In order to build the relationship as early as possible, each student will be assigned an advisor during their freshman year and keep this same advisor/mentor during their matriculation. In this program, the faculty member will do more than just help the student select their courses once per quarter. This faculty mentor will also provide career advice, and perhaps insight regarding other issues specific to the needs of the student. The faculty mentor will also build a relationship with the student by participating in program networking activities and workshops/seminars throughout the school year. In conclusion, it is believed that the student's exposure to a professional in their chosen career path as well as a consistent, symbiotic relationship with this role model will encourage the student to remain in school until graduation. Since the retention rates among students at this university is already high (around 80% of freshmen will graduate within 5 years) we expect that the advising

and mentoring program will not significantly increase the overall university statistics. However, we expect the advising program to positively affect our students' experience. Each year the ECE department polls the graduating seniors via the senior exit survey. The students are asked approximately 40 questions about their experience over the four years. The response rate is typically around 50%. The senior exit survey identified one area that needs attention: the quality of advising. Based on this data and the anecdotal evidence from the focus group, it is hypothesized that by improving the quality of advising, the students' experience will improve, particularly for women and minorities. In conclusion, a better advising experience may translate to higher retention rates among the women and minority students. It is important to note that previous to this program specific data on retention rates among minority populations were not collected or tracked. This program has proven to be successful in the ECE department for improving female and minority enrollment and it would serve as a great model for the institute to meet its diversity goals. Therefore, the primary purpose of this action plan is to grow the highly successful ROSE-BUD program into an institution-wide ROSE-BUD MAPS program.

As part of the professional development program, students will be taught professional skills, including communication, teamwork, understanding ethics and professionalism. These activities will provide an additional benefit for female and URM students because they can begin to develop social networks as soon as they arrive on campus. Some of the key activities will involve one of the three annual career fairs. One will be an internship fair where students can go interview upper classmen who have worked at various companies in order to identify opportunities. Another event will be the career fair walkabout which will involve a faculty member or upper classmen walking the career fair with the freshmen to help with their presentation and elevator speech to help them get their first internship.

### **ROSE-BUD Mentoring Methodology**

Based upon the activities of the ROSE-BUD program, it is believed that more female and URM students will graduate from this university in ECE and the enrollment of women and minorities in the ECE department will be doubled. In addition, based upon the addition of the ROSE-BUD MAPS program the recruitment and retention of female and URM students for the entire campus will be improved. The mentoring program is specifically targeted to the unique aspects of the

URM student. The fact that this university has and advertises a program specifically for URM students may encourage more of these students to apply and attend. Following this strategy, the ECE department in conjunction with the efforts of the admissions and development offices, has been able to significantly improve the representation of women and minorities student populations in the department. In the year that the ROSE-BUD program was proposed, the enrollment of women and URM students in the Electrical and Computer Engineering Department significantly lagged the national average despite the fact that the ECE faculty and the overall student enrollment in the STEM fields was on par or better than the national average. In the current year, women represent 10% of the student body (up from 6%) and underrepresented minority students represent 3% of the student body (up from 2%). The ROSE-BUD scholars, who currently are sophomores or freshmen, represent 6 of the 33 women and 3 of the 10 URM students. As the ROSE-BUD scholars mature in the program and if we continue the recruitment efforts, we think we can continue to improve these numbers. This data is summarized in Table 2.

**Table 2: Enrollment trends in ECE [14]**

	<b>2007-2008</b>	<b>2011-2012</b>	<b>National average percentage</b>
Electrical & Computer Majors	277	327	
WOMEN	18 (6%)	33 (10%)	14% <sup>a</sup>
URM	5 (2%)	10 (3%)	14% <sup>a</sup>

The most successful programs for women and minorities provide strong financial support, create a successful learning environment, access to role models and faculty mentorship, and ensure existence of peer support. The primary goal of the mentoring program is to develop a strong sense of community across multiple disciplines and cultures. The ideal way to create a critical mass among our underrepresented students is to build networks across disciplines.

Additional faculty from other departments will be recruited to expand the ROSE-BUD program beyond the ECE department. Each faculty mentor will be provided with specialized training concerning diversity and the special needs of women and minorities in STEM education. The training will summarize the literature and best practices concerning underrepresented

populations in STEM education. Additionally, the facilitator will discuss some of the activities that have proven to be successful in retaining these students. The advisors will be selected based upon their expressed interest in improving the diversity of their department. In addition students will be recruited to take a leadership role in the advising and mentoring network. The development of student teams will create a sense of community among the underrepresented students. This is a great example of paying forward what has been received as part of the program.

Engineering and science students typically have excellent technical preparation but there is typically not much focus on the personal and professional preparation also necessary to succeed. There is also a need to increase students’ experiences with multiple cultures and diverse thinking. As a vehicle for building this sense of community, we choose to target the mentoring/networking activities towards the development of professional skills. Although extremely important to a successful career, these types of skills are not acquired naturally without guidance and mentoring. Our belief is that the ROSE-BUD Scholarship and Mentoring program will combine networking, mentoring, professional, personal and technical development as a way to increase individual students’ sense of belonging, and thereby increasing chances for retention. Successful ROSE-BUD professional activities will be expanded campus wide. Table 3 lists a summary of network and professional development activities that have proven to be successful for the ROSE-BUD program.

**Table 3: ROSE-BUD Activities**

Title	Description
Welcome Picnic	Mentors, mentees and faculty will meet informally at Hawthorn Park for a picnic and networking.
Luncheon with NI ELP program	Female students from SWE, gEECS and ROSE-BUD will have a luncheon with an engineer and Rose alum from National Instruments to discuss careers and opportunities.
Roundtable discussion	ROSE-BUD scholars met over lunch to discuss and brainstorm ideas that would improve networking and professional development activities. In addition, the students identified activities and resources that would help with academic success.
Day Out	Scholars and faculty will attend the women's and men's basketball games against Mount St. Joseph to support Heather and Vashon.
How to get an Internship	Student share stories about their internship experiences as well as

	unique methods they use to obtain an internship.
Explore Engineering - Dance Pad Mania, Scribbler Robot	Scholars, faculty will work with IEEE and Eta Kappa Nu to host an Explore Engineering activity for middle school students to teach them about electricity, sensors, and programming by using Scribbler robots. In the past, K - 12 students also learned about electricity concepts by building a light, touch and sound dance pad.
Career Fair Walk-About	Upperclassmen who have jobs or internships will be paired with underclassmen to walk the career fair. The upperclassmen will mentor the underclassmen to help them gain valuable insight about the one minute elevator speech and interviewing.
End of Year Celebration	Students and faculty will meet for dinner and discuss the year and brainstorm ideas and activities for the upcoming year.

## Conclusion

The focus on student-centered learning is already ingrained in the culture of the institute. The ROSE-BUD mentoring program provides the education, training, and awareness of issues related to diversity to educate all of the stakeholders and benefit the community at large. The awareness and inclusion of a more diverse student body have been adopted and are being sustained in our culture by creating a climate that is welcoming and nurturing for all students. Although the aggregate numbers of women are well represented (as compared to the national average) they are clustered in a few majors such as Biomedical Engineering. This demographic negatively affects all of the students in the department who will go onto careers in industrial and government settings with minimal exposure to how to work with diverse populations. The ROSE-BUD program will provide the formal mechanism and framework by which this university can continue to improve in the recruitment and retention of minority students with the added component of professional and personal development. Through the development of the student, faculty and staff, this program will be sustained through those networks formed.

Although in the beginning stages, the ROSE-BUD MAPS program has already garnered its initial support on campus including a game plan to migrate the program to include other majors in the next two years. It has also recently received institutional finances for scholarships and to offer the mentoring workshop and programming. The program has also received corporate support in the amount of \$15, 000 to start the initial programming in spring 2013.

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