Diversity Impacts in Large Research Centers:
Case Study of the US NSF Engineering Research Centers Program

David McLaughlin and Kathleen Rubin
College of Engineering, University of Massachusetts Amherst, USA

Brooke Cooley, AAAS Fellow
National Science Foundation, USA

Theme: This abstract is submitted as a Strand P policy/practitioner contribution, in conjunction with Theme 8. Building an enterprising state, in the "Equal opportunities for all" sub-theme.

Keywords: diversity, research center, strategic plan, engineering workforce

Introduction: The National Science Foundation's Engineering Research Center (ERC) Program is a key component of the engineering research and education enterprise in the United States. ERC's aim to develop a new interdisciplinary culture in engineering research and education in partnership with industry. NSF has funded 61 ERCs since 1985. Together, they have advanced knowledge and technology in dozens of different areas and educated new generations of engineers who understand industrial practice and the process of advancing technology, design, manufacturing, and innovation, thus ready to work productively in a global economy upon graduation. An important element of the ERC program is its commitment to advancing the diversity of the engineering workforce. This stems from the viewpoint that success in research, education, team-creativity, and innovation in a global economy will ultimately depend on our ability to educate and nurture a diverse workforce that includes the talents of all people. ERC's are nominally funded by the NSF ERC program for a 10-year period. Each ERC is required to develop and implement a diversity strategic plan in collaboration with the schools and departments that provide faculty and students to the center from the lead and partner universities. These plans define goals, milestones, and intended actions to increase the diversity of the center's leadership team, faculty, undergraduate and graduate students and its graduates. Among the university partners are institutions that predominantly serve groups that are underrepresented in science and engineering (ie, women, African Americans, Native Americans, and Hispanic Americans) and they employ various strategies to increase diversity at all levels of center participation. As a result of such efforts, the ERC program has twice as many women at undergraduate and faculty levels, and 30% greater involvement at graduate student levels than national U.S. engineering averages compiled by

the American Society for Engineering Education (ASEE). The involvement of underrepresented racial and ethnic minorities in the ERCs is significantly higher than ASEE averages. Beyond these numbers, participation in the ERC program has broadened the way many academics think about diversity and enabled them to view their own roles as researchers and educators more broadly, to the point where a number of professors are now making increased contributions to diversity themselves as a result of their interaction with the ERC program. The present cohort of 20 ERC's involves 20 universities serving in the lead with 63 partner universities, spanning a group of nearly 1000 engineering and science faculty members; 10,000 K-12 and university students; and more than 500 industrial partners. One of the lead universities is North Carolina Agricultural and Technology University, a university that predominantly serves African Americans and it has a highly effective European Partner, the Hannover University Medical School in Hannover Germany. This paper summarizes the strategies undertaken by this group of centers to increase diversity; documents impacts achieved; and provides insights learned. This paper is thus a case-study in Triple Helix collaboration in which national-scale government-funded research centers work strategically to incorporate diversity goals into their overall strategic planning.

The U.S. NSF ERC program. At the request of the White House and the National Academy of Engineering, the Engineering Research Centers (ERC) Program was established at the National Science Foundation in 1984 as a national priority to strengthen the competitiveness of U.S. industry. The goal was to establish centers that would develop a new interdisciplinary culture in engineering research and education in partnership with industry. Together they would advance knowledge and technology and educate new generations of engineers who understand industrial practice and the process of advancing technology, design, and manufacturing, thus ready to work productively in industry upon graduation. As a result three generations of ERCs were established, 61 in all, between 1985 and 2013. The 52 centers that completed their full ten year term of NSF support have been highly successful in demonstrating that interdisciplinary centers focused on engineered systems could be a powerful driver to motivate research programs to combine fundamental inquiries with research focused on technology to advance a broad range of new fields, technology, and industries. They formed partnerships with thousands of firms that helped focus the research on useful and transformative technologies and prepare graduates for successful careers as leaders in industry and academe. Education programs provided a mentored,

interdisciplinary research experience for undergraduates and graduates and introduced pre-college teachers and their students to engineering concepts to stimulate interest in careers in engineering.

ERC's are supported with up to 10 years of funding from the ERC program, guided by NSF and peer reviews each year and major renewal reviews at years 3 and 6. Planning for self- sufficiency begins around year 6, when centers begin developing business plans to sustain themselves upon graduation from ERC program funding. One of the unique features of the ERC program is that the program leadership and staff are engaged with the oversight of centers over several years and come to understand from experience how to develop guidance that will help focus ERCs to more effectively meet program goals and achieve their visions.

Diversity as a priority in ERCs. The National Science Foundation asserts that Engineering Research Centers must embrace the cultural, gender, racial, and ethnic diversity of the U.S. in the composition of their leadership, faculty, and student teams and their graduates in order to assure that all talented people can pursue and receive engineering degrees and be engaged in engineering research and education. NSF expects the faculty and staff of all ERCs and the administrations of all institutions receiving NSF funding to share this commitment and to devote the time and effort required to ensure that the diversity of the Centers' leadership teams, faculty, and students at all levels serves as a model for diversity within each institution and for the nation as a whole. This expectation is made with the understanding by NSF that ERCs do not have the authority to hire faculty, accept students, or grant degrees. Each ERC is expected to demonstrate a significant commitment to and success in exceeding national engineering-wide averages for the involvement of women, underrepresented racial minorities, and Hispanic Americans as leaders, faculty, undergraduate, masters, and doctoral students, and as ERC students who have graduated. Since no set of formal requirements can ensure that a desired level of dedication to achieving diversity is engendered, the following are required elements of a diversity strategy, the success of which depends in large part on the spirit in which they are implemented by the center and its collaborating departments and university-level schools. In fulfilling its obligations under the agreement and in compliance with the requirements of federal law, no university receiving federal funds will employ quotas or set-asides based on race. Each ERC is required to:

- Prepare and execute a diversity strategic plan with goals, milestones, and intended actions to increase the diversity of the center's leadership team, faculty, undergraduate and graduate students and its graduates.

- Demonstrate the existence of a partnership among the affiliated Deans of Engineering, other Deans, and the chairs of departments of the affiliated ERC faculty to increase the diversity of the center's leadership team, faculty, undergraduate and graduate students, and graduates over the duration of NSF's support.

- Develop outreach connections with NSF programs focused specifically on increasing diversity of science and engineering students and faculty through the involvement of women, underrepresented racial minorities, and Hispanic American students.

- Develop and strengthen long-term partner and/or outreach partnerships with predominantly female, African American, Native American, and Hispanic American serving institutions.

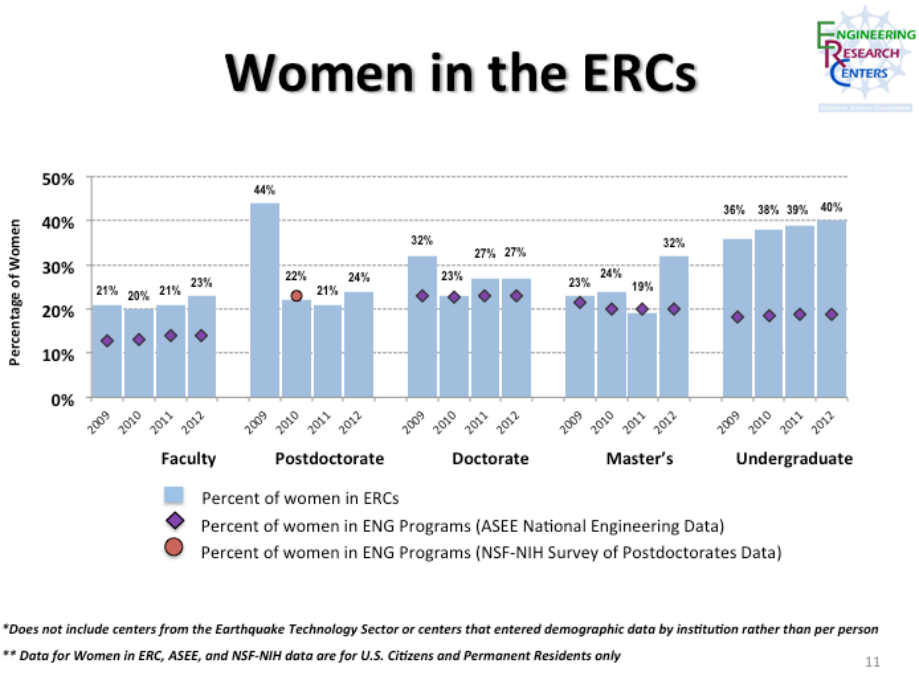
- Introduce diverse cadres of precollege students to the excitement and challenges of engineering through summer and/or year-round programs focused on design and research.

- Focus any Research Experiences for Undergraduates (REU) and Research Experiences for Teachers (RET) programs on diversity.

Additional strategies ERC's have employed to impact diversity include forming partnerships with institutions that predominantly serve underrepresented groups; research strategies that specifically enable students to "take charge" of a substantive research agenda; and pipeline programs that make opportunities available to under-represented students as they progress from undergraduate through to graduate and faculty levels.

The figure below compares the participation of women in the ERCs (bar plots) against national averages for women in all academic engineering programs (diamonds). The ERC's have engaged substantially more women at the undergraduate levels than the national average (40% versus less than 20%) and achieved more modest increases at the faculty, post-doctorate, doctorate, and master's levels. Similar

kinds of results have been obtained for Hispanics, underrepresented racial minorities, and persons with disabilities.



Summary and Insights: ERC participants have been surveyed on several occasions about their attitudes toward diversity and the attention given to this topic in their recurring strategic planning sessions. The overwhelming preference of participants has been to retain the program's strong focus on improving diversity among ERC faculty, staff, and students. ERC participants recognize that engineering problems require a diversity of perspectives and a workforce that reflects the diversity of the nation. Moreover, as a group, they are proud of their success in this area, and do not want to risk losing ground. A SWOT (Strengths, Weaknesses, Opportunities and Threats) analysis was conducted by surveying the perspectives of participants of 17 different centers in job titles ranging from student to center director.

Strengths: A key strength identified by this group is that the NSF Engineering Research Centers are producing women and underrepresented minorities with advanced degrees in engineering in greater numbers than the national US averages. Another strength identified by industrial partners is that industrial diversity initiatives have benefitted from their relationships with ERC's.

Weaknesses: A weakness identified by participants is the wealth and breadth of knowledge of industry members is not always used effectively to understand the role of diversity in industry.

Opportunities: Opportunities for improvement include developing more diverse populations at the post-doctoral level and the specific placement of high-level directors at each center to provide continuing leadership and focus on diversity issues.

Threat: Questions remain about the degree to which the culture of an ERC becomes institutionalized within the academic home institutions that employ the faculty, staff, and student participants. To the extent that home academic departments do not sufficiently buy-into the diversity engagement and recruiting strategies of the ERCs, the long-term sustainment of the impacts may be threatened.

The ERC program intends to conduct a Diversity Climate survey to the current cohort of 20 active centers as a way to better understand the strengths and weaknesses of ERC diversity climates that underpin the statistics.