Surmounting the Barriers: Ethnic Diversity in Engineering Education: Summary of a Workshop

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Ethnic Diversity in Engineering Education

Summary of a Workshop

ASEE AMERICAN SOCIETY FOR ENGINEERING EDUCATION

NATIONAL ACADEMY OF ENGINEERING
OF THE NATIONAL ACADEMIES

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CONTENTS

EXECUTIVE SUMMARY

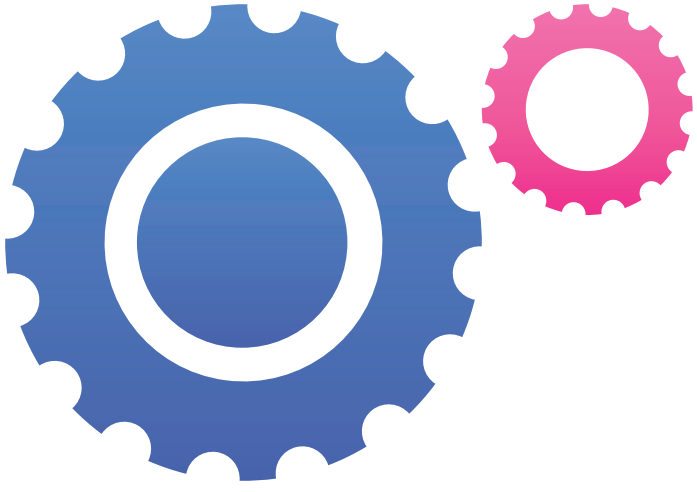
Surmounting the Barriers: Ethnic Diversity in Engineering Education was the title of a workshop held September 26-27, 2013 to take a fresh look at the impediments to greater diversification in engineering education. While the goal of diversifying engineering education has long been recognized, studied, and subjected to attempted interventions, progress has been fitful and slow. The goals of the workshop were to identify and discuss the impediments to diversity, and to draw on the experience of its participants in finding ways to move forward.

The workshop, held at the Keck Center of the National Academies in Washington, D.C., brought together about 50 educators in engineering from two- and four-year colleges plus about 20 staff members from the three sponsoring organizations: the National Science Foundation, the National Academy of Engineering and the American Society for Engineering Education (the attendees are shown in Appendix A). The NSF funded the workshop.

A pre-workshop survey and subsequent deliberations at the workshop itself sought to explain why past recommendations to improve diversity had not been adopted in full or in part. Using the survey and workshop responses, researchers identified a series of key impediments. These included a lack of incentives for faculty and institutions; inadequate or only short-term financial support; an unsupportive institutional and faculty culture and environment; a lack of institutional and constituent engagement; systemic problems in higher education, including a failure to be more engaged in K-12 and inadequate faculty skills; a lack of learning communities that serve to improve retention; a difficult curriculum, heavy on math; and inadequate assessments, metrics, and data tracking.

A follow-up meeting in Texas ended with agreement between two administrators – one at Prairie View A&M University and the other at West Houston Center of Houston Community College – to develop a "Transfer to PVAMU Plan" for African American and Hispanic students. Florida participants scheduled a one-day Diversity Summit August 1, 2014 at the University of Florida, Gainesville. Graduate students were encouraged to participate.

Additional regional workshops were expected, including a California effort to commit to specific diversification steps and measure results.



SECTION I — WORKSHOP OVERVIEW

The bulk of the workshop consisted of small-group discussions of issues framed and illuminated by each day's speakers. The small groups reported to plenary sessions at the end of each day, allowing participants to hear ideas from a complete cross-section of their peers. (The workshop agenda is shown in Appendix B).

The small-group breakout sessions were designed to illuminate the underlying impediments to ethnic diversity in engineering education; to consider concrete steps toward overcoming the barriers toward greater diversification; and to identify models of local success that could be moved to large-scale implementation. On the morning of the first day, breakout group participants addressed six strategic themes (see Table 2 on page 17) and the relevant impediments to their adoption, pooling their experiences, sharing success stories and identifying nuances of the impediments. After lunch, each group returned to the same themes/impediments, but this time focused on next steps – brainstorming strategies to overcome the impediments. It was these latter strategies that were communicated to the whole workshop at the afternoon plenary session on Day One.

Day Two followed a similar format, with a morning session to discuss impediments and share successes and an afternoon session to brainstorm solutions, followed by a report-out at a plenary session. This time, however, participants were organized into groups arranged primarily by geography. This arrangement was used in recognition of the unique challenges and opportunities presented by different educational systems (e.g. strong statewide articulation arrangements in Florida), legal environments (e.g., affirmative-action bans in California and Michigan), local differences in the makeup of minority populations, state support, and other funding. As a result, the plenary session on Day Two heard how participants from different areas of the country saw the way forward given their own special circumstances.

Meal times were designed to encourage networking and included two informal dinners (the first, on the eve of the conference, was not a formal part of the workshop but was well attended).

The workshop heard from six speakers, two to open each day and one at each lunch session:

- Freeman A. Hrabowski, III, President, the University of Maryland, Baltimore County
- Robert T. Teranishi, Associate Professor of Higher Education, New York University, and Professor of Education, UCLA
- Eric Jolly, President, Science Museum of Minnesota
- Karan L. Watson, Provost and Executive Vice President for Academic Affairs, Texas A&M University
- Amir Mirmiran, Dean, College of Engineering and Computing, Florida International University
- Patricia B. Campbell, President, Campbell-Kibler Associates

Summaries of their addresses are provided in Section VI.

SECTION II — FRAMING THE ISSUE: A LONG, SLOW TREK

The workshop was opened by Bevlee A. Watford, Associate Dean for Academic Affairs in the College of Engineering at Virginia Tech and Vice President, External Affairs for the American Society for Engineering Education. She noted that, on reviewing more than 40 years of studies on increasing ethnic diversity in engineering education (see Analysis of Historical Reports in Section III), many commonalities are to be found among the recommendations. Thus, there has been something approaching a consensus for many years on what is needed to achieve ethnic diversity in engineering education. Yet the percentage of underrepresented minorities enrolled nationwide remains well below their percentage in the population.

The workshop focus was primarily on efforts that the university-level engineering education community itself could undertake to improve diversity. The earlier studies noted above were sometimes framed around a broader construct, but many of their recommendations were directed at the university level. Given the earlier studies and the similarity of their recommendations, Watford noted a sense among many in engineering education that may be summarized as, "We know what needs to be done. Why is it not happening?" It was a sentiment to be heard many times, from many different participants, before the final plenary session, and one that formed the underlying rationale for the workshop. Watford indicated that the purpose of the workshop was, thus, fivefold:

- to identify and illuminate the impediments to diversity,
- to understand why previous diversity recommendations had not been implemented or, if implemented, why they had fallen short,
- to share success stories about instances where barriers to diversity had been identified and surmounted,
- to identify the resources that would enable real solutions to implement steps toward progress, and
- to locate supporters and allies who could propel change.

In a welcoming address, C. D. (Dan) Mote, Jr., President of the National Academy of Engineering, noted that, while previous attempts to achieve broad ethnic diversity in engineering education had fallen short, it is important to take the lessons from those efforts and consider ways to move forward. This workshop, he said, offers a chance to rethink the issues and do things differently.

SECTION III — PRE-WORKSHOP PREPARATIONS

Pre-Workshop Surveys

To prepare for the workshop, participants were surveyed in advance and asked to answer eight questions ranging from why past attempts to enhance racial and ethnic diversity in engineering had not succeeded to why there are not more summer programs or research assistantships for students from underrepresented minority populations (see Appendix C). These questions were developed following analysis of a preliminary survey of a smaller number of participants that helped crystallize the main issues. The survey results helped identify a short list of impediments to diversity that could be used to organize the discussions of the workshop.

Analysis of Historical Reports

For 40 years, studies and reports by various governmental and academic bodies have been presenting recommendations on enhancing ethnic diversity. Many of these are strikingly similar, yet new workshops are still occurring and relatively little has changed. Progress has stalled or been reversed among African Americans and Native Americans and has occurred only marginally among Hispanic Americans as shown in Figure 1.

The tables that follow summarize the main thrusts of the recommendations presented in the 17 reports listed at the end of this section. The tables were prepared by Kellie Green during the period she served as a Christine Mirzayan Science and Technology Policy Fellow at the National Academies. Table 1 groups the recommendations by theme, stakeholder, and level of intervention (at which point in the educational spectrum it made sense to lend a helping hand).

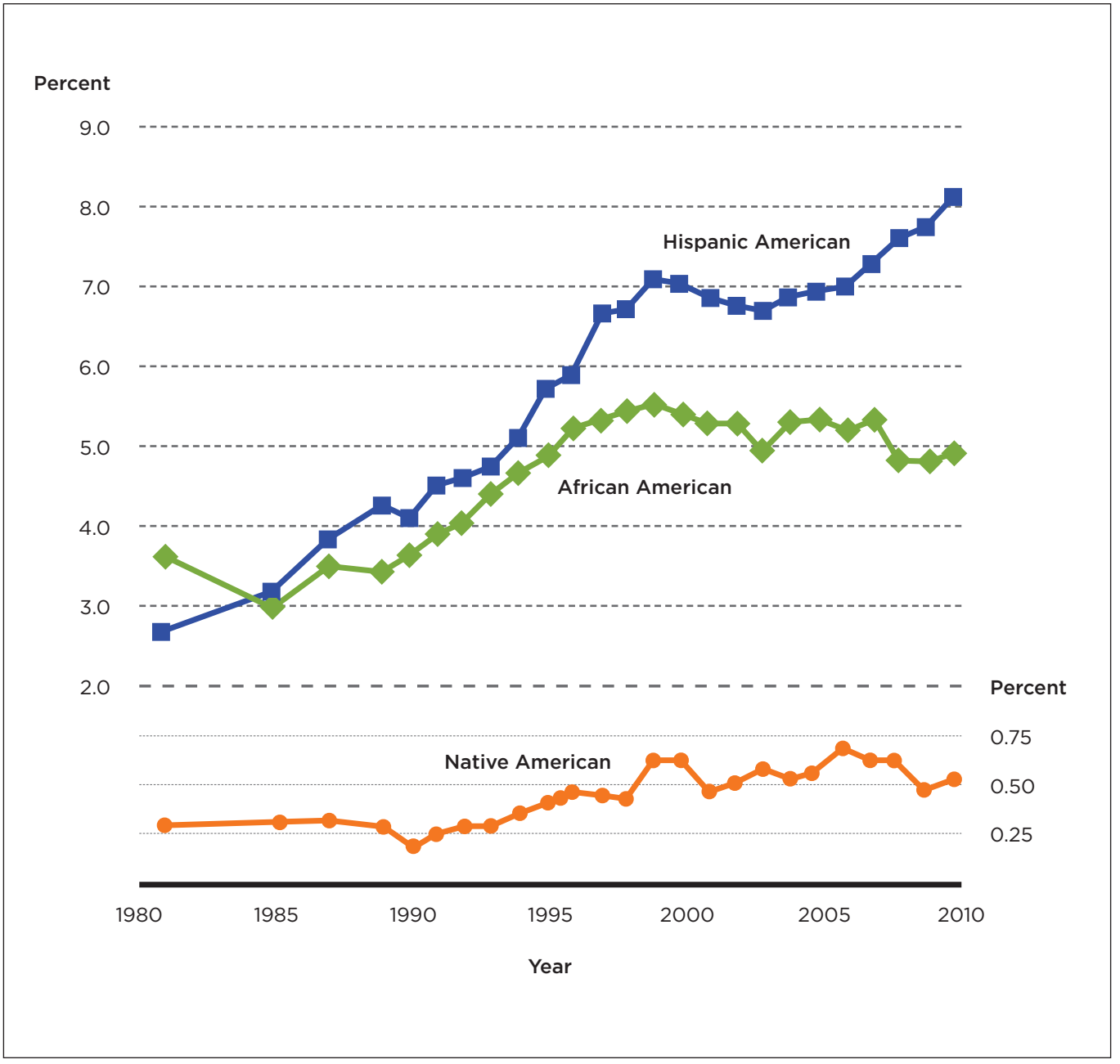


Figure 1. Minorities as a percentage of US baccalaureate engineering graduates

Note: Data tabulated by the National Science Foundation from the Department of Education and the Engineering Workforce Commission.

Different axis scaling used for *Native American* category to enhance visibility.

Source: Data for 1981-1989: *Women, Minorities, and Persons with Disabilities in Science and Engineering* (1994), Appendix table 5-25 http://www.nsf.gov/statistics/wmpdse94/chap5/appntab/appn525a.xls

Data for 1990-2010: *Women, Minorities, and Persons with Disabilities in Science and Engineering* (2013), Table 5-13, http://www.nsf.gov/statistics/wmpd/2013/tables/tab5-13.xls

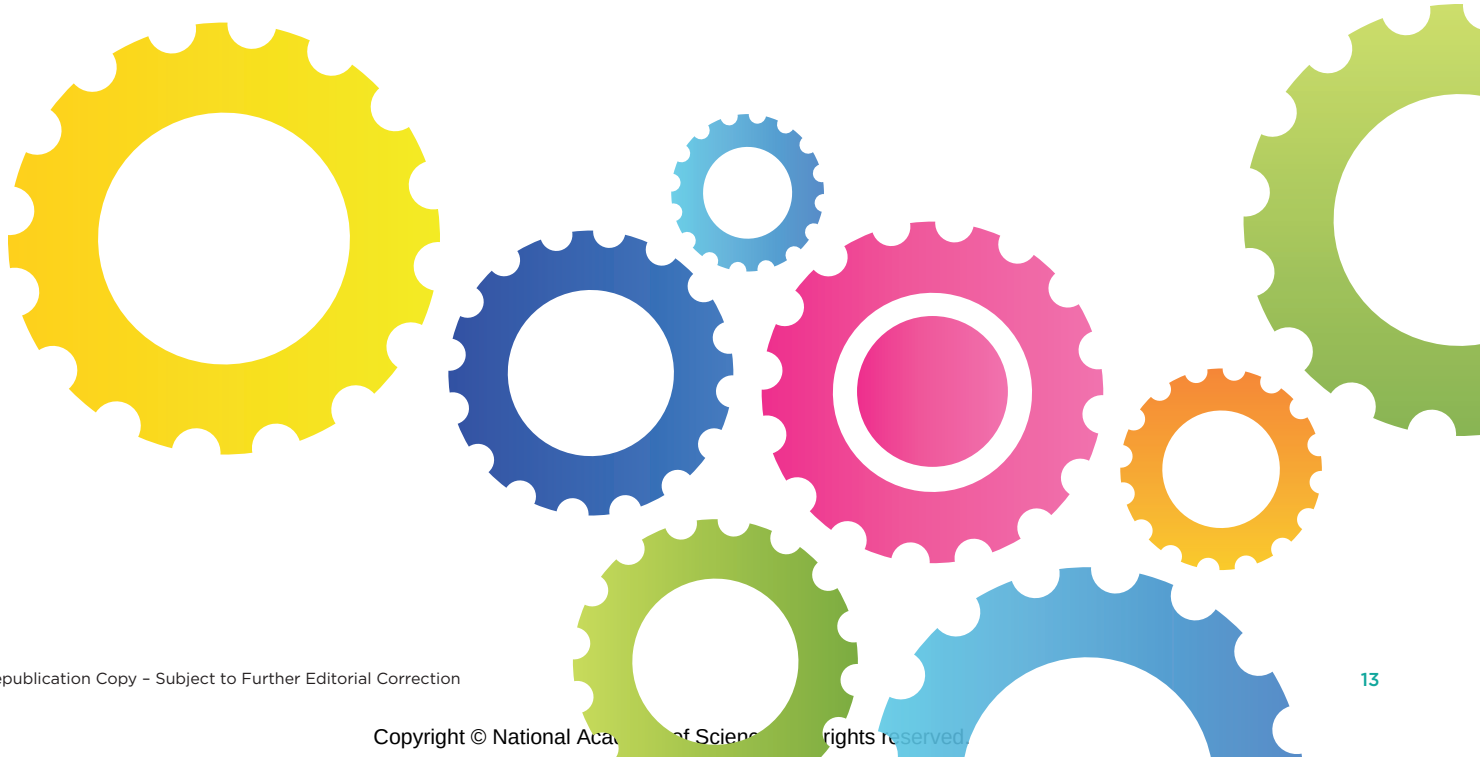
Table 1. Historical recommendations to assist in the recruitment, retention and employment of underrepresented minorities in engineering

Education Stakeholder	Pre-College	College	Post College/ Graduate or Professional School
Student	• Taking courses in science and mathematics • Taking part in summer enrichment programs • Taking part in non-summer enrichment programs • Performing public service • Taking part in Upward Bound, Talent Search, and other organizations • Taking part in summer training programs • Participating in military awareness programs • Going to conferences	• Tutoring and mentoring other students • Generating plans, ideas, goals, etc. for academic support programs • Evaluating and documenting their experience • Performing public service • Participating in summer research opportunities • Going to conferences • Having minority students take part in self-paced instruction	• Evaluating and documenting their experience • Performing public service • Going to conferences
Educational Institution	• Providing minority students with opportunities for self-paced instruction • Giving teachers and instructors leave time for professional development • Developing and maintaining outreach programs for teachers (establishing partnerships between pre-college teachers and university science and engineering faculty) • Participating in teacher recruitment • Evaluating programs that are targeted at minorities	• Encouraging cross-institutional/organizational cooperation to develop programs targeted at minorities • Helping foster individual institution efforts to support minorities • Developing faculty/staff-led support activities (mentoring by faculty, and tutoring by students) • Creating research opportunities for undergraduates • Opening cultural centers • Maintaining and developing professional organizations • Encouraging curriculum development • Encouraging collaboration with government and industry • Encouraging the development of minority engineering orientation programs • Maintaining centers for career opportunities • Developing and maintaining Teacher Preparation Courses • Preparing teachers with science and mathematics training • Providing teachers with bilingual courses • Providing minority students with opportunities for self-paced instruction • Giving teachers and instructors leave time for professional development • Developing and maintaining outreach programs for teachers (establishing partnerships between pre-college teachers and university science and engineering faculty) • Performing self-assessments of programs developed for minorities • Maintaining a database of demographic trends • Evaluating programs that are targeted at minorities	• Maintaining a database of demographic trends • Evaluating programs that are targeted at minorities

Continued on page 13.

Table 1. Historical recommendations to assist in the recruitment, retention and employment of underrepresented minorities in engineering (Continued)

Education Stakeholder	Pre-College	College	Post College/ Graduate or Professional School
Government	• Funding support activities • Developing organized ways to fund programs and evaluate them • Maintaining a database of demographic trends • Evaluating programs that are targeted at minorities	• Funding scholarships, grants, work study • Developing organized ways to fund programs and evaluate them • Maintaining a database of demographic trends • Evaluating programs that are targeted at minorities	• Funding fellowships and work study • Maintaining a database of demographic trends • Evaluating programs that are targeted at minorities
Private Sector	• Communicating science to the public • Performing self-assessments of programs developed for minorities	• Communicating science to the public • Performing self-assessments of programs developed for minorities	• Improving minorities' careers by creating policies among public and private employers that are sensitive to minority needs • Creating jobs for minorities



For the purposes of discussion, these various specific historical recommendations may be summarized as **six general strategic themes for achieving diversity**. These themes were used to charge the breakout groups for their discussions on Day One of the Workshop.

A. **Inculcating and Reinforcing Students' Academic and Professional Knowledge**
   - Taking courses in science and mathematics
   - Tutoring and mentoring other students
   - Generating plans, ideas, goals, etc. for academic support programs
   - Evaluating and documenting their experience
   - Taking part in summer enrichment programs
   - Taking part in non-summer enrichment programs
   - Performing public service
   - Taking part in Upward Bound, Talent Search, and other organizations
   - Taking part in summer training programs
   - Participating in summer research opportunities
   - Participating in military awareness programs
   - Going to conferences

B. **Pedagogical enhancement of future and current teachers and faculty**
   - Developing and maintaining Teacher Preparation Courses
   - Preparing teachers with science and mathematics training
   - Providing teachers with bilingual courses
   - Providing minority students with opportunities for self-paced instruction
   - Providing teachers and instructors with reduced course loads
   - Giving teachers and instructors leave time for professional development
   - Providing summer workshops for teachers
   - Developing and maintaining outreach programs for teachers (establishing partnerships between pre-college teachers and university science and engineering faculty)
   - Participating in teacher recruitment

C. **Strengthening Organizational Receptivity to Ethnic Diversity**
   - Encouraging cross-institutional/organizational cooperation to develop programs targeted at minorities
   - Helping foster individual institution efforts support minorities
   - Developing faculty/staff-led support activities (mentoring by faculty and tutoring by students)
   - Creating research opportunities for undergraduates
   - Opening cultural centers
   - Maintaining and developing professional organizations
   - Encouraging curriculum development
   - Encouraging collaboration with government and industry
   - Encouraging the development of minority engineering orientation programs
   - Maintaining centers for career opportunities

D. **Enhancing Economic Enablement of Students and Student-support Organizations**
   - Funding scholarships, grants, fellowships, work study
   - Funding support activities (mentoring, tutoring, professional organizations)
   - Developing organized ways to fund programs and evaluate them

E. **Enhancing Stakeholder Communication and Action**
   - Communicating engineering and science to the public
   - Creating a work environment that is inclusive through the creation of policies that are sensitive to the minority needs
   - Creating jobs for minorities
   - Publicizing positive stories of minority accomplishments to the public

F. **Increasing Educational Research and Policy Development**
   - Performing self-assessments of programs developed for minorities
   - Maintaining a database of demographic trend
   - Evaluating programs that are targeted at minorities

To show how these historical recommendations for increasing diversity have been revisited regularly, Table 2 shows a matrix of the six recommendation categories noted above and the decades and reports in which they were presented.

Table 2. Summary of historical recommendations by document and decade

Recommendation Categories	1970s	1980s	1990s	2000s	2010s
A. Inculcating and Reinforcing Students' Academic and Professional Knowledge	[1], [2], [3]	[4], [5], [6], [7], [8]	[9], [10]		
B. Pedagogical improvements (targeted at future and current teachers and students)	[1], [2], [3]	[4], [5], [7], [8]	[9], [10]	[11], [12], [13]	[14]
C. Organizational Receptivity	[1], [2], [3]	[4], [6], [7], [8]	[15], [9], [10]	[16], [12], [13]	[14]
D. Economic Enablement	[3]	[7], [17], [8]	[9]	[16], [12], [13]	[14]
E. Public and Community Education and Institutional Involvement		[4], [8]		[11], [13]	
F. More Educational Research and Policy Development	[1], [2], [3]	[4], [8]	[15], [9]	[16]	

Note: Numbers in the brackets refer to the reports listed under *References*.

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Recommendations 1-3, 6

2. National Research Council. Committee on Minorities in Engineering. (1977). *Retention of Minority Students in Engineering: A Report of the Retention Task Force*. Washington, D.C.: National Academy of Sciences.
Recommendations 1-3, 6

3. Planning Commission for Expanding Minority Opportunities in Engineering. (1974). *Minorities in Engineering: A Blueprint for Action*. Summary and Principal Recommendations. Reprinted from the report of the Planning Commission for Expanding Minority Opportunities in Engineering. New York, NY: Alfred P. Sloan Foundation.
Recommendations 1-4, 6

4. Dix, L.S. (Ed.). National Research Council. (1987). *Minorities : Their Underrepresentation and Career Differentials in Science and Engineering. Proceedings of a Workshop*. Washington, D.C.: National Academies Press.
Recommendations 1-3, 5-6

5. National Research Council. (1985). *Engineering Graduate Education and Research*. Washington D.C.: National Academy Press.
Recommendations 1, 2

6. National Research Council. (1986). *Engineering Undergraduate Education*. Washington, D.C.: National Academy Press.
Recommendations 1, 3

7. National Science Board. (1986). *Undergraduate Science, Mathematics and Engineering Education*. Washington D.C.: National Science Foundation.
Recommendations 1-4

8. Task Force on Women, Minorities, and the Handicapped in Science and Technology. (1989). *Changing America: The New Face of Science and Engineering*. Final Report. Washington, D.C.
Recommendations 1-6

9. Commission on Engineering and Technical Systems Office of Scientific and Technical Personnel. (1993). *Major Issues in Engineering Education: A Working Paper of the Board on Engineering Education*. Washington, D.C.: National Research Council.
Recommendations 1-4, 6

10. Committee on the Feasibility of a National Scholars Program. (1996). *National Scholars Program Summary: Excellence with Diversity for the Future*. Washington, D.C.: National Academies Press.
Recommendations 1-3

11. Katehi, L., Pearson, G., & Feder, M. A. (Eds.). Committee on K-12 Engineering Education, National Academy of Engineering, and National Research Council. (2009). *Engineering in K-12 Education: Understanding the Status and Improving the Prospects*. Washington, D.C.: National Academies Press.
Recommendations 2, 5

12. Landis, R. B. (2005). *Retention by Design: Achieving Excellence in Minority Engineering Education*. National Action Council for Minorities in Engineering (Reprinted from 1991).
Recommendations 2-4

13. Congressional Commission on the Advancement of Women and Minorities in Science Engineering and Technology Development Opportunities in Science and Engineering. (2000). *Land of Plenty: Diversity as America's Competitive Edge in Science, Engineering and Technology*. Arlington, VA: National Science Foundation.
Recommendations 2-5

14. National Academy of Sciences, National Academy of Engineering, and Institute of Medicine. (2011). *Expanding Underrepresented Minority Participation: America's Science and Technology Talent at the Crossroads*. Washington, DC: National Academies Press.
Recommendations 2-4

15. Center for Science, Mathematics, and Engineering Education. (1996). *From Analysis to Action: Undergraduate Education in Science, Mathematics, Engineering, and Technology*. Washington, D.C.: National Academies Press.
Recommendations 3, 6

16. Committee on Equal Opportunities in Science and Engineering. (2004). *Broadening Participation in America's Science and Engineering Workforce: The 1994-2003 Decennial and 2004 Biennial Reports to Congress*. Arlington, VA: National Science Foundation.
Recommendations 3, 4, 6

17. National Science Board. (2003). *The Science and Engineering Workforce: Realizing America's Potential*. Arlington, VA: National Science Foundation.
Recommendation 4

SECTION IV—WORKSHOP DISCUSSIONS

A Regional Scale-up Initiative: The Florida Example

The closing first-day plenary session was devoted to identifying the key impediments to implementing prior recommendations to greater diversification in engineering education. On the second day, attendees had the same overall charge, but this time they were organized by region. Each breakout group therefore shared a common frame of reference as to any regional considerations that might factor into the failure to implement change. This section looks at how a regional initiative (in this case, involving colleges and universities in Florida) might serve as a scalable example for other states or regions.

Most attendees were impressed with a comprehensive plan for change that was developed at the conference by representatives from Florida colleges and universities. The Florida breakout group identified a series of local successes, some impediments that might inhibit the scale-up of these local successes, and some strategies for overcoming these impediments.

The problems identified were many. Some were common to colleges and universities in other regions, such as institutional indifference to change. Others were more specific to Florida, or more urgent because of local conditions, such as admissions decisions being made without input from colleges of engineering, and financial aid decisions being based solely on merit and not on merit and need. After due consideration, however, the Florida members of the workshop agreed on undertaking a "meeting of the willing" during the winter of 2013-14 to discuss and expand on local successes, especially new collaborative models with community colleges.

The following summary of the Florida breakout session appears courtesy of Angela S. Lindner, Associate Dean for Student Affairs at the University of Florida.

Introductory Discussion: State-specific Concerns

- The University of Florida budget model is known as RCM, for Responsibility-Centered Management. Participants said this has been a barrier in many ways. In essence, RCM decentralizes decisions and financial authority, favoring academic units (colleges); ideally, it encourages these units to take greater responsibility for revenue generation and spending decisions. Those units that find new ways of generating revenue will gain under this model. Information about this model in higher education is available at the following links, along with viewpoints on its benefits and risks:
    - http://cfo.ufl.edu/wp-content/uploads/2012/09/IntrotoRCM.pdf
    - http://www.uky.edu/Provost/FinancialModel/files/Education_Training/RCM_at_major_public_universities.pdf
    - http://www.insidehighered.com/news/2010/12/13/budget
    - http://www.nea.org/assets/img/PubThoughtAndAction/TAA_97Spr_07.pdf
- The Florida universities also expressed concern about impending cuts to the Florida Bright Futures Scholarship Program. As state funds for this program diminish, the state legislature has threatened to increase the merit standards for eligibility for these funds, namely SAT and ACT scores. The group expressed concern about the impact on minority students, although the representative from Florida A&M University reported that many of that school's engineering students are not on Bright Futures at all. More information is provided in the links below.
    - http://www.floridastudentfinancialaid.org/ssfad/bf/
    - http://articles.orlandosentinel.com/2013-04-08/features/os-florida-bright-futures-ucf-cuts-20130408_1_florida-students-florida-medallion-florida-academic-scholars

Local Successes, Impediments, and Strategies

The remainder of the discussion followed a format of identifying local successes, possible impediments to replicating these successes, and potential strategies for overcoming impediments. This discussion is summarized in Table 3.

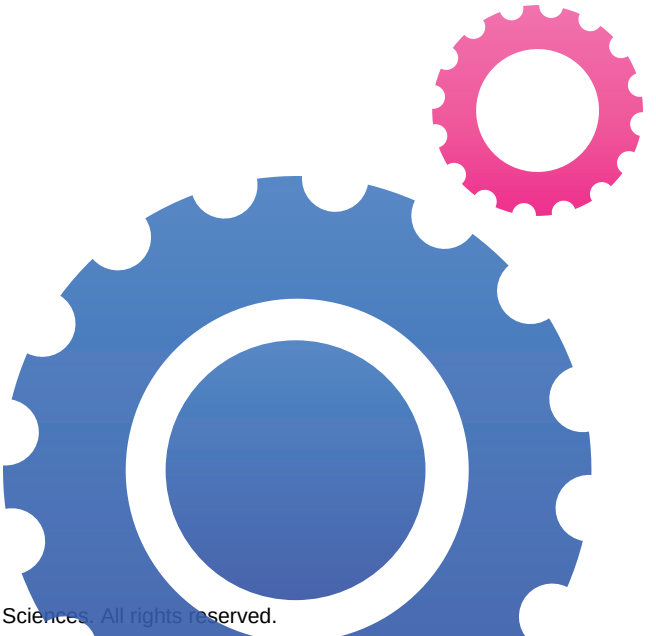


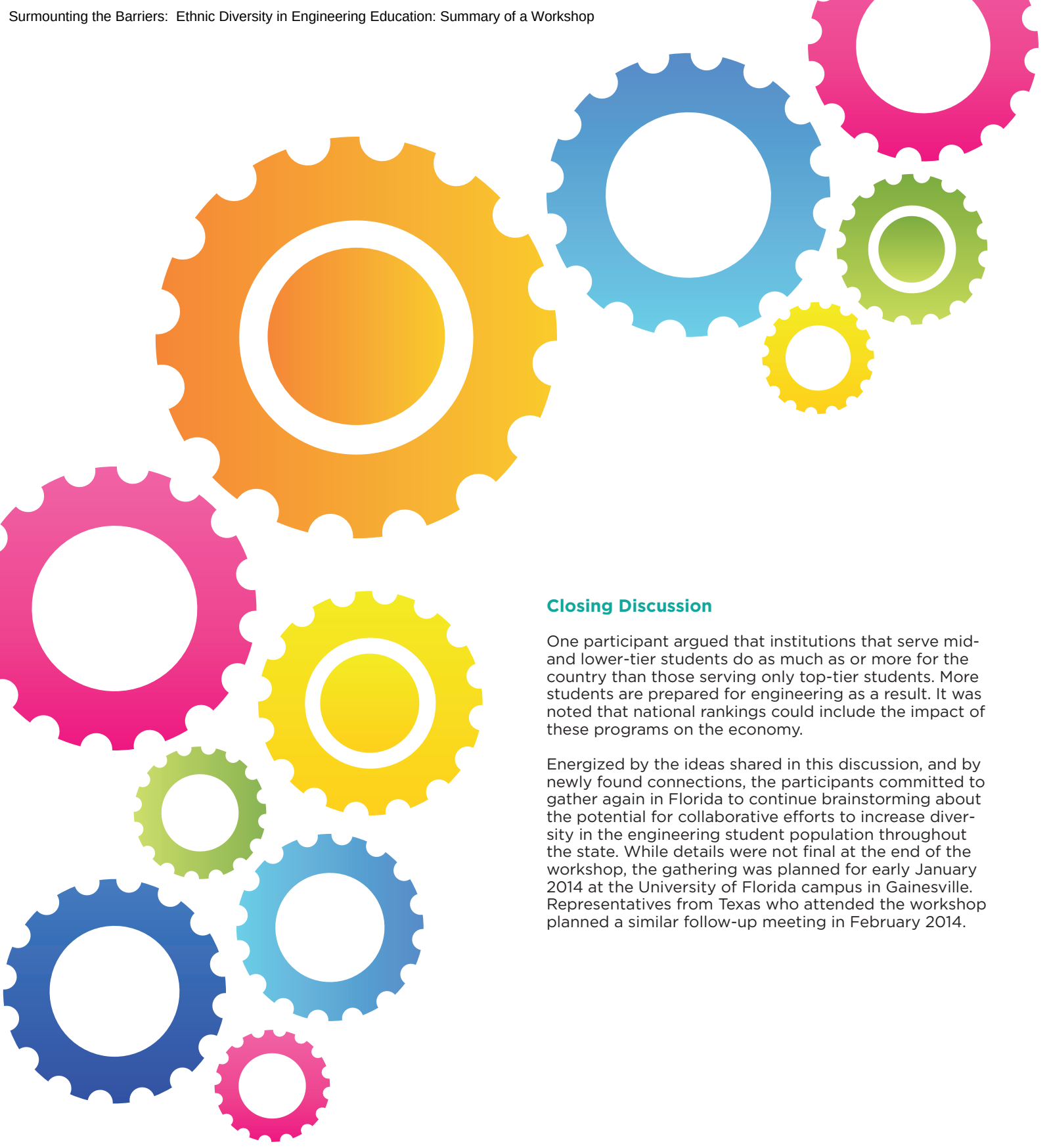
Table 3. Local successes, impediments and strategies: The Florida example

Local Success	Possible Ethnic Diversity Impediments	Potential Strategies for Overcoming the Impediments
The University of Florida's (UF) Florida Opportunity Scholars Program (http://fos.ufsa.ufl.edu/). This program provides funding and support services for first-generation students from low-income backgrounds. The program is responsible for retention rates that equal or exceed the average UF undergraduate population retention rate.	• Centralized admissions offices control decisions and colleges have no influence on decisions. • Historically, donors are not able to earmark funds for specific majors. • Institutions may be unwilling to establish such a program because of cultural climate. • Many of the younger Florida institutions have small donor bases. • Because of the generosity of the Bright Futures Program, many institutions have not established programs for recruiting students from high school.	• Work with financial aid offices to learn students' level of need. • Start a similar program at the college level. • Convert existing college scholarships to need-based. • Work with development offices to target scholarships for students in need.
One faculty member noted the difference a single leader can make in terms of support for diversity in a department. In this case, there was a departmental culture change as the result of a single chair, although this was undercut when the chair left and the department reverted to its old ways. (The conversation then turned to how a department or college can institutionalize the good that one enlightened leader begins.)	• Diversity is not a concern or focus of the institution, college, or department. • Reliance on one individual to energize the environment. • Too much concern about Supreme Court decisions and violating any specific ruling (on admissions policies, for example).	• Identify and engage the willing. • "Change the practice" so that new leaders cannot alter the good that was started. An example might be changing the college constitution to put diversity front and center in its mission, and then instituting an awareness of diversity in every practice, from selecting committee members to choosing new faculty. • Place diversity in the mission statement of the college or department. • Keep the dialogue about diversity alive. The deans drive this, but dialogue should be encouraged at every level. One example: including a "Diversity Spotlight" in each dean's newsletter sent out to faculty.
Gator Engineering at Santa Fe Program at UF (http://www.eng.ufl.edu/gesf/). A new program (in its first year in 2013) established by the UF College of Engineering in collaboration with the UF and Santa Fe College offices of admissions, registrar, and financial affairs, it allows the college to select a pool of freshmen applicants who are not ready to be admitted to UF. Instead, they will take all chemistry, math, and physics classes, along with other general education courses, at Santa Fe College, a community college, for a maximum of three semesters. The unique aspect of this program is that they will become UF students at the beginning of their second semester with all the rights and privileges of a UF student but taking courses at Santa Fe. Since the pool of eligible students will most likely be diverse, this allows the College of Engineering to nurture diversity in its undergraduate student population.	• Convincing the university admissions office to change its model (open it up to colleges). • From the point of view of one college represented in the discussion, the University of Central Florida, an AA degree already provides a student automatic admission to UCF. Thus, UCF would not use a program such as this to increase enrollment. • Universities other than UF expressed some skepticism about whether such a program was applicable to their own institutions, because they do not have the same elite pool of freshmen as UF. There was skepticism that the "next tier" of students would be successful candidates for study at their universities.	• Universities with no enrollment problems could benefit from a program like this by targeting increasing diversity in their student populations. • Also, if diversity is not a concern, universities may want to develop a program like this to focus on preparation of students for engineering study. • The deans of the Florida universities should meet to discuss how this program can serve as a model throughout the state. • UCF already partners strongly with area community colleges in transfer programs. Garnering buy-in for a program like this may not be so difficult. • Engaging in a statewide conversation about innovative partnering with community colleges will broaden the conversation about the role that community colleges can play in better preparing students for engineering study and increasing diversity within the engineering student population.

Continued on page 19.

Table 3. Local successes, impediments and strategies: The Florida example (Continued)

Local Success	Possible Ethnic Diversity Impediments	Potential Strategies for Overcoming the Impediments
STEPUP, UF's College of Engineering freshman bridge program, is now entering its 20th year. A year-long program, it targets underrepresented students in engineering (http://www.eng.ufl.edu/students/freshmen-programs/stepup/).Funded strictly from personal and corporate donations to the UF Foundation, it has a strong track record of increasing retention of students through their first year in engineering. The critical summer component provides students with preparatory instruction in calculus, chemistry, physics, engineering design, modeling, and professional development. Peer mentors are hired to guide the students throughout the year. Students do not register for courses until their fall term, and the College covers the costs of room and board, food, supplies, etc. during the six-week summer term. This program provides a spotlight for employers seeking diversity in their internship and permanent employment pools. Numerous scholarships exist for students who have participated in this program. A newly endowed program, STEPOUT, covers the cost of experiential learning opportunities (research, study abroad, etc.) for STEPUP students from years 2-4.	• Florida International University and FAMU also have freshman bridge programs. However, the College of Engineering at FIU cannot itself admit students to the university's program. • Lack of donor funding is an impediment to establishing a program like this at universities with a shallower donor base. • Without financial support for the program, students must take classes in the summer term so that Bright Futures can cover the cost of tuition and fees.	• Universities should capitalize on the Federal Work Study (FWS) program for peer mentors involved with such a program. • Universities can work with their development offices to coordinate raising funds for a similar program.
Hire Federal Work Study students for undergraduate research. This approach has been pursued successfully by the University of Southern Florida. Students are paired with graduate students for a richer experience.	• Lack of student awareness of research opportunities can be an impediment. • Faculty do not desire freshmen in their laboratories.	• Encourage students to apply to the FWS program. • Market an undergraduate research program specifically for FWS students.
UF and FAMU regularly track student retention, where students go, and which students leave the university. Many universities and some colleges have information systems staff who are dedicated to pulling data. By close tracking of students in their cohorts (gender, ethnicity, participation in retention programs, etc.), colleges are able to assess the vulnerable populations in need of support and the effectiveness of existing support programs (including advising).	• Lack of access to accurate data or to data at all on some campuses. • No knowledge of who runs the university's data center.	• Meet with the university IT/data staff. • Set up regular tracking reports to study retention of different populations.



Closing Discussion

One participant argued that institutions that serve mid- and lower-tier students do as much as or more for the country than those serving only top-tier students. More students are prepared for engineering as a result. It was noted that national rankings could include the impact of these programs on the economy.

Energized by the ideas shared in this discussion, and by newly found connections, the participants committed to gather again in Florida to continue brainstorming about the potential for collaborative efforts to increase diversity in the engineering student population throughout the state. While details were not final at the end of the workshop, the gathering was planned for early January 2014 at the University of Florida campus in Gainesville. Representatives from Texas who attended the workshop planned a similar follow-up meeting in February 2014.

Understanding the Key Underlying Impediments to Implementing Prior Recommendations

Much of the first day of the workshop was dedicated to breakout sessions, with each group addressing one of the six strategies for achieving diversity listed in Table 2 and impediments to their adoption.

A. Inculcating and reinforcing students' academic and professional knowledge
B. Pedagogical enhancement of future and current teachers and faculty
C. Strengthening organizational receptivity to ethnic diversity
D. Enhancing economic enablement of students and student support organizations
E. Enhancing stakeholder communication and action
F. Increasing education research and policy development

These discussions were informed by identification of impediments in the pre-workshop surveys as presented in Appendix C. Following the workshop, Roberta Spalter-Roth, director of the Department of Research and Development at the American Sociological Association, and two additional researchers re-examined the pre-workshop surveys and the breakout group outputs (Appendix D) in order to further categorize and refine the core impediments underlying the problem. They developed an untested coding scheme for common impediments that achieved a reasonable level of inter-rater reliability. Their scheme identified six major types of impediments, with associated "symptoms" as listed below:

I. Lack of Incentives or Financial Support

- Inadequate faculty incentives
- Lack of institutional incentives
- Inadequate funding
- Lack of sustained funding because funding sources tend to favor flashy or new programs
- Funder policies that favor short, three- to five-year grants
- Inadequate flexibility from grant funders on what is done, how, and how long

II. Unsupportive Institutional and Faculty Culture and Environment

- Indifferent faculty culture
- Inadequate faculty commitment
- Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training
- Cultural, organizational, and individual issues
- Non-conducive environment
- Size, proximity, and geographic isolation of faculty

III. Lack of Institutional and Constituent Engagement

- Inadequate constituent community engagement
- Constituencies pitted against each other
- Unrealistic industry expectations of student knowledge, skills, and abilities at graduation
- Insufficient ownership by funders and institutions

IV. Systemic Problems among Institutions of Higher Education

- Failure of colleges/universities to be more engaged in K-12
- Energy to run programs decays over time
- Inadequate attention to faculty knowledge and skills
- Inadequate faculty skills

- Faculty/chairs/deans lack adequate management training
- Lack of substantial, sustained, and coordinated pressure throughout all parts of the educational system
- Insufficient availability of qualified faculty and staff
- Inadequate attention to pre-college feeders
- Inadequate political will
- Inadequate K-12 teacher knowledge and skill

V. Curriculum Issues

- Lack of learning communities that apply a holistic approach to college retention
- A difficult curriculum, heavy on math, that often is a challenge for underrepresented students

VI. Problems with Evaluation (measures and metrics)

- Inadequate support for research on best practices
- Inadequate ability to develop, collect, and display metrics
- Data tracking limits
- Engineering's lack of approachability by outside experts
- The fact that the funded assessment timeline is shorter than the student graduation timeline.

Some of the issues and challenges in effectively recruiting and retaining engineering students from diverse backgrounds are related specifically to the engineering curriculum. But many issues relate to providing a nurturing and comfortable social environment for students who may know very little about the University experience, and this requires a concerted and coordinated university effort going well beyond the confines of an engineering college.

A broad range of social and financial issues, including dependence on financial assistance to attend university, living away from home for the first time, dealing with their own healthcare needs and even finding local transportation, face our diverse students in significant measure. This is particularly true for first-generation college students. Engineering colleges must therefore work very closely with numerous offices and support structures within the University. It truly requires a sustained and coordinated effort to help these students be successful.

Thomas W. Peterson, Provost and Executive Vice Chancellor, University of California - Merced

Strategies for Surmounting Impediments: 13 Suggestions for Change

The success of this workshop depended on identifying possible steps that could help push forward on a front where progress in the past has been discouragingly slow. What follows are 13 strategies presented during the workshop, attributed to the participant or breakout group that suggested them. It is important to note that these are possible strategies for surmounting impediments, not consensus strategies, and are not specific plans.

1. **Link greater diversity to the college or university's mission.** If an institution professes to serve the community that surrounds it, or if its mission statement sets diversity as a goal, make it live by its words. (Gary Kuleck, University of Detroit – Mercy)

2. **Make a business case for why diversity matters.** Social justice is a fine argument, but it's the bottom line that institutions and donors understand best. (Patricia Campbell, Campbell-Kibler Associates, and Minnesota region)

3. **Improve two- to four-year pathways.** Check articulation agreements to make sure they align two-year colleges with their four-year partners. Recognize that this isn't a one-way street; four-year colleges need to take an active interest in two-year colleges and offer their support and resources. (Angela Lindner, University of Florida; Texas and California regions; and the breakout session on Enabling Economic Capacity)

4. **Revise hiring strategies.** The goal is to increase the number of underrepresented minorities at majority institutions, but search committees won't take diversity seriously unless they're told to – and unless they're held accountable. (Emily Allen, San Jose State; and the Session on Strengthening Organizational Receptivity, referencing University of Maryland, Baltimore County)

5. **Know your students.** Don't make assumptions about the men and women in your classes. U.S. demographics are changing faster than you think. Don't assume engineering students today share the same experiences and values as the engineering students you went to school with – or share the same financial background. (Session on Enabling Economic Capacity; and the Florida, Michigan, California and Upper Midwest regions)

6. **Make engineering approachable.** Make it clear to all that "engineering runs in our veins." (Amir Mirmiran, Florida International University; and Eric Jolly, Science Museum of Minnesota). Hire faculty with industry experience (Paul Plotkowski, Grand Valley State; and Dan Dimitriu, San Antonio College)

7. **Make an institutional commitment via funding.** (Bobby Wilson, Texas Southern University; and the Florida region)

8. **Seek partners in local industry.** From General Mills in Minneapolis to BP in Alaska, corporations have a vested interest in the future of engineering. (Sessions on Strengthening Organization Receptivity and Enabling Economic Capacity; and the Michigan region)

9. **Capitalize on proven successes.** Living-learning communities, bridge programs, 3+2 (five-year) experiences and others have all been shown to work. (Pamela McCauley-Bush, University of Central Florida; Gary Kuleck, University of Detroit – Mercy; Nathan Klingbeil, Wright State University; and several breakout sessions)

10. **Deal with problem faculty and seek out and reward willing allies.** Don't accept bigotry, and while you're tackling it, seek out a community of the willing who will help faculty members from underrepresented minority groups succeed so they don't burn out. (Session on Pedagogical Enhancement of Future and Current Teachers and Faculty; Session on Strengthening Organizational Receptivity; and Michigan and Florida regions)

11. **Push for change at the government level.** Some government policies are out of alignment with the reality of engineering students from underrepresented minority groups. These include short project grant terms, and clinging to the paradigm that an engineering student will graduate in four years, which is not the norm. (Session on Reinforcing Students' Academic and Professional Knowledge and Session on Enabling Economic Capacity)

12. **Leverage the professional societies and organizations.** Among the suggestions: Use ABET as an ally for two- to four-year articulation agreements. Ask ASEE to help draw up a first-class online Calculus course. See if the National Academy of Engineering will offer awards for outstanding teaching. And tap into the many minority professional organizations – NSBE, SHPE, AISES, and so on. (Tom Peterson, University of California, Merced; Felecia Nave, Prairie View A&M University; and Sessions on Strengthening Organizational Receptivity and Enabling Economic Capacity)

13. **Spread the word.** The regional group that included colleges and universities in Florida is already doing this. By the end of the workshop they had agreed to meet over the winter under the aegis of the University of Florida to find ways to adapt existing best practices to other institutions in the state. (Angela Linda, University of Florida; and Texas and Florida regions)

It is clear that engineering schools and engineering professionals cannot address the issues about recruiting and retaining more diverse, committed, and enthusiastic people into engineering and technology fields alone. There can be no aspect of the pre-college student's or student engineer's learning experience, whether in mathematics, sciences, humanities, arts, or engineering, that does not excite and challenge all students, lest the true strength of mind, knowledge, experience, and especially personal understanding, needed for the competition ahead will be weakened for all.

Karan Watson, Provost and Executive Vice-President, Texas A&M University

SECTION V—POST WORKSHOP COMMENTARY AND ANALYSIS

Reality Check: What Impediments Have Tripped Up Similar Recommendations in the Past?

A key question before the workshop participants was why previous recommendations for increasing diversity in engineering education had not been implemented.

Change can only happen if the major impediments are fully understood and then overcome. Bearing that in mind, the list of possible strategies for surmounting diversity impediments presented in Section V is paired with suggestions of the types of impediments noted in Section IV that have bedeviled similar recommendations in the past. This cross-referencing is shown in Table 4.

Table 4. Recommendations and impediments cross-reference

POSSIBLE STRATEGIES	UNDERLYING IMPEDIMENTS THAT MAY WEAKEN THE STRATEGIES					
	I. Lack of Incentives or Financial Support	II. Unsupportive Institutional and Faculty Culture and Environment	III. Lack of Institutional and Constituent Engagement	IV. Systemic Problems among Institutions of Higher Education	V. Curriculum issues	VI. Problems with Evaluation
1. Link greater diversity to the college or university's mission		●				
2. Make a business case for why diversity matters	●			●		
3. Improve two- to four-year pathways	●	●	●			
4. Revise hiring strategies		●				
5. Know your students		●	●		●	
6. Make engineering approachable			●		●	
7. Make an institutional commitment via funding	●					●
8. Seek partners in local industry			●			
9. Capitalize on proven successes		●		●	●	●
10. Deal with problem faculty and seek out and reward willing allies		●		●		
11. Push for change at the government level	●					●
12. Leverage the professional societies and organizations		●		●		
13. Spread the word			●			

In discussing the above – identified impediments and strategies – it is reasonable to note that addressing diversity is a "wicked problem"[1] that requires consideration of complex interdependencies. The author of that phrase, Johnnella E. Butler, notes that the effort to solve one aspect of diversity may reveal or create other challenges. For example, she said, there is the challenge of supporting economically "the changing financial model that compositional diversity demands; how to meet the diverse pedagogical needs that result from diverse student demographics; how to structure and compensate interdisciplinary teaching and scholarship."

Lisa Lattuca, professor in the School of Education and the Center for the Study of Higher and Postsecondary Education of the University of Michigan, supports Butler's last point when she observes:

> "Findings from a large-scale study of undergraduate engineering programs reveal that acceptance of diversity as a professional value is far from achieved. Engineering alumni three years on the job reported that working with people who are different from them in terms of gender, race/ethnicity, or cultural backgrounds was moderately to highly important in their current work, but they also reported that their undergraduate programs gave modest attention, at best, to such skills. Faculty and graduating seniors provided a similar picture of the curriculum: both groups reported that their programs placed very little emphasis on diversity as a professional value. Programs seem to be overlooking the need to help students understand how their beliefs and attitudes about others can affect their interpersonal relationships with their classmates today and with their colleagues tomorrow, as well as the evidence that diversity can enhance team performance and produce more effective solutions to complex problems."

The National Academy of Engineering report, Colloquy on Minority Males in STEM [2], raises several research questions that are broadly applicable in seeking to understand impediments to ethnic minorities in engineering:

- What are empowering, culturally relevant pedagogies that foster future STEM achievement? In what learning spaces (in and out of school) are they practiced? (p. 8)
- What is the effectiveness of various school models (magnet schools, charter schools, and learning communities in conventional schools) in preparing students for collegiate study of engineering? (p. 8)
- There should be holistic approaches to understanding undergraduate recruitment, matriculation, retention, and graduation. (p. 8)
- It is important to identify models of institutions and programs that are effective at engaging [students] at the undergraduate levels. How scalable are such programs? How might they be adapted, as appropriate, from ad hoc pilots to institutionalized programs? It is especially important to determine what policies and procedures encourage or inhibit faculty to support the recruitment and retention of graduate students of color, for example through mentoring and other supportive activities. (p. 9)

Any strategy proposed to overcome existing impediments should have implicit or explicit answers to questions such as those shown above. There should also be explicit acknowledgement of institutional issues fostering innovation in higher education, such as those that appeared in the September 30, 2013 issue of the Chronicle of Higher Education [3]:

- Richard K. Boyer: "It's not uncommon to see a 'silo' mentality where there's little incentive, let alone reward, to work outside one's immediate department."
- Jose Cruz: "Leaders need to emphasize that efforts to improve student success are not about lowering standards and expectations, but rather about high expectations coupled with high levels of support. And they need to validate and replicate success by investing in the institutionalization of proven initiatives."
- Susan Herbst: "What faculty hate— rightfully so — is change they don't understand or … that is out of their control."
- Anne-Marie Nuñez: "When … experiments are coupled with careful collection and analysis of data (including studying financial aid thresholds and tracking students' experiences in college), institutions can adjust their policies and deploy their resources to serve more diverse students."
- Robert Samuels: "The biggest thing blocking true innovation in higher education is that there is no shared understanding of how to judge and monitor instructional quality."

Also relevant is a comment sent in after the workshop by Tonya L. Peeples, Professor of Chemical and Biochemical Engineering and Associate Dean for Diversity and Outreach at the University of Iowa:

> "In higher education (and other sectors) there is a need to address underlying psychological systems which erode the ability of even the most well-meaning people to overcome implicit negative associations with minority students, faculty, and community members. When these negative patterns of thinking go unacknowledged and unexamined, the potential to develop an inclusive environment of scholarship and learning is impeded. Examination and deconstruction of the prevailing American social record, which causes us to advantage members of the majority with the 'benefit of the doubt' and at the same time causes us to disadvantage minorities, may help us overcome this impediment.
> University faculties are not presented with incentives and rewards to encourage diversity efforts. Many institutions have not provided course buy-outs, reduced teaching loads, or financial support to enable faculty to implement impactful diversity programs. Lack of concrete rewards and support with time and finances leads many faculty to defer or ignore diversity issues for the sake of professional advancement along traditional avenues of achieving institutional rank and stature."

Lattuca supports Peeples' point when she observes from the study previously cited that acceptance of diversity as an academic goal is not widespread:

> "Our studies of faculty, administrators and students from 31 U.S. institutions indicate that while associate deans for undergraduate education do not believe that there is a trade-off between academic excellence and diversity in the undergraduate student population, the majority of program chairs believe that trade-off is necessary, and engineering faculty members appear uncertain about the question. Our study could not identify the source of these differing beliefs, but the findings suggest the need for dialogues that address what may be unfounded beliefs about the impossibility of achieving both diversity and excellence. Research evidence challenges the widespread belief about the existence of a strong relationship between standardized admissions test scores and secondary school performance and subsequent collegiate academic success – and thus the belief that recruiting a diverse student population requires sacrificing educational excellence."

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3. Boyer, R.K. (2013, September 30). What Are the Barriers to Innovation? *The Chronicle of Higher Education*. Retrieved from: http://chronicle.com/article/What-ARE-the-Barriers-to/141869/?cid=at [Accessed October 23, 2013]

SECTION VI — INVITED SPEAKERS

Day One

Keynote—Freeman Hrabowski: We Need to Look in the Mirror

Freeman A. Hrabowski, III has been president of the University of Maryland, Baltimore County since 1992, but his experience with surmounting barriers to ethnic diversity in education goes back at least 50 years to his participation in the Birmingham Children's March in 1963. He showed a news photo to prove it – and to demonstrate that change in education is possible. Hrabowski also chaired the National Academies' committee that produced the 2011 report Expanding Underrepresented Minority Participation – specifically, report findings and recommendations across preparation, access, and financial/academic/social support were reviewed by Hrabowski. The report is available at: http://www.nap.edu/catalog.php?record_id=12984)

A key message of Hrabowski's speech was a call to change the culture on campuses and the culture within engineering education, and he said there had been too little discussion of these topics. There is a widespread acceptance that a lot of students simply won't make it in STEM fields, he said, and this is borne out in practice, and not just for underrepresented minorities; for any ethnic group, fewer than 50 percent of those who enter college with an interest in STEM will graduate in STEM fields within five years. If so many students have such a bad experience, he asked, why should students from underrepresented minorities be any different? "We need to look in the mirror," he said.

Hrabowski said there were signs of progress in grappling with the need to increase minority representation, such as programs focusing on the all-important first-year experience. But he identified several barriers, too. These included a lack of funding to replicate models that are known to work; a reliance by institutions on grant money, which is ephemeral, rather than a commitment to spending money themselves; the burden placed on women and minorities who do succeed to fill the need for minority members on academic committees; and student debt. "There's a lot of money for students who are well prepared," he said. "A lot of minorities are not."

Hrabowski said too many students in STEM fields were graduating with decent grade point averages but weak grades in their science courses. "It's very difficult if you've not done really well at the undergraduate level to succeed at the graduate level," he said. He challenged colleges and universities to ask themselves how to identify the people on campus in engineering who have an interest in understanding why there isn't more minority representation.

Morning Speaker—Robert Teranishi: Challenging Assumptions about Minorities

Robert T. Teranishi is Associate Professor of Higher Education at the Steinhardt School of Culture, Education, and Human Development at New York University, co-director for the Institute for Globalization and Education in Metropolitan Settings, and Professor of Education at UCLA's Graduate School of Education and Information Studies. His message challenged the stereotype of Asian students as a "model minority" – a homogenous group of high achievers.

The real picture is much more complex. Vast differences in growth rates in the Asian/Pacific Islander population within the United States have shattered the homogeneity and created a diverse kaleidoscope of communities, from Vietnamese in Westminster, Calif. – the city with the highest per-capita concentration in the United States of people of Vietnamese origin – to Chinese in Brooklyn, N.Y., to Hmong in St. Paul, Minn. For those who think of the University of California at Berkeley when they think of Asian students, Teranishi had another surprise: The largest educational sector in which Asian/Pacific Islander participate is actually community colleges, and the proportion of them in that sector is increasing. And nearly half of all Asian/Pacific Islanders leave college without earning a degree.

Teranishi said national demographics are critical to efforts to increase diversity in education. One reason: The picture is always changing. Burma, Nepal, and Bhutan, for example, have sent a quarter million refugees to the United States in the last five years, he said. "We have to think about who these students are...and what it means for how we approach our work with this large and growing population," he said. Approaches that work for East Asian students may not work as well for students from South or Southeast Asia.

Teranishi's talk spurred much discussion during the workshop, and the lesson about not making assumptions about Asian Pacific/Islanders was clearly one that applied to other minorities as well. Teranishi's findings were a warning to everyone against making assumptions about any particular minority. "We have to think about subgroups at an even more granular level," he said.

Luncheon Speaker—Eric Jolly: We Need to Change Who Asks the Questions

In any endeavor, the questions you ask structure the answers you get, said Eric Jolly, president of the Science Museum of Minnesota. And we keep asking the same questions.

Jolly's speech was a plea to diversify the engineering education discussion beyond a small set of people who share a common educational background and a common perspective. That can only be achieved by changing the questions and changing the people who ask them. Who sets the priorities for our work? Who benefits? What if we could show students from underrepresented minorities that success in engineering is leading to improvements in their own communities?

To make this happen, Jolly challenged each institution represented at the workshop to identify the people on their campuses who can bring something to the table. Asked from the floor whether lack of money wasn't the issue, he said the money was there – but we choose not to apply it to encouraging diversity. "We've been talking about retrofitting institutions," he said. "Now we're talking about redesigning them."

Day Two

Keynote—Karan Watson: Taking a Strategic Approach

Karan L. Watson, Provost and Executive Vice President for Academic Affairs at Texas A&M University and President of ABET, called on participants to change their way of thinking in leadership roles – to think strategically. "Diversity has to be a habit at our institutions for everybody," she said. She recommended four books:

- Why So Slow?: The Advancement of Women [1]
- Mistakes Were Made (But Not by Me): Why We Justify Foolish Beliefs, Bad Decisions, and Hurtful Acts [2]
- Don't Think of an Elephant! Know Your Values and Frame the Debate [3]
- A Sense of Urgency [4]

From these she drew several lessons:

- Bigotry exists and is a problem that should be dealt with, "but the real problem is the micro-aggressions, the subtleties … it's not enough for us to take care of the bigots."
- We need to guard against cognitive dissonance and confirmation basis, and to beware of thinking "It's not us, it's them."
- It's unfair and inappropriate to put a single minority representative in charge of changing the culture of a whole institution.
- We need to make sure the other side doesn't get to frame the issue – when that happens, she said, we lose control. When it comes to underrepresented minorities, "Why aren't they here?" is the wrong question because it makes "them" the problem. The real question is "Why aren't we fair to all students?"
- We need to make alliances with other interest groups so that excellence and diversity are aligned within an institution. Texas A&M's diversity plan, for example, drawn up in 2009, makes each college and each vice president a unit accountable for ensuring an equitable climate for diversity, and measures how they do, not just against other colleges within the university but against similar units at other institutions.

Watson drew several questions, including whether ABET could do more to overcome barriers to underrepresented minorities (it has been doing more, she said, but it's driven by the professional engineering societies), and where to look for alliances. On the second point, she drew attention to an agreement under which community college students who are co-enrolled at Texas A&M are eligible for financial aid even though they take most of their credit hours at the community colleges. One advantage of this arrangement, she said, is that it allows them to take calculus in small classes at the community college instead of mega-classes at Texas A&M.

Morning Speaker—Amir Mirmiran: Action Steps toward Increasing Diversity

Amir Mirmiran spoke from his perspective as Dean of the College of Engineering and Computing at Florida International University, the second largest producer of Hispanic engineers in the United States and the eighth largest producer of African American engineers; as a veteran of two National Science Foundation workshops on broadening minority participation; and as principal investigator of the study "Building Partnerships and Pathways to Address the Foundational Grand Challenge for Engineering Education – Concrete Steps towards Broadening Participation" (http://eic3.eng.fiu.edu/nsf/), which spelled out action steps for institutions in Part I and extended it to corporate America in Part II.

Mirmiran made the case for diversity from several points of view – social justice, business and professional. And he laid out a five-point plan:

1. Start early.
2. Get away from conveyor-belt education and em-

brace well-tried concepts such as just-in-time math.
3. Take advantage of the GI Bill to attract STEM students.
4. Make diversity a priority in faculty development and recruitment.
5. Empower Hispanic-serving Institutions (HSI's) and Historically Black Colleges and Universities (HBCU's).

Expanding on the last point during questions, Mirmiran noted that colleges and universities that serve large numbers of underrepresented minorities are on the front lines of change in education: "They're already seeing the reshaped face of American ethnicity."

Luncheon Speaker—Patricia Campbell: We Know So Many of the Answers Already

Just as Hrabowski spoke from a personal history of discrimination based on race, Patricia B. Campbell, president of Campbell-Kibler Associates, noted her own difficulties in trying to enter engineering as a woman in the 1960s. With the perspective of 35 years of research to increase gender and race equity in math, science, engineering and technology education, she pointed out that it is the interaction of so many different impediments that makes entering STEM fields so tough for underrepresented minorities. She checked off some of the problems – and some of the solutions:

- The complexity of the FAFSA form (Free Application for Federal Student Aid) baffles many families, causing them not to file for financial aid. When tax preparers fill out FAFSA forms at the same time they complete the family's tax forms, there is a major increase in low-income students receiving aid and going to college.
- Highly achieving low-income students tend to enroll in less competitive schools and are not aware that college application fees can be waved. Delaware is tackling this problem with a program to send information about financial aid and fee waivers to high-achieving, low-income high school students. This has been found to almost double the number of students gaining admission to a college that matches their academic qualifications.
- "We continue to make math a critical filter, and we know better." Making remedial courses more flexible and tied to individual strengths and weaknesses moves students to college-level math courses faster.
- The myth that spatial skills are biologically determined persists. However, practice has repeatedly been found to improve spatial skills and reduce or eliminate gender differences. With improved spatial skills comes improved retention for those who come into engineering with low spatial skills.

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3. Lakoff, G. (2004). *Don't Think of an Elephant: Know Your Values and Frame the Debate*. White River Junction, VT: Chelsea Green Publishing.
4. Kotter, J. P. (2008). *A Sense of Urgency*. Boston, MA: Harvard Business Press.

APPENDIX A: LIST OF PARTICIPANTS

Aaron Wenger	*Itasca Community College*
Amir Mirmiran	*Florida International University*
Angela Lindner	*University of Florida*
Anna Vallie	*Turtle Mountain Community College*
Arturo Pacheco-Vega	*California State University*
Bart Sheinberg	*Houston Community College*
Becky Packard	*Mount Holyoke University*
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Bobby Wilson	*Texas Southern University*
Cammy Abernathy	*University of Florida*
Carlos Rodriguez	*American Institutes for Research*
Charles Henderson	*Western Michigan University*
Charles Reilly	*University of Central Florida*
Dan Dimitriu	*San Antonio College*
Elizabeth Boylan	*Alfred P. Sloan Foundation*
Emily Allen	*San Jose State University*
Emir Macari	*California State University, Sacramento*
Eric Jolly	*Science Museum of Minnesota*
Felecia Nave	*Prairie View A&M University*
Frankie Santos Laanan	*Iowa State University*
Freeman Hrabowski	*University of Maryland, Baltimore County*
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Gregory Washington	*University of California, Irvine*
Henry Frierson	*University of Florida*
Herb Schroeder	*University of Alaska*
Jennifer Karlin	*South Dakota School of Mines*
Jose Zayas-Castro	*University of South Florida*
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Masoud Milani	*Florida International University*
Michele Lezama	*The National GEM Consortium*
Miguel Gonzalez	*University of Texas, Pan American*
Nathan Klingbeil	*Wright State University*
Olivia Graeve	*University of California, San Diego*
Pamela McCauley-Bush	*University of Central Florida*
Patricia Campbell	*Campbell-Kibler Associates*
Paul Plotkowski	*Grand Valley State University*
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APPENDIX A: LIST OF PARTICIPANTS (CONTINUED)

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Janice Cuny	*Program Director for Computing Education (CNS/CISE)*
Dorothy Jones-Davis	*Science & Technology Policy Fellow (EEC)*
Pramod Khargonekar	*Assistant Director for the Directorate of Engineering (ENG)*
Theresa Maldonado	*Director of the Division of Engineering Education and Centers (EEC)*
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National Academy of Engineering Staff

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Catherine (Kitty) Didion	*Senior Program Officer*
C.D. (Dan) Mote Jr.	*President*
Proctor Reid	*Director, Program Office*
Jason Williams	*Senior Financial Assistant*

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Ashok Agrawal	*Managing Director, Professional Services*
Rocio Chavela	*Manager of Faculty Development*
Norman Fortenberry	*Executive Director*
Nathan Kahl	*Managing Director, Communications and Society Advancement*

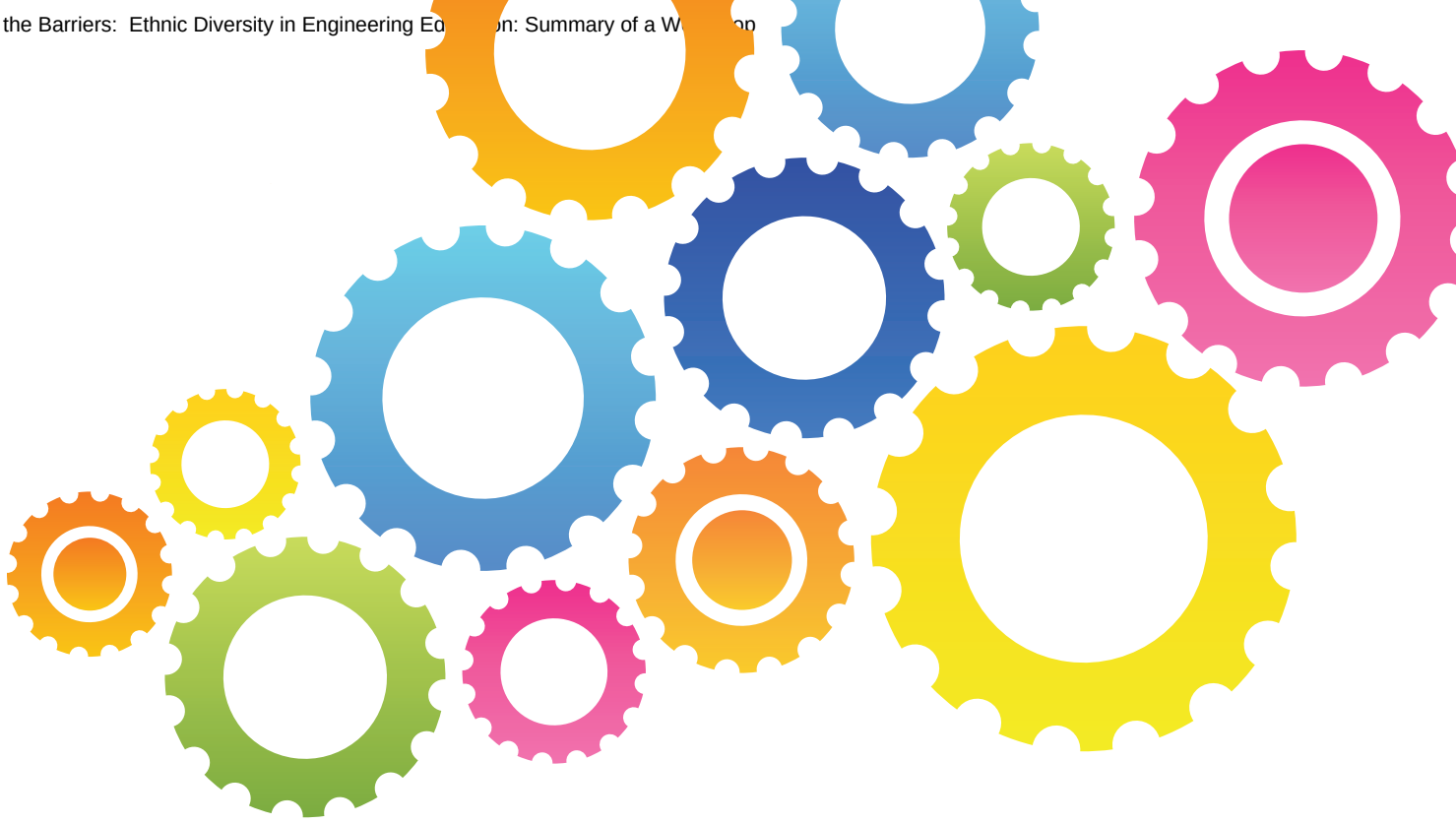
APPENDIX B: MEETING AGENDA

Keck Center of the National Academies
Washington, DC

Thursday, September 26, 2013	
8:00 AM - 8:30 AM	**Breakfast**
8:30 AM - 9:00 AM	**Welcome and Charge** Bevlee Watford, *Virginia Tech* C. D. (Dan) Mote, Jr., *National Academy of Engineering*
9:00 AM - 10:15 AM	**Opening Session** Freeman Hrabowski, *University of Maryland, Baltimore County* Robert Teranishi, *New York University*
10:15 AM - 10:30 AM	**Break**
10:30 AM - 12:00 PM	**Breakout Session I** By recurring recommendation theme. Identification of exemplars of local success and barriers to broader implementation.
12:00 PM - 1:30 PM	**Lunch** Eric Jolly, *Science Museum of Minnesota*
1:30 PM - 3:30 PM	**Breakout Session II** Return to Breakout I groups and discuss strategies for overcoming impediments to broader implementation identified in Breakout I
3:30 PM - 4:00 PM	**Break**
4:00 PM - 5:30 PM	**Full Group Discussion** Plenary for reports from breakouts and discussion
5:30 PM - 6:00 PM	**Break**
6:00 PM - 7:30 PM	**Dinner**

APPENDIX B:
MEETING AGENDA (CONTINUED)

Friday, September 27, 2013	
8:00 AM - 8:30 AM	**Breakfast**
8:30 AM - 9:00 AM	**Summary of Day I** Bevlee Watford, *Virginia Tech*
9:00 AM - 10:15 AM	**Opening Session** Karan Watson, *Texas A&M University* Amir Mirmiran, *Florida International University*
10:15 AM - 10:30 AM	**Break**
10:30 AM - 12:00 PM	**Breakout Session III** By reccurring physical or thematic region. Identification of exemplars of local success and barriers to broader implementation.
12:00 PM - 1:30 PM	**Lunch** Patricia Campbell, *Campbell-Kibler Associates*
1:30 PM - 3:00 PM	**Breakout Session IV** Return to Breakout III groups and discuss strategies for overcoming impediments to broader implementation identified in Breakout III.
3:00 PM - 3:15 PM	**Closing Remarks** Bevlee Watford, *Virginia Tech*



APPENDIX C: HIGHLIGHTS OF PRE-WORKSHOP SURVEYS

To prepare for the workshop, participants were surveyed in advance and asked to answer eight questions ranging from why past attempts to enhance racial and ethnic diversity in engineering had not succeeded to why there aren't more summer programs or research assistantships for students from underrepresented minority populations. These questions were developed after analyzing a preliminary survey of a smaller number of participants that helped crystallize the main issues.

About the Surveys

Participants' views and insights on challenges to increasing racial and ethnic diversity in engineering education were explored via two pre-workshop surveys. The first survey asked participants (n=17) to define impediments to implementing established best practices and previous recommendations for increasing diversity in engineering education, and to identify barriers to removing them. The answers were analyzed and consolidated into a number of factors impeding diversity. A second survey was then sent in which respondents (n=33) rated these factors by importance and relative difficulty in addressing, and also indicated which stakeholder (academia, government, foundations, or associations) bears primary responsibility for addressing each factor.

Survey Results

The results of the second survey were analyzed and the summary below presents the findings. For each of the eight questions, the tables list the emerging impeding factors ranked in a descending order by their importance mean scores, ranging from 4-Very Important to 1-Not Important. The other two columns represent the relative difficulty of addressing the factor, and whose responsibility it is to address it. The last table lists common factors across all eight questions.

A perceived lack of financial support and resources surfaced in answers to many of the questions, as it often does. Survey respondents also tended to see this issue as one of the hardest to address. In general they saw it as the responsibility of government, rather than academia, foundations, or associations, to meet this need.

On other issues, however, there was a clear call to academia to address nagging problems hindering diversification. For example, when respondents were asked what prevents colleges and universities from maintaining a statistical equivalence in the retention, persistence, and graduation rates of minority and majority students with similar academic and socio-economic profiles, they identified educational institutions themselves as the best place to address five different factors, ranging from a lack of social integration and student support services to the lack of a standardized set of metrics.

In addition, no fewer than 10 contributing factors were offered in response to a question about why more doctoral institutions don't include more underrepresented minorities in STEM as research assistants, from too few students in the pipeline to competition from foreign students.

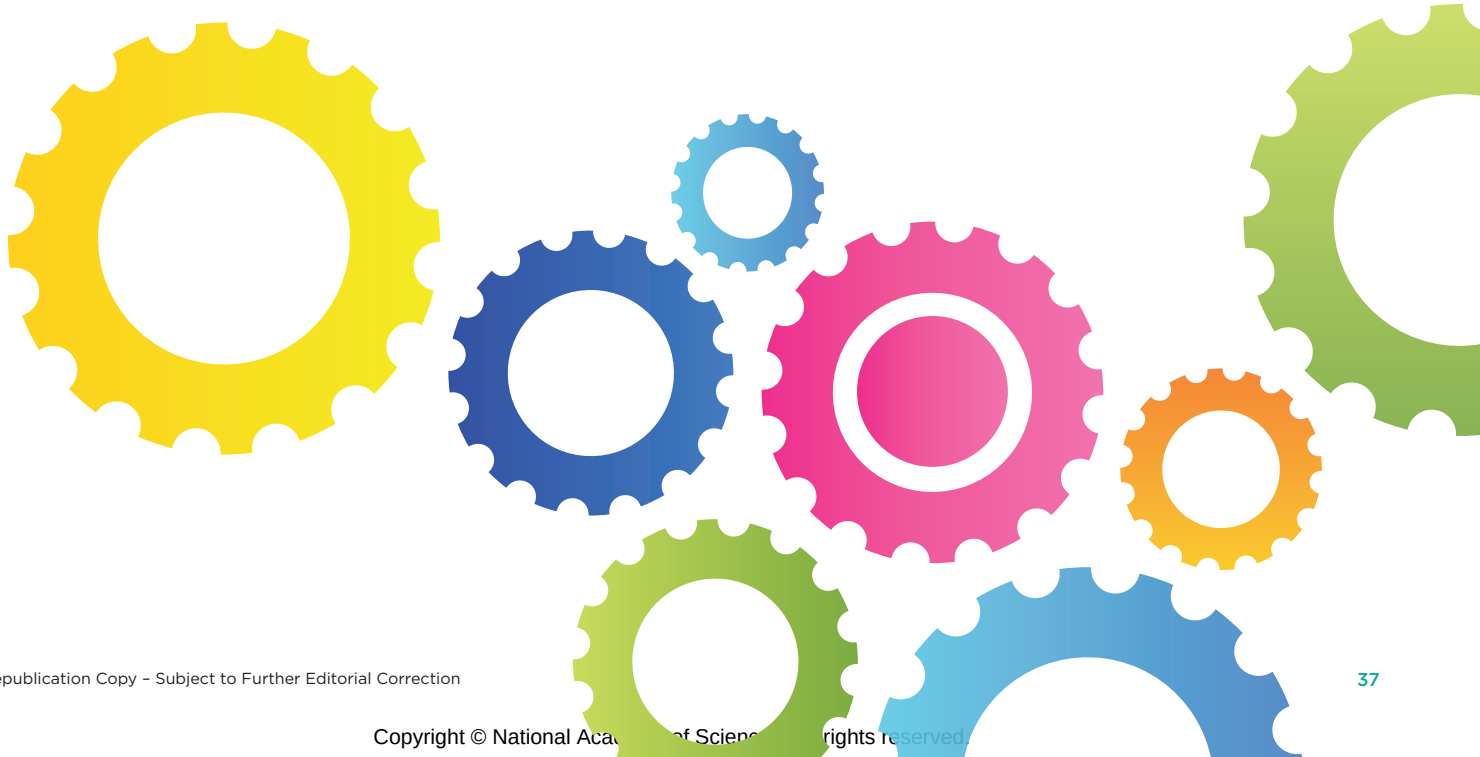
Respondents identified several barriers to enhancing racial and ethnic diversity, and some themes recurred in answers to different questions. These included a lack of institutional incentives, cultural stereotypes and insufficient cultural competency, and the limited availability of qualified staff and faculty.

Q1. Why were past recommendations on mechanisms to enhance racial and ethnic diversity in engineering not implemented; i.e., **what factors impeded the implementation** of such prior recommendations?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Limited financial support and resources	3.45	2.78	10%	71%	10%	10%
Not enough underrepresented students entering the pipeline, especially at the graduate level	3.39	3.21	36%	58%	3%	3%
Lack of institutional incentives	3.09	2.38	58%	29%	10%	3%
Low priority and lack of institutional motivation, will, and commitment	3.07	2.58	88%	3%	3%	6%
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	3.06	3.00	78%	0%	3%	19%
Resistance to change	2.91	3.00	94%	3%	0%	3%

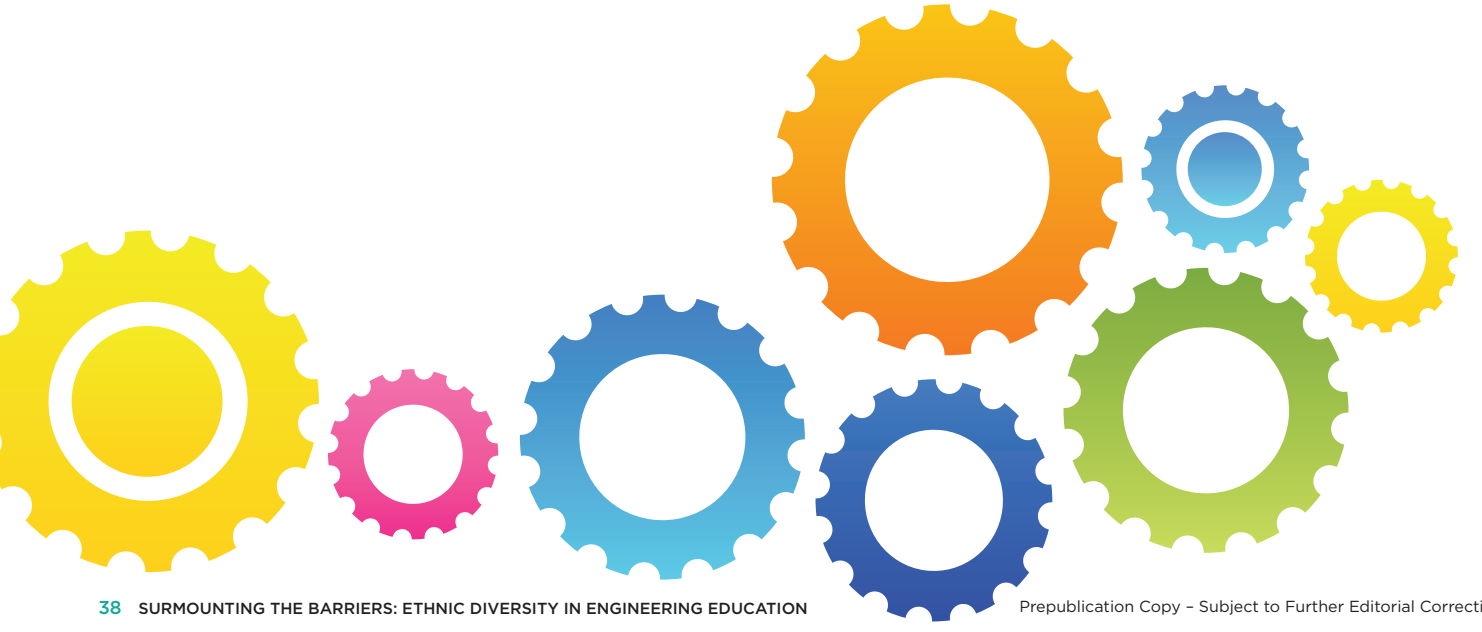
Q2. What barriers, if any, do colleges and universities face in **strengthening the institutional receptivity** towards a more diverse student body in engineering and science?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Limited financial support and resources	3.30	2.66	16%	81%	3%	0%
Lack of diversity among faculty themselves	3.21	3.09	71%	16%	7%	7%
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	3.00	2.70	90%	3%	3%	3%
Lack of social integration efforts and student support services	3.00	2.19	87%	3%	3%	7%
Lack of institutional incentives	2.88	2.24	58%	23%	16%	3%
Supreme Court rulings	2.45	2.84	7%	81%	7%	7%



Q3. What impedes colleges and universities from creating targeted outreach and recruitment activities that constitute a coordinated "feeder system" for higher education institutions to help cultivate underrepresented minority students?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Engagement, cooperation, and linkages with community colleges and high schools	3.42	2.38	81%	10%	7%	3%
Limited financial support and resources	3.33	2.72	13%	68%	19%	0%
Low priority and lack of institutional motivation, will, and commitment	3.27	2.88	91%	6%	3%	0%
Lack of institutional incentives	3.06	2.58	63%	22%	13%	3%
Availability of qualified staff and faculty	3.03	2.63	94%	3%	3%	0%
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	3.00	2.82	78%	0%	0%	22%



Q4. What prevents colleges and universities from **maintaining a statistical equivalence in the retention, persistence, and graduation rates** of minority and majority students with very similar academic and socio-economic profiles?

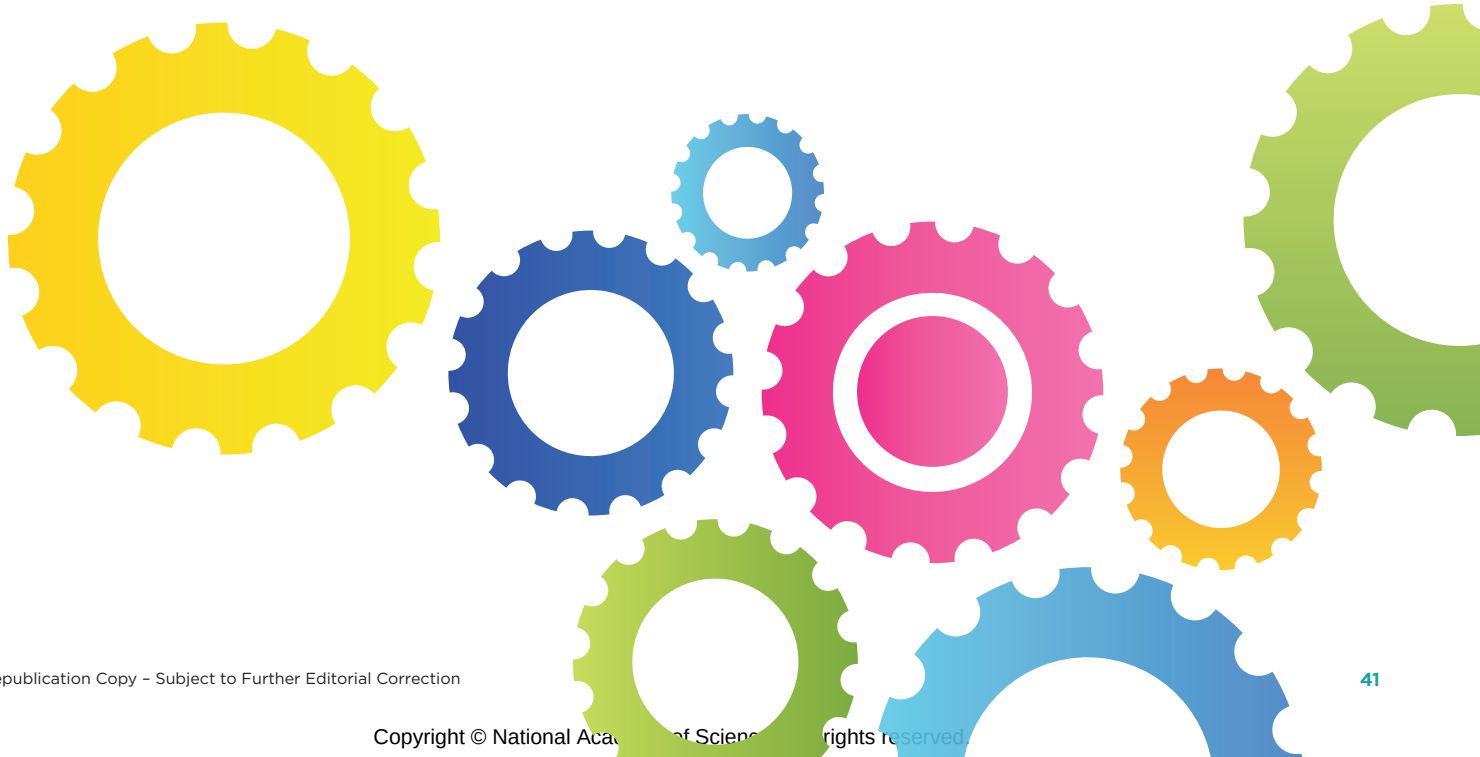
	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Socioeconomic disparities among students	3.26	3.27	15%	48%	22%	15%
Bad alignment between systems and lack of coordinated efforts	3.19	2.87	59%	38%	0%	3%
Limited financial support and resources	3.19	2.83	14%	72%	14%	0%
Lack of social integration efforts and student support services	3.19	2.47	100%	0%	0%	0%
Lack of institutional incentives	3.00	2.42	63%	13%	20%	3%
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	2.81	2.77	83%	0%	0%	17%
The lack of a standardized set of metrics for retention and graduation	2.23	2.62	55%	31%	3%	10%

Q5. What precludes colleges and universities from **implementing widespread summer programs in STEM** that target underrepresented minority high school students?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Limited financial support and resources	3.67	2.45	14%	43%	43%	0%
Low priority and lack of institutional motivation, will, and commitment	3.40	2.72	89%	4%	4%	4%
Engagement, cooperation, and linkages with community colleges and high schools	3.37	2.31	71%	18%	0%	11%
Availability of qualified staff and faculty	3.03	2.42	100%	0%	0%	0%
Liability and legal aspects of recent youth policies regarding equal opportunity	2.67	2.68	30%	67%	0%	4%

Q6. What inhibits colleges and universities from increasing the recruitment, preparation, professional development, and retention of **well-qualified elementary and secondary teachers in STEM** who are prepared to teach diverse students?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Negative views of the teacher profession and lower salaries	3.39	3.29	15%	48%	11%	26%
Lack of institutional incentives	3.17	2.68	70%	22%	4%	4%
Availability of qualified staff and faculty	3.16	2.72	76%	17%	3%	3%
Longer term hiring strategies	3.11	2.74	63%	26%	4%	7%
Lack of partnerships with professional development schools	2.68	2.43	63%	7%	7%	22%
Low standards of teacher education accreditation	2.61	2.90	30%	44%	0%	26%



Q7. What constrains the ability of doctoral institutions to include more **underrepresented minorities in STEM** as research assistants?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Not enough underrepresented students entering the pipeline, especially at the graduate level	3.40	3.19	63%	20%	10%	7%
No commitment from faculty	3.23	2.81	50%	27%	20%	3%
Lack of diversity among faculty themselves	3.13	3.11	47%	30%	13%	10%
Less mentors and sponsors for minority students	3.13	2.63	43%	33%	17%	7%
Insufficient information on graduate schools for first-generation doctoral students	2.93	2.12	40%	27%	20%	13%
Limited financial support and resources	2.90	2.65	33%	40%	10%	17%
Engagement, cooperation, and linkages with community colleges and high schools	2.90	2.38	37%	33%	13%	17%
High selectivity of some schools	2.73	2.69	23%	47%	10%	20%
No cross-departmental support structure	2.59	2.44	21%	38%	21%	21%
Competition for foreign students	2.41	2.24	21%	35%	10%	35%

Q8. Why has **removing impediments** to broadening participation of domestic racial and ethnic minorities been such a challenge?

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Quality of high schools in areas with diverse populations	3.47	3.62	63%	22%	16%	0%
Limited financial support and resources	3.31	2.82	56%	25%	13%	6%
Lack of substantial, sustained, and coordinated pressure throughout all parts of the education system	3.25	3.21	53%	22%	22%	3%
Socioeconomic disparities among students	3.13	3.14	38%	44%	13%	6%
Lack of institutional incentives	3.09	2.62	34%	44%	19%	3%
Lack of involvement of university and colleges in K-12	3.06	2.76	44%	25%	25%	6%
Rising tuition of higher education	3.03	3.29	34%	38%	25%	3%

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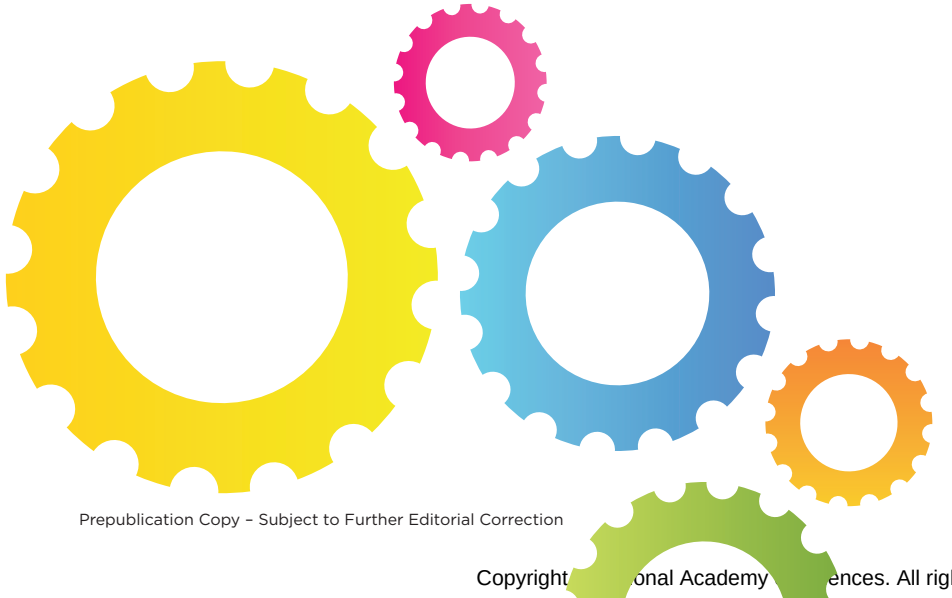


Q8. Why has **removing impediments** to broadening participation of domestic racial and ethnic minorities been such a challenge? (Continued)

	Importance (mean) 4 = very important 1 = not important	**Difficulty of addressing** (mean) 4 = extremely challenging 1 = very easy	**Who should address it?** (percentage of responses)			
			Academia	Government	Foundations	Associations
Availability of qualified staff and faculty	2.88	2.79	25%	44%	25%	6%
Lack of learning communities that address a holistic approach to college retention	2.88	2.48	28%	38%	28%	6%
A difficult curriculum heavy on math that is a challenge underrepresented students	2.74	3.00	32%	23%	32%	13%
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	2.69	2.79	19%	34%	44%	3%
Standardized testing	2.66	2.86	13%	53%	22%	13%
Liability and legal aspects of recent youth policies regarding equal opportunity	2.23	2.70	13%	20%	43%	23%
Ineffective ranking systems for colleges and universities	1.90	2.62	10%	19%	23%	48%

Common factors across questions

	Average importance rates across questions (4 = very important; 1 = not important)							
	Q1	Q2	Q3	Q4	Q5	Q6	Q7	Q8
Limited financial support and resources	3.45	3.30	3.33	3.19	3.67		2.90	3.31
Lack of institutional incentives	3.09	2.88	3.06	3.00		3.17		3.09
Cultural stereotypes, insufficient cultural competency, and lack of cultural sensitivity training	3.06	3.00	3.00	2.81				2.69
Availability of qualified staff and faculty			3.03		3.03	3.16		2.88
Engagement, cooperation, and linkages with community colleges and high schools			3.42		3.37		2.90	
Low priority and lack of institutional motivation, will, and commitment	3.07		3.27		3.40			
Not enough underrepresented students entering the pipeline, especially at the graduate level	3.39						3.40	
Lack of social integration efforts and student support services		3.00		3.19				
Socioeconomic disparities among students				3.26				3.13
Lack of diversity among faculty themselves		3.21					3.13	
Liability and legal aspects of recent youth policies regarding equal opportunity					2.67			2.23

APPENDIX D: HIGHLIGHTS OF BREAKOUT SESSIONS AND THEIR PLENARY REPORTS

The core of the workshop was a series of breakout sessions arranged by theme on Day One and by region on Day Two. Groups typically had six to eight participants. Morning sessions focused on identifying impediments to diversification and sharing local success stories in overcoming these; afternoon sessions were designed to produce strategies that could help push diversification forward on a broad front rather than one institution at a time. Each breakout group reported to the plenary session at the end of each day. The plenary sessions brought the findings from all of the breakout sessions before the workshop as a whole. Each group was given roughly equal time to present; however, the reports on Day Two, as participants were leaving, were necessarily shorter than those on Day One.

The themes for day one were identified via analysis of prior reports to prioritize previously recommended strategies by which to enhance diversity:

A. Inculcating and reinforcing students' academic and professional knowledge
B. Pedagogical enhancement of future and current teachers and faculty
C. Strengthening organizational receptivity to ethnic diversity
D. Enhancing economic enablement of students and student support organizations
E. Enhancing stakeholder communication and action
F. Increasing education research and policy development

The regions for Day Two were:

A. Florida
B. Texas
C. Michigan
D. California
E. Minnesota and Upper Midwest
F. (For attendees from other regions) Student progression to higher education

What follows are notes from each breakout session discussion as well as the plenary presentation by each breakout group. These notes were taken by scribes and edited as needed for clarity.

BREAKOUT SESSION NOTES, DAY 1 (groups were arranged by theme)

A. Inculcating and reinforcing students' academic and professional knowledge

This group saw faculty culture, coupled with lack of resources and government policies (e.g., short-term grants) as key barriers to greater diversification. This aligns with the first two impediments identified in Section II, Lack of Incentives and Financial Support as well as Unsupportive Institutional and Faculty Culture and Environment.

Suggested strategies that were identified for overcoming these impediments include the following:

- Government: Extend grant terms beyond two, three, or even five years based on specific output data, to recognize that institutional change is long-term; promote articulation between two- and four-year colleges, in both directions; study what happens to students enrolled in two-year engineering programs in community colleges.
- Faculty: Increase the number of faculty from underrepresented minorities at majority institutions.
- Lack of resources: Use students as resources whenever possible; promote living/learning communities; provide community space organized by discipline for students.

B. Pedagogical enhancement of future and current teachers and faculty

A key impediment raised in this group was that of an "Unsupportive Institutional and Faculty Culture and Environment." Specific issues raised included: an absence of tenured faculty from underrepresented minority populations, the isolation of ethnic minority students due to their small numbers, and a need for cultural sensitivity training for faculty and academic staff members. Possible strategies for overcoming these impediments include the following:

- Increase the presence of role models and faculty who "get it" through more active efforts to attract and retain faculty members drawn from underrepresented populations. Such methods include (a) providing better guidance to search committees, (b) protecting ethnic minority hires from the excessive requests for service activities they are likely to receive, and (c) building networks for mentors for such faculty.
- Reduce student isolation via active community building in support of student groups and social activities.
- Enhance cultural sensitivity by (a) working with those faculty and staff who recognize that a problem exists and then have this group engage those who may be more skeptical through structured discourse, (b) educating all faculty about who our students are; holding regular training in cultural sensitivity; and making administrations aware of the business justification for increasing diversity.
- Raising recognition of the diversity challenge by improving assessment methods such that more compelling data can be provided on effective mechanisms for addressing the challenges.

C. Strengthening organization receptivity to ethnic diversity

This group focused on key impediments such as "Unsupportive Institutional and Faculty Culture and Environment" as well as "Systemic Problems among Institutions of Higher Education." The group discussed the issue of colleges and universities creating some accountability around efforts to promote diversity. Much of its discussions focused on an institution's relationship to its surrounding community, in places diverse as urban Detroit and rural South Dakota. If an institution's mission includes serving the community, the group's members felt, than it has to live up to this. This implied a stronger commitment to hiring more diverse faculty, building accountability for diversity efforts into the evaluation of chairs, deans, and vice-presidents. It also meant using pressure from external groups such as the federal government and the local business community in support of diversity efforts.

D. Enhancing economic enablement of students and student support organizations

This group focused on the key impediments of "Lack of Incentives or Financial Support" and "Systemic Problems among Institutions of Higher Education."

The group listed the following impediments:

- Too little emphasis on funding research into what works.
- No generally accepted business case for why diversity efforts are important.
- A tendency to fund the flashy and new rather than a program that will replicate success.
- The tendency of the energy radiated by the initial backers of a project to dissipate over time.

Among the possible strategies to address these impediments were the following:

- Improve two- to four-year pathways.
- Increase research funding into programs that build diversity.
- Build corporate partnerships in engineering education similar to those forged between medical schools and hospitals.

E. Enhancing stakeholder communication and action

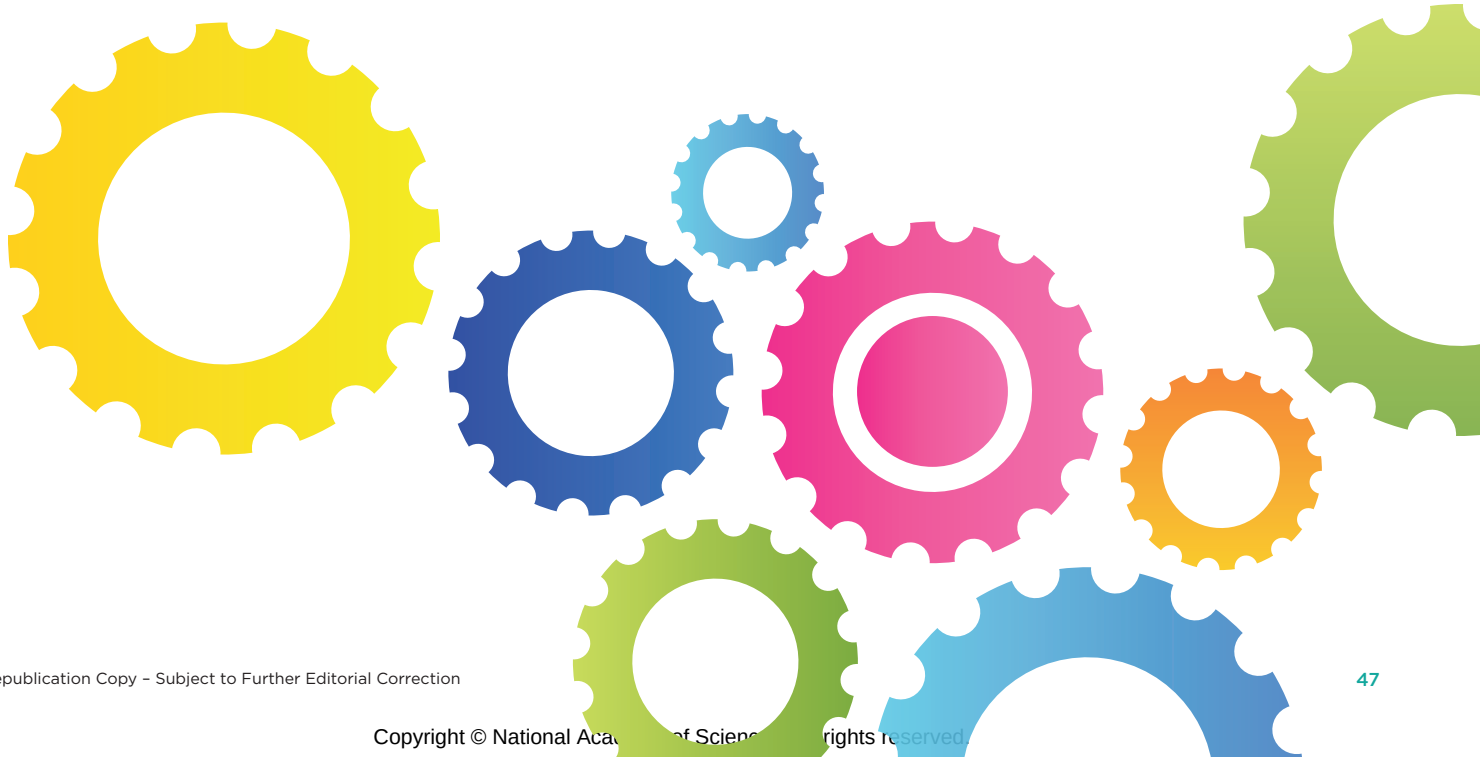
This group focused on the key impediment of "Lack of Institutional and Constituent Engagement" and "Systemic Problems among Institutions of Higher Education."

This group challenged engineers to examine the way they communicate. How should we engineers talk about our discipline? What is the culture that engineers want to convey? The group saw a lack of communication as an impediment to diversity.

The group also had a challenge for federal agencies: to dedicate more funding to looking at diversity. And it suggested a policy paper from the American Society for Engineering Education (ASEE) to back this up and to keep the agencies' feet to the fire could be helpful.

Like many groups, it said there was a need to be specific about the value of engineering. And it went a step further: It noted the importance of distinguishing between engineering and science and not slipping indiscriminately between the two terms when talking about engineering.

The group said engineers could look to Google as an example of a company that had successfully challenged the prevailing culture and changed perceptions about the corporate environment. And it saw social networks as a new public face for engineering – and as a way of answering the communications gap it had identified at the beginning.



F. **Increasing Education Research and Policy Development**
This group identified the central question not as "what works?" but as "how do we scale it up?" It wondered whether we had studied students to death, and if it might not be better to research faculty to figure out next steps in promoting greater diversity.

One suggestion was to look at broad issues of education outside the classroom itself – admissions, mentoring, changing the culture of being a faculty member. Faculty members, the group suggested, make huge assumptions about who's in their classrooms, and this needs to change.

The group also tackled financial impediments to increasing the number of underrepresented minorities in engineering education. One suggestion: Maybe we shouldn't be measured by the same graduation yardsticks as other disciplines.

BREAKOUT SESSION NOTES, DAY 2 (groups were arranged by region)

A. **FLORIDA**
See the summary presented in Section IV.

This region took the concrete step of arranging for a "meeting of the willing" after the workshop to discuss and expand on local successes, especially new collaborative models with community colleges. The one-day Diversity Summit will be held at the University of Florida, Gainesville on August 1, 2014

B. **TEXAS**
Texas identified three barriers to increased diversification and discussed ways to overcome them. These were:

- The two- to four-year articulation. The challenge is in the attitudes to and implementation of these compacts.
- A need for more organizational development and management training, for department heads as well as faculty.
- A capacity bottleneck, which could be broken by increasing the number of regional flagships in Texas.

Like Florida, Texas participants planned a follow-up meeting. This was held in Houston on February 23 and 24, 2014, with three from the 2013 delegation attending. Mary E. Smith, assistant deputy commissioner of the Texas Higher Education Coordinating Board, served as facilitator and compiled a 13-page report. The NEA's Catherine Didion was an invited speaker. The meeting ended with agreement between Bartlett M. Sheinberg, director of the West Houston Center for Science and Engineering at Houston Community College, and Felecia Nave, associate provost at Prairie View A&M University, to develop a "Transfer to PVAMU Plan" for African American and Hispanic students.

C. **MICHIGAN**
In this breakout, there was agreement with the view that the traditional understanding of what predicts a good engineering student is fundamentally flawed. This group saw solutions in tying funding to the value added in support of creative programs, and in re-funding science centers in the state that have been recently defunded.

D. **CALIFORNIA**
California is already managing the changing demographics that will eventually alter the face of the rest of the country. At the same time the state produces 10 percent of all engineers in the United States. There is huge enrollment pressure; the rate of applications to engineering schools in the University of California system alone has far outpaced the increase in admissions. The breakout session discussed four local issues that could have an impact:

- Reinstating the Engineering Liaison Council that used to bring together Engineering Deans from the UCs and the CSUs with community college faculty to focus on engineering-related curricula to discuss how all three could work together.
- Working to repeal or amend Proposition 209, the 1996 amendment to the state Constitution that banned considerations of race, sex, or ethnicity in higher education.
- Focusing on first-generation immigrants and first-generation college students.
- Integrating disparate ad-hoc programs designed to increase diversity.

E. **MINNESOTA AND THE UPPER MIDWEST**
This region identified three barriers to success:

- geographic isolation,
- a lack of sustainability around existing programs, and
- limited recognition.

It called on powerful allies such as ABET to make a business case for greater diversity in addition to an appeal to social justice.

F. **STUDENT PROGRESSION TO HIGHER EDUCATION (NON-REGIONAL)**
This group, which was charged with identifying barriers to student progression nationwide and brainstorming solutions, discussed four issues:

- The need for a central repository for information about 3+2 and 2+2+2 programs.
- A change in thinking about financial aid to take into account students whose careers at colleges and universities will stretch over more than four years.
- A need for research institutions to recognize that, right now, they are overlooking many great B.S. graduates of Minority-Serving Institutions.
- An online math course, to be created through a consortium of schools, which will foster diversity as well as making math more accessible to students whose high schools let them down.

APPENDIX E: POST-WORKSHOP EVALUATION REPORT

After the workshop, ASEE surveyed all attendees to follow up on workshop outcomes, gauge its utility and success, and to determine whether such workshops would be useful in the future – and, if so, whether they could be improved. The survey was completed by 30 workshop attendees, a response rate of about 75 percent. The survey's findings on outcomes, satisfaction, overall workshop feedback, and recommendations for improvement are summarized in this appendix.

Summary

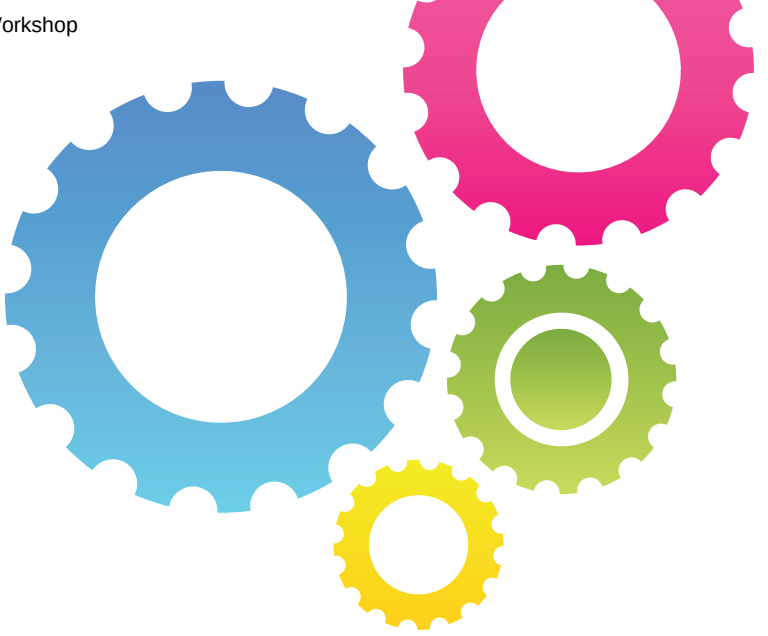
Overall, participants characterized the workshop as being very useful and targeting the right impediments standing in the way of enhancing diversity in engineering education. They were very satisfied with the workshop presenters and speakers, as well as with the topics discussed. Participants also reported increased awareness, knowledge gains, and collaboration and implementation ideas in enhancing diversity as a result of the workshop.

Participants also had specific recommendations for improving future workshops through providing more time, more background information and documentation, better breakout sessions, diversifying the institutional mix at the workshop, and securing buy-in and commitment from decision-makers. In addition, there were suggestions about broadening the focus beyond ethnic diversity and addressing new topics in future workshop agendas.

Meeting Outcomes

Table E.1. Outcomes (n=30)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The workshop helped me to identify root causes of impediments to enhancing ethnic diversity in engineering education and to understand their complexities and interactions.	**43.3% (13)**	33.3% (10)	16.7% (5)	3.3% (1)	3.3% (1)
The workshop showcased examples of strategies and promising practices in overcoming impediments to enhancing ethnic diversity.	40.0% (12)	**53.3% (16)**	6.7% (2)	0.0% (0)	0.0% (0)
After this workshop, I have a better understanding of strategies for overcoming impediments to ethnic diversity in engineering education.	36.7% (11)	50.0% (15)	6.7% (2)	6.7% (2)	0.0% (0)
Interactions and discussions with peers gave me ideas for implementing strategies relevant to my institution/region.	**53.3% (16)**	36.7% (11)	10.0% (3)	0.0% (0)	0.0% (0)
I expect to use the information gained from this workshop to initiate implementation plans for enhancing ethnic diversity in my institution.	33.3% (10)	**46.7% (14)**	10.0% (3)	6.7% (2)	3.3% (1)
After the workshop, I plan to contact workshop peers to further discuss and share implementation strategies around enhancing ethnic diversity.	**53.3% (16)**	23.3% (7)	16.7% (5)	6.7% (2)	0.0% (0)



In their open-ended answers to the questions about meeting outcomes, respondents said the experience was very valuable in that it provided a unique way for universities to crystallize a plan for combatting barriers to diversity within the institutions, but also collaboratively on a state level. Participants shared that they enjoyed the networking opportunity that the workshop provided, and some reported that they have already begun communication and collaboration with other workshop participants and peers from their state. Others shared that they became aware of best practices for enhancing diversity in engineering education.

The very few people who reported less favorably on tangible outcomes expressed concerns that it's hard to achieve major outcomes and impact from a single workshop, and that, although people may know what to do, they may not be able to implement it due to lack of resources, institutional resistance, or other factors.

Overall Meeting Feedback

Table E.2. Overall meeting feedback (n=30)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
The content presented and discussed was informative and relevant to challenges for enhancing ethnic diversity.	**63.3% (19)**	36.7% (11)	0.0% (0)	0.0% (0)	0.0% (0)
The presenters/participants were adequately selected.	**60.0% (18)**	30.0% (9)	6.7% (2)	3.3% (1)	0.0% (0)
The workshop enhanced my knowledge.	**53.3% (16)**	36.7% (11)	6.7% (2)	3.3% (1)	0.0% (0)
The workshop was well organized.	**76.7% (23)**	16.7% (5)	6.7% (2)	0.0% (0)	0.0% (0)
The workshop format encouraged interaction, discussion, and learning.	**76.7% (23)**	20.0% (6)	3.3% (1)	0.0% (0)	0.0% (0)

In their open-ended comments in the overall meeting feedback section, respondents highlighted the workshop speakers in particular as excellent.

Workshop Satisfaction

Table E.3. Satisfaction (n=30)

	Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree
Overall quality of the workshop and the experience.	**70.0% (21)**	20.0% (6)	10.0% (3)	0.0% (0)	0.0% (0)
Attendees' assignments to breakout sessions.	36.7% (11)	**50.0% (15)**	13.3% (4)	0.0% (0)	0.0% (0)
Quality of break-out session discussions.	40.0% (12)	**43.3% (13)**	6.7% (2)	10.0% (3)	0.0% (0)
Quality of speakers/presenters.	**80.0% (24)**	20.0% (6)	0.0% (0)	0.0% (0)	0.0% (0)
Networking and knowledge sharing opportunities.	**70.0% (21)**	26.7% (8)	3.3% (1)	0.0% (0)	0.0% (0)
Meeting materials.	33.3% (10)	**46.7% (14)**	16.7% (5)	3.3% (1)	0.0% (0)
Pace and time management.	43.3% (13)	**50.0% (15)**	6.7% (2)	0.0% (0)	0.0% (0)
Outreach and communication about the event.	**53.3% (16)**	43.3% (13)	3.3% (1)	0.0% (0)	0.0% (0)
Meeting facilities.	**76.7% (23)**	23.3% (7)	0.0% (0)	0.0% (0)	0.0% (0)
Location.	**73.3% (22)**	26.7% (8)	0.0% (0)	0.0% (0)	0.0% (0)

In their open-ended comments on satisfaction rankings in Table 3, respondents reiterated their high level of satisfaction with the speakers and presenters overall, highlighting the plenary speakers as the best. Related to meeting materials, an attendee suggested that a summary of all known best practices in increasing diversity in higher education be provided to meeting participants to inform and structure discussions around identifying barriers to implementing them. The only meeting component that generated a slight variation in satisfaction levels was the quality of breakout sessions. Respondents reported that the second-day sessions were more effective in that they grouped participants by region, allowing the groups to address familiar statewide barriers to diversity. Conversely, the rationale for the composition of break-outs on the first day of the meeting was not clear to participants, and the more unstructured format made potential takeaways more challenging and harder to grasp.

Workshop participants were also asked an open-ended question on what they found most helpful about the meeting. Numerous attendees said that the speakers and presentations were outstanding, inspiring and educational. Karan Watson's talk was highlighted as particularly helpful since it focused on institutional-level actions to make change happen. Furthermore, many agreed that participants in the workshop formed a very motivated and diverse group of engineering professionals that together with great speakers, articulated issues around diversity in engineering education particularly well. Other workshop features that people valued were networking, knowledge sharing, small-group discussions on specific issues, and the opportunity to share and hear about effective strategies and lessons learned. Some of the most helpful information focused on linkages between two- and four-year engineering programs. Another piece of useful information was the presentation on Wright State's early Engineering Math model. Several participants also found the plenaries, the breakout sessions, and the reporting time to be helpful.

Suggestions

Numerous respondents firmly stated that it would be useful to hold diversity workshops regularly in the future because they find the meetings motivating. Participants felt that there is a sense of urgency around the issues surrounding diversity. Therefore, annual meetings with follow-ups on the actions taken as a result of the workshop, presentation of accomplishments, and progress reports may be a good idea. Some suggested expanding the focus of the workshop to also address diversity of engineering faculty. Others suggested having separate targeted workshops emerging from the results and recommendations of this broader workshop that focus on different aspects of the pipeline and on the different types of institutions and the different issues that they face. For instance, there could be separate workshops on recruiting minorities into STEM fields, on the success of minorities in STEM fields, on the issues of math preparation of minorities, etc.

Those who were more hesitant as to the need for and effectiveness of future meetings noted that although workshops raise the visibility of problems around diversity, the issue is much broader than just racial differences. Furthermore, without a commitment from the highest authorities to address the diversity impediments head on, the chance of making an impact is lessened.

Improvements

Workshop participants were also asked to provide suggestions and recommendations on how future diversity workshops could be improved. Many urged providing more time at each session and making the workshop longer, especially so that participants have more time to strategize about how to apply the new information in practice.

Several comments addressed the purpose of the workshop. One recommendation for future meetings was to provide at the very beginning of the first day a summary of known best practices, a clear objective for the workshop, a more defined charge and trajectory to the groups, and clarification on the anticipated output of the workshop (report, policy outcomes, etc.). Those things did take shape and emerge on the second day of the 2013 workshop, but it would have been more effective to start with them at the beginning.

A number of people would improve the breakout sessions, which they noted did not always match some of the underlying and most difficult to address challenges to diversity that surfaced through the pre-workshop brainstorm survey. In that sense, some participants felt that there was a disconnect between the pre-workshop survey and its findings, and the breakout sessions at the workshops. Sometimes, the breakout session discussions were too long, less focused on the workshop's biggest question, and poorly led or facilitated, which made it harder to synthesize and derive true meaning, lessons or action plans. Furthermore, some thought that the breakout sessions on local practices focused too much on anecdotes and story-telling, at expense of hard evidence and tangible impact. Discussions and presentations showcased local programs' summaries and success stories, while ignoring challenges they had encountered and the primary impediments to diversity such as weaknesses in faculty culture, teaching, student peer and campus environments, budgets, etc. that need to be addressed. That all relates to the actual objective of the workshop. If it is to share information about existing programs and interventions, that could be done effectively in a workshop format, or through other means of information exchange and knowledge sharing. However, if the objective is to get to the root cause of impediments to diversity and strategies to overcoming such impediments, the workshop agenda, sessions, and discussions should address that. Ultimately, focusing on practical solutions and providing action plans, especially on the regional group level, would be most effective.

Many respondents felt that any workshops need to diversify the institutional mix, including more participants and viewpoints from smaller, private, and urban institutions and community colleges, which are currently not

well represented in the discussion about diversity in engineering education. The needs of students in different types of institutions, and also in different geographical regions, are different and need to be specifically attended to and addressed separately. In addition, there is a need for examples of partnerships between community colleges and universities, stressing diversity efforts in recruiting and retaining.

One important insight noted that there were two different issues in the room that need very different solutions: getting more minorities into selective universities; and getting more graduates out of less selective institutions, which is where the numbers of minorities are the largest. These are completely different issues and they kept getting conflated, usually from the point of view of the selective institutions. Furthermore, it appears that at the workshop there were some implicit assumptions about the challenge to inclusion being at the feed side of the STEM pipeline, which takes focus away from academic institutions themselves. Colleges and university should also address why they are not doing better in retaining minority students who are on paper just as capable as their majority counterparts, why they are not recruiting these students into graduate school, and finally why are they not adding minority Ph.D. students to their faculties.

Another important insight that was highlighted by workshop participants in their comments was that the diversity strategies emerging from the workshop discussions would require buy-in and action from decision-makers and administrators. For workshop participants who are not in that position, or don't have leverage over decision-makers and administrators, implementing plans is not an immediate possibility. There was less at the workshop about how to work with faculty and staff who work with students on a day-to-day basis. Workshops on diversity need to draw decision makers (deans, provost, etc.) and administrators to buy in and participate, so they can buy into implementation and funding of solutions. Overall, some participants seemed more driven and dedicated than others, and factors such as institutional resistance and motivation for increased diversity should be considered when targeting workshop participants in order to optimize on the outcomes.

Additional topics

For future workshops on diversity, participants also suggested additional topics that were not addressed at this meeting. According to many, this workshop was rightly focused on ethnic diversity, as one of the most pressing issues about engineering education. However, participants felt that it would be greatly beneficial to broaden the focus to other forms of diversity (e.g., gender, disability, sexual orientation and identity, etc.) and to spend an equal amount of time on devising strategies for overcoming diversity impediments for those underrepresented groups as well. We are further behind in dialogue about some of the underrepresented groups in engineering, yet more and more diverse students and faculty want to be more visible and valued.

Additional topics suggested for future workshops included a focus on faculty and student culture, conceptions of intelligence, teaching approaches, as well as alternative models of funding that look beyond state and federal funds. One person thought that identifying quantitative assessment tools to determine what impact, if any, our interventions are having on diversity is still a challenge and therefore should be addressed at the workshop. Another suggestion was to examine the well-being of existing faculty of color and to determine the threats to their advancement and potential to be change agents at our institutions.