Report

on the National Science Foundation (NSF)-Supported Professional Development Workshop for Underrepresented Minority Master’s and Doctoral Engineering and Materials Science Students and Their Faculty/Staff Advisors

November 18-19, 2011

QEM Network

February 2012
Description of the Quality Education for Minorities (QEM) Network Workshop Series
Focused on the Professional Development of
Underrepresented Minority Students in Engineering and Materials Science
November 2009 – November 2011

In 2009, the QEM Network received support from the National Science Foundation (NSF) Directorate for Engineering (ENG) to conduct a workshop to focus on the significant underrepresentation of minorities and women in the U.S. engineering workforce. The 2008 Annual Report of the National Action Council for Minorities in Engineering (NACME) reported that, in 2006, only 12.5 percent of bachelor’s degrees in engineering in the U.S. were awarded to minorities, while almost 30 percent of the U.S. population was African American, Latino, or American Indian.

The first workshop in the series, “Mentoring of Underrepresented Minority Undergraduate Students in Engineering,” was conducted in November 2009. The workshop brought together 142 students and their faculty advisors from 15 institutions that enrolled significant numbers of underrepresented minorities in engineering. The workshop’s goal was to increase the participants’ understanding of the roles that faculty and peer mentoring can play in enhancing the professional outcomes of undergraduate engineering majors who are members of underrepresented groups. Students and faculty/staff advisors from the participating institutions as well as workshop consultants at the initial workshop strongly recommended that QEM/NSF efforts expand to the graduate level. At a small follow-up meeting in July 2010, faculty participants recommended that a workshop be conducted for faculty.

The second workshop, conducted in May 2011, convened three-member engineering faculty/staff teams from 14 institutions with master’s and doctoral programs in engineering with significant enrollments of underrepresented minority graduate students. Forty (40) senior engineering faculty and administrators gathered to share best practices and strategies for mentoring and advising underrepresented minority graduate students in engineering and to offer suggestions and resources for the graduate student workshop that would take place in November 2011.

In 2011, the Division of Materials Research in the Directorate for Mathematical and Physical Sciences provided support to enable the inclusion of underrepresented minority graduate students in materials science, and the third workshop in November 2011 focused on the professional development of underrepresented minority graduate students in engineering and materials science. The 14 participating institutions enrolled, in 2009, 1,473 minority students who were pursuing graduate engineering degrees full-time (American Society for Engineering Education, Institutional Survey, 2009). The goals of the workshop were to: (1) provide master’s and doctoral engineering and materials science students from underrepresented minority groups with information, resources, and skills development opportunities to increase their success in graduate school and in transitioning to careers in academe, government, or industry; and (2) provide opportunities for the 102 student participants to network with each other as well as with the 42 engineering and materials science faculty and other professionals attending the workshop.
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QUALITY EDUCATION FOR MINORITIES NETWORK

Report on the National Science Foundation (NSF)-Supported Professional Development Workshop for Underrepresented Minority Master’s and Doctoral Engineering and Materials Science Students and Their Faculty/Staff Advisors

November 18-19, 2011

Overview
The workshop was held on November 18-19, 2011, at the Four Points by Sheraton BWI Airport Hotel, in Baltimore, MD. The purposes of the workshop were to: (1) provide master’s and doctoral engineering and materials science students from underrepresented minority groups with information, resources, and networking opportunities to increase their success in graduate school and in transitioning to engineering and materials science careers in academe, government, or industry; and (2) increase awareness among faculty members of potential challenges that underrepresented minority students may face as they prepare to enter engineering and/or materials science careers. The workshop agenda is at Appendix A.

This workshop, supported by the NSF Engineering Directorate and the Division of Materials Research in the NSF Mathematical and Physical Sciences Directorate, was the third in a series of three workshops. Participants in the workshop included 102 graduate students and 42 faculty/staff representing 14 institutions with graduate engineering or materials science programs.

The first workshop in the series was held in November 2009 and focused on mentoring of underrepresented minority undergraduate students in engineering. This activity involved 142 students together with 19 faculty advisors from 15 institutions. The second workshop, conducted in May 2011, brought together 40 faculty/staff, generally in three-member teams, from 14 institutions, 12 of which were represented in the November 2009 workshop.

Activities in the third workshop began on the evening of Thursday, November 17, with a reception that provided an opportunity for students to meet informally with their peers and faculty advisors and share information regarding their career and other interests. Students from the following institutions participated in the November 2011 workshop:

| City College of New York, CUNY | North Carolina A&T State University |
| Florida A&M University-Florida State University | Prairie View A&M University |
| Florida International University | Stanford University |
| Georgia Institute of Technology | Tuskegee University |
| Massachusetts Institute of Technology | University of Puerto Rico at Mayaguez |
| Morgan State University | University of Texas at El Paso |
| New Mexico State University | University of Virginia |
I. Workshop Highlights: Plenary Sessions

Broadening Participation in Engineering/Materials Science
Opening workshop presentations on “Broadening Participation in Engineering/Materials Science” were given by Dr. Omnia El Hakim, Program Director of Diversity and Outreach, NSF Directorate for Engineering, and Dr. Ian Robertson, Division Director, NSF Division of Materials Research, Directorate for Mathematical and Physical Sciences. Dr. El Hakim noted that underrepresented groups, women, and persons with disabilities bring new ideas, talent, skills, and experiences to the science and engineering workforce. She also listed a number of challenges to increasing the participation of these individuals in engineering careers, including a lack of role models; lack of a welcoming campus environment; competing family needs; and a lack of community support.

Dr. Robertson gave data on the production of engineering doctoral degree recipients among underrepresented minority groups. He noted that, in 2008, for American Indians/Alaska Natives, the number of recipients was in the low single digits, and for African Americans and Hispanics was slightly more than 100 each.

Dr. Robertson emphasized to the students why they should pursue a career in engineering or science. He stated that engineering and science would provide the knowledge and skills necessary for addressing key societal challenges. These challenges include sustaining the availability of clean air and clean drinking water; developing sufficient power to serve the Nation and the next generation of transportation systems; and using communication technologies more effectively.

21st Century Achievements and Grand Challenges in Engineering
Dr. Thomas Peterson, Assistant Director for the NSF Engineering Directorate, discussed 21st Century Achievements and Grand Challenges in Engineering. He listed the following as examples of challenges that are being addressed through NSF support: the Cyberinfrastructure Framework for the 21st Century; the National Robotics Initiative; the National Nanotechnology Initiative; the Advanced Manufacturing Initiative; the Materials Genome Program; and Real-time Networks.

Dr. Peterson stressed that NSF is positioned at “ground zero” in addressing energy, health, environmental, and economic challenges through engineering as well as in addressing the stagnation in the number of degrees awarded to underrepresented groups over the last decade. He stated that broadening participation is an NSF funding priority, along with catalyzing innovation and investing in human capital. Among NSF’s funding achievements are several basic research activities that have led to direct societal benefits. These benefits include the development of barcode technology; DNA research; memory storage; retinal implants; clean, abundant water through purification techniques; affordable, effective medicines through artificial pathways for rare drugs; and radar technology. Dr. Peterson encouraged the students to take time early in their careers to plan ways they can become familiar with and participate in NSF opportunities.
Financing Graduate Education through the NSF Graduate Research Fellowship Program
Dr. Gilbert John, Program Director for the NSF Graduate Research Fellowship Program (GRFP), gave an overview of the Program. He noted that the Program was initiated in 1952 and has served approximately 46,500 Fellows to date. Former Fellows include 30 Nobel Laureates and 440 members of the National Academy of Sciences. The five-year Fellowship, which provides three years of support, includes a yearly stipend and an educational allowance to the Fellow’s graduate institution. In the electronic application process, students must submit a research plan and a description of the intellectual merit and broader impacts of their proposed plans. Dr. John suggested that students seek assistance from a faculty member on campus, or from regional GRFP application development workshops that may be offered in their respective areas.

Networking: How to Do It and with Whom
Ms. DiOnetta Jones, Associate Dean for Undergraduate Education and Director, Office of Minority Education at the Massachusetts Institute of Technology (MIT), spoke to the students about the importance of networking. She emphasized that students should have a business card to distribute to people they contact during networking sessions and prepare a brief speech that describes them and their work. Ms. Jones recommended that students familiarize themselves beforehand with the people who will be attending a networking event and think ahead about what they want to gain. She mentioned that students should not be afraid to contact “famous” or “popular” people in specific fields and should be persistent if they cannot be reached on the first try.

Preparing Students to Meet Expectations and Tomorrow’s Challenges
Dr. Wesley Harris, Charles Stark Draper Professor of Aeronautics and Astronautics, and Associate Provost for Faculty Equity, Massachusetts Institute of Technology, emphasized in his discussion of this topic that diversity and excellence are not orthogonal and that engineering is vital to the joy of living. According to Dr. Harris, useful solutions of complex problems require diverse approaches/proposals; diverse experiences; diverse skills and knowledge; diverse people; mutual trust and respect; and expected and required input from all stakeholders. He also outlined the following steps for effectively completing a Ph.D. thesis: (1) select a topic; (2) develop a hypothesis; (3) state three key questions which, when answered, will validate the hypothesis; and (4) select the tools needed to answer the three questions through simulation, experimentation, and analytical and empirical research.

How to Succeed in Graduate School
Dr. Christine Ortiz, Professor of Materials Science and Engineering and Dean for Graduate Education at the Massachusetts Institute of Technology (MIT), spoke to the students on how to succeed in graduate school. She provided advice regarding graduate school experiences and offered the following recommendations to students:

- Be proactive and seek out interactions with faculty members;
- Find multiple mentors, each of whom can provide something you need;
- Identify what is needed from an individual faculty member and explicitly ask the faculty member to assist you in addressing the needs (It is easier for a professor to
respond to specific requests for assistance than to general requests for mentorship); and

• Transition from thinking of yourself as a bright student to seeing yourself as a potential colleague by attending departmental lectures and other departmental activities; joining professional associations and societies; attending conferences to network with others; and seeking opportunities to present your work inside or outside your department.

Tools for Assessing Graduate Engineering/Materials Science Programs and Student Outcomes
Dr. Joanne Bechta Dugan, Professor of Electrical and Computer Engineering, University of Virginia, noted that assessment is a way of gauging whether a program is working effectively. The instruments she mentioned used student production to gauge mastery of engineering analysis. According to Dr. Dugan, for accreditation purposes, programs must show measurable performance improvement, so assessment methods should be constructed to accurately portray performance. She emphasized that greater clarity of operations and better student performance are among the unexpected benefits of program assessment.

Career Pathways in Engineering and Materials Science
Dr. Andrea Stith, AAAS and Howard Hughes Project Consultant, spoke on preparing for a career in engineering or materials science. She recommended that students complete an individual development plan (IDP) to help establish their specific short- and long-term goals. Students can use the IDP to establish milestones, identify tools required to be successful, and identify expectations for a specific field. IDPs also can serve as self-assessment tools, helping students identify the skills they need to meet expectations and achieve their career goals. Faculty and peers can assist with the self-assessment.

According to Dr. Stith, when completing the IDP, students should consider which career options best fit their skills, values, and interests. They also should think about how their skills transfer to different positions. This will help ensure they are prepared to take on challenges that arise when pursuing a career (e.g., competition from others interested in pursuing the same career and changes in opportunities available in a given field). Dr. Stith suggested that the students discuss and revise their IDPs with their mentors. IDPs should be reviewed annually to monitor progress and be revised as needed.

After completing an IDP, students should seek mentors familiar with their chosen career field. They also should look for a variety of experiences that will prepare them for their careers. Postdoctoral experiences, for example, provide opportunities to acquire skills and gain experience. Dr. Stith emphasized that students should develop and maintain a network of people who can share relevant career information or otherwise assist them.

Ethical Considerations in Engineering Research and Practice
Dr. Deborah G. Johnson, Anne Shirley Carter Olsson Professor of Applied Ethics, School of Engineering and Applied Science, University of Virginia, discussed excerpts from the National Academies report, “On Being a Scientist: A Guide to Responsible Conduct of
Research.” She noted that the Guide was concerned with ethical considerations related to: the treatment of data; research misconduct (fabrication, falsification, and plagiarism); and responding to suspected violations of professional standards. Other ethical considerations mentioned by Dr. Johnson included: rules governing human participants and animal subjects in research; laboratory safety in research; sharing of results; authorship and the allocation of credit; intellectual property; competing interests, commitments, and values; and the researcher’s place in society.

Engineering Students Without Borders Project
Dr. Garrick Louis, Associate Professor, Department of Systems and Information Engineering, University of Virginia, described the Engineering Students Without Borders (ESWB) Project, for which he served as Faculty Advisor. The project, which addresses the provision of basic human needs such as clean water and health in developing communities, involves professionals and students in 250 chapters worldwide, including 180 on college campuses. Current ESWB international projects are taking place in Belize, Cameroon, the Dominican Republic, Guatemala, Haiti, Honduras, Mexico, Nicaragua, Uganda, and South Africa.

In response to ethical issues that arose in an ESWB international project, the ESWB, through NSF support, now promotes cultural sensitivity for community-based research projects; trains undergraduates at ESWB meetings; requires the building and testing of successful prototypes before full project implementation; and requires an institutional contact/liaison to the community where work is being conducted.

Meeting the Challenges and Opportunities in Engineering
Dr. Eugene DeLoatch, Dean of the School of Engineering, Morgan State University, told the students that more women and underrepresented minority engineers are needed. He described challenges early African American engineers faced in pursuing their education. For example, in 1968, six Historically Black Colleges and Universities (HBCUs) graduated 88 percent of black engineers. Dr. DeLoatch also noted that the attendance at the current workshop was evidence that the field has come a long way. He emphasized, however, that more needs to be done to increase diversity in engineering.

Dr. DeLoatch suggested that engineers should consider entrepreneurship when looking at potential future careers. Entrepreneurs should have an ability to communicate their ideas as well as provide what people want. He mentioned that students are free to pursue their own ideas, but should do so in an ethical manner that is concerned about human life. He also encouraged students to think of becoming engineering professors who have the ability to create things themselves as well as produce people who go on to achieve great things.

II. Workshop Highlights: Panel Discussions

Navigating the Engineering Graduate Education Pipeline
Dr. Clara Nieto-Wire, Louis Stokes Alliance for Minority Participation (LSAMP) Bridge to the Doctorate Recipient, City College of New York; Dr. Lufthansa Kanta,
Lecturer/Post-doctoral, Department of Civil Engineering, Texas A&M University; and Dr. Monica Cox, Associate Professor, Engineering Education, Purdue University, gave accounts of their experiences in progressing along the engineering graduate education pipeline. They emphasized the importance of creating short- and long-term plans for teaching, research, and service that include yearly goals. The panelists also suggested that the participating students develop plans to acquire the resources they need to achieve their goals.

Dr. Nieto-Wire noted that, as a mother, she wanted to balance her life and work. She credited the NSF Alliance for Graduate Education and the Professoriate (AGEP) and other NSF-supported programs with helping her career advancement, particularly in continuing her education while carrying out her family responsibilities.

What to Ask/Expect of Your Mentor

Doctoral students Mr. Ibraheem Muhammad (NC A&T State University) and Ms. Annie Weathers (University of Texas at Austin), and Dr. Gilda Barabino, Professor of Biomedical Engineering, Georgia Institute of Technology, participated in a panel focused on managing relationships with mentors during graduate study. Mr. Muhammad and Ms. Weathers suggested that senior graduate students and post-doctoral fellows play an important role as mentors. They emphasized the importance of seeking out others with similar background experiences and of learning to accept criticism as constructive rather than personal. Dr. Barabino stated that relationship building is the most important aspect of mentoring, and that unhealthy mentoring is worse than no mentoring. She stressed the need for cultural awareness and recognition of the isolation of minority students. According to Dr. Barabino, mentors should steer students toward independence and should expect them to be increasingly proactive as the relationship matures. She emphasized that mentors and advisers should know enough about a student’s personal life to know how it would affect research productivity, but have limits on how personal the relationship is allowed to become.

III. Workshop Highlights: Concurrent Breakout Sessions

Students were assigned to Concurrent Breakout Sessions over the two days based on: (1) the number of years they had been doctoral students; and (2) the desire for every student to attend each of a trio of concurrent sessions focused on careers in academe, government, and industry.

Preparing Graduate Engineering/Materials Science Students to Meet Academic Requirements and Professional Expectations

Master’s Students

Dr. Arturo Bronson, Professor of Mechanical Engineering at the University of Texas at El Paso, and Dr. Neville Parker, Professor of Civil Engineering at City College of New York, CUNY, led a discussion with participating master’s students on how to pursue academic and professional success in engineering and materials science. They stressed that students should focus on both the fundamentals of their chosen fields and the
fundamentals of teaching, and that building critical thinking skills was vital to success. They suggested that students should plan for interdisciplinary work with global impact. As an example, Dr. Parker described his work on water supply in Tanganyika, Africa.

Some students expressed curiosity about the factors that contribute to effective teaching in engineering. In response, the discussion leaders listed the following traits of successful teachers:

- describe concepts in different ways to engage all students;
- make students feel comfortable asking for help;
- explain the relationship between formulas and reality; and
- anticipate and clear up underlying assumptions that hinder understanding.

The discussion leaders also advised students to increase interaction with other students to generate research ideas. Students were urged to show initiative in pursuing and continuing research that interests them.

**Doctoral Students – First and Second Year**

Dr. Monica Cox, Associate Professor of Engineering Education, Purdue University, and Dr. Garrick Louis, Associate Professor of Systems and Information Engineering, University of Virginia, led a discussion with first- and second-year doctoral students centered on concepts for achieving academic and professional success, namely: learning to teach engineering; finding a thesis advisor and identifying research topics; interacting effectively with advisors; developing a research agenda; communicating problems and solutions; and preparing for qualifying examinations.

Students were urged to seek excellence in their teaching by: talking to exemplary teachers on campus; volunteering their time to help advisers with laboratories and lectures; and being active learners themselves through attending campus teaching workshops and engineering education conferences. Drs. Cox and Louis recommended that students schedule regular meetings with advisers and maximize their time with the research team by understanding responsibilities and concerns ahead of meeting times. Early and incremental publishing were cited as sound strategies for gaining necessary visibility in an engineering field.

**Doctoral Students – Third Year or More**

Dr. Percy Pierre, Professor, Department of Electrical and Computer Engineering, Michigan State University, and Dr. Tequila Harris, Assistant Professor, Department of Mechanical Engineering, Georgia Institute of Technology, talked with students who were in at least the third year of a doctoral program. The session began with a focus on mentoring. Drs. Harris and Pierre noted that mentoring undergraduates can help graduate students identify useful resources, learn how to ask questions, and improve their writing skills.

The discussion leaders recommended students pay special attention to their research interests as well as the research interests of their dissertation mentors. They also emphasized students should not be afraid to pursue “crazy” ideas, because those ideas
might lead to insights that significantly impact the field. The discussion leaders also noted additional laboratory experiences could be obtained by participating in a postdoctoral program.

Approximately half the students in the group expressed an interest in teaching. Group discussion leaders suggested the students prepare a portfolio that includes their research interests and vision; their graduate and undergraduate research experiences; and their teaching philosophy and experience. Students who want to teach also should be aware that some institutions place more emphasis on teaching than others, and students should plan accordingly when pursuing a faculty position.

The students were encouraged to work with their research mentors on proposals for external support. It was suggested that students become familiar with calls for proposal submissions by different funding agencies and keep up to date on changes to program solicitations and deadlines. Students were reminded that upon completion of their doctoral degree programs, their dissertations might be used as the basis for a proposal to a funding source.

Career Pathways in Engineering/Materials Science

*Careers in Academe*

Dr. Janet Rutledge, Vice Provost and Dean of the Graduate School, University of Maryland, Baltimore County, told the students that the first year as a faculty member should be spent establishing a laboratory and preparing for coursework. However, she emphasized that new faculty should contribute to their disciplines by publishing as soon as possible and attending professional conferences. New faculty should look for programs that interest them, including the NSF Early Career Faculty Development (CAREER) Program and the Broadening Participation Research Initiation Grant in Engineering (BRIGE) Program, and contact NSF program officers for more information. They also should share what they are doing with others in their department, including the chair and key faculty, who can serve as advocates.

Dr. Sheldon Weinbaum, Emeritus CUNY Distinguished Professor of Biomedical and Mechanical Engineering, City College of New York, discussed the joys of mentoring and teaching. He noted that teaching provides faculty members an opportunity to find their voices and to help students achieve great things. He emphasized that mentoring benefits the faculty as well as the students, because it enhances teaching and performance in the department. Dr. Weinbaum said that, because of its benefits, faculty members should enjoy mentoring.

Dr. Tequila Harris, Georgia Institute of Technology, recommended that students teach whenever they can and participate in a postdoc. The postdoc opportunity may be at an academic institution, a national laboratory, or in industry. Postdocs offer an opportunity to build relationships with collaborators. She suggested to students, when applying for a postdoc, to look for experiences that will develop or enhance their teaching, proposal writing, management, or other skills required to be successful in academe.
She also pointed out that promotion and tenure policies differ among institutions. New faculty should be aware of when the tenure clock starts and what are the expectations for promotion. Dr. Harris said that faculty members should ask questions about the tenure process during their job interviews. Service, teaching, and research play a role in the promotion and tenure process. Faculty should prepare themselves to advance in their field by serving on panels, attending conferences, and showing leadership.

**Careers in Government**

Dr. James Turner, Director, Office of International Affairs, National Oceanic and Atmospheric Administration (NOAA), discussed career opportunities in the Federal government related to engineering and materials science. He noted that the roles of a researcher at a Federal laboratory are to: conduct research to support government needs; develop standards, protocols, and processes; develop and characterize new materials; and work with scientists to convert the results of basic research into applications for the private sector. Federal scientists also play a key role in providing the foundation for intellectual property policies for emerging technologies.

Dr. Turner stated that the Nation cannot afford to outsource government expertise and knowledge, and there is a need for more minority and women scientists and engineers in the Federal workforce. He mentioned that the public expects Federal scientists and engineers to: protect public health and safety; provide national security; improve standards of living; and provide scientific infrastructure that can support a vigorous economy.

Dr. Stephanie Adams, Professor and Department Head, Department of Engineering Education, Virginia Polytechnic Institute and State University, discussed her work at the National Science Foundation (NSF). She noted that most Federal jobs (84 percent) are provided outside Washington, DC. Dr. Adams previously served in the NSF Engineering Directorate as a program director and an American Association for the Advancement of Science (AAAS) Science and Engineering Policy Fellow. Her responsibilities at NSF included organizing and conducting review panels on a variety of topics related to research in engineering education. She pointed out that engineering graduate students seeking a job in government should consider National Laboratories and government-supported post-docs.

**Careers in Industry**

Dr. Samuel Miller Allen, Professor in the Department of Materials Science and Engineering at the Massachusetts Institute of Technology, Dr. Percy Pierre, Michigan State University, and Dr. Arturo Bronson, University of Texas at El Paso, advised students on how to prepare for engineering and materials science careers in industry. Approximately 80 percent of engineering students pursue industrial work, including careers in government laboratories, nonprofit research and development organizations, and entrepreneurship.

It was emphasized in the groups that Ph.D. training is not wasted in industry because industrial employers seek trained thinkers who can define and solve problems from
incomplete data in ill-defined domains. Discussion facilitators suggested that students do basic research as early as possible. Participation in basic research will provide more flexibility in movement to other research and product development areas. Students were advised to devote ample time and attention to the job search; to focus on building communications skills; and to gain some understanding of accounting and business principles.

IV. Workshop Highlights: Responses from Student Teams on Institutional Efforts to Broaden Participation

Representatives from each institutional team summarized key points from their discussion, held the previous evening, on the effectiveness of current institutional efforts to broaden participation in engineering/materials science at the undergraduate and graduate levels.

Questions Students Addressed
Each of the 14 institutional student teams provided written responses to the following four questions:

1) How supportive is the overall climate on your campus of the presence, irrespective of major or degree level, of underrepresented minority students?
2) How supportive is the climate in your institution’s School of Engineering/Materials Science of the presence of underrepresented minority students as engineering/materials science majors at the undergraduate and graduate levels?
3) Are you aware of special efforts at your institution to recruit and retain underrepresented minority students, in general, and in engineering/materials science, in particular? If so, which recruitment and/or retention strategies do you think are most effective/least effective?
4) Are there specific strategies not currently in place at your institution that the institution could use to strengthen its efforts to attract and retain underrepresented minority students in engineering/materials science?

Question 1: Overall Campus Climate
All teams felt the overall climate on their respective campuses was supportive. In one instance, the students even described their campus climate as outstanding. A number of the teams attributed the supportive climate to the existence of student clubs and other campus organizations that involved student leadership and institutional recognition.

One issue cited by the students was the small number of underrepresented minority faculty on campus. Some students suggested that faculty should spend more time assisting students in enhancing their academic achievement. On the other hand, students stated that faculty at their institution care about underrepresented minority students and usually “go the extra mile” to ensure that the students comprehend their assignments and are academically equipped to succeed. According to the students, faculty are very nurturing and frequently help them stay on top of their academic workloads.
In some cases, new engineering students are welcomed to the campus by clubs and organizations such as the National Society of Black Engineers, Black Greek Letter Organizations, and Latino Fraternities and Sororities. While students felt their institutions were very supportive, some noted that the institution is even more supportive for those students who have a scholarship or a fellowship because of the additional resources that are available to students with extra funding.

One team reported that students do not feel different at their institution because of their ethnicity. However, they noted that some students do not have role models, either because they have not felt the need to cultivate relationships with faculty of color, or because no significant number of faculty of color exists on their campuses. Another institution developed a peer mentoring program in which each entering freshman is paired with a senior undergraduate student. The institution has a graduate diversity office that helps recruit and retain underrepresented minority students. This office has developed a mentoring institute that pairs new graduate students with a mentoring coach and a faculty member to assist the students in addressing issues that might arise.

Question 2: Climate in the School of Engineering/Materials Science

Generally, the student teams reported that the Schools of Engineering were very supportive. Some teams reported supportive climate varies across departments. Faculty and staff go out of their way to assist, show concern for, and even provide personal assistance to students. At one institution, the School of Engineering conducts a summer program for new freshmen that prepares them to take the institution’s entry examination, qualifying them for their first-year classes. The program also is used to teach new students how to study as an engineering student.

Some teams reported that their deans were the driving forces behind supportive efforts to enhance campus diversity activities. One team attributed a supportive climate in engineering to the institution’s lack of cultural and language barriers since a large majority of the students were of the same ethnicity. Students pointed out that one measure of institutional support is the financial support in the form of scholarships and fellowships such as the McNair Fellowships, National Action Council for Minorities in Engineering (NACME) Fellowships, and support through the NSF Louis Stokes Alliance for Minority Participation (LSAMP) Program.

According to one team, supportive departments within the School of Engineering, in addition to having a nurturing staff, have discretionary funds that are set aside to assist underrepresented minority students who need help with funding. This team also reported that non-supportive departments put a lot of effort into recruiting underrepresented students but little or no effort into the retention of these students.

One team reported that, while the School of Engineering does a wonderful job of attracting students to the institution, at the departmental level many students feel ignored or neglected because so few minority students are enrolled in the department.
Question 3: Special Recruitment and Retention Efforts

The teams reported on special efforts on their campuses to recruit and retain underrepresented minority students in engineering/materials science and on which of the efforts are most/least effective. The most effective special efforts identified by the student teams included the following:

- Use of campus organizations and programs such as the National Society of Black Engineers (NSBE), the Louis Stokes Alliance for Minority Participation (LSAMP), and the NSF Bridge to the Doctorate;
- Participation in college fairs and attendance at targeted high schools to recruit minority students;
- Saturday academies and the “Introduce a Girl to Engineering” Program for middle and high school students;
- Professional development opportunities for students (e.g., workshops and conferences);
- Financial incentives that pay for undergraduate and graduate education in engineering/materials science;
- Collaborations with industry;
- Engineering Week, with a focus on engineering career opportunities;
- Development of tutoring programs and supplemental instruction for core engineering courses to assist underrepresented students in their undergraduate pursuits;
- A summer Research Experiences for Undergraduates (REU) program focused on increasing the number of underrepresented minorities pursuing graduate education and research-related careers;
- Dual degree programs;
- Well-rounded experiences for students in academia and industry;
- Guest lectures to introduce undergraduates to different research opportunities;
- Graduate student participation in recruiting trips; and
- Establishment and maintenance of a campus center for diversity in engineering responsible for recruiting activities, including summer research opportunities for underrepresented students.

The teams reported the following recruitment and retention efforts as being least effective:

- Frequent curriculum changes;
- Inconsistent publishing requirements;
- Inconsistent teaching requirements and a lack of mentoring throughout the teaching experience;
- Graduate student-led underrepresented minority-serving organizations (According to one of the student groups, graduate students possess neither the time nor the numbers to consistently and successfully maintain these organizations. A staff person to monitor these organizations would be helpful); and
- Admission of students to an institution’s pipeline programs that is construed erroneously by some as being equivalent to admission to the institution.
Question 4: Specific Strategies Not Currently in Place to Strengthen Recruitment and Retention

The student institutional teams reported being aware of specific strategies not currently in place at their respective institutions that could be used to strengthen their institutions’ efforts to attract and retain underrepresented minority students in engineering/materials science. The following strategies were offered:

• An undergraduate course in public speaking;
• Emphasis on graduate school as early as possible (for example, offering freshman courses on engineering leadership);
• Mandatory tutoring time to solidify students’ knowledge and understanding of foundation-level curricular material;
• Encouragement and facilitation of cross-cultural interactions, including with non-minority students;
• Student participation in cross-disciplinary meetings with various engineering departments;
• Workshops on federal programs offering fellowships, scholarships, or grants for students;
• A mentoring program in which a graduate student is paired with an undergraduate student for the duration of the students’ time at the institution;
• A mentoring program in which senior faculty mentor junior faculty, junior faculty mentor graduate students, and graduate students mentor undergraduate students;
• Workshops for graduate students on proposal writing at which students partner with faculty on preparing proposals; and
• A dissertation-writing forum where students can exchange ideas and strategies and provide feedback to each other on dissertation chapters.

V. PowerPoint Presentations

PowerPoint presentations given by speakers, panelists, and discussion leaders at the November 2011 workshop may be obtained by clicking on the name of the presenter in the workshop’s agenda posted at QEM’s website:
http://www.qem.org/GradEng_Agenda_Final.htm

The agendas for the November 2009 and the May 2011 workshops can be obtained through the following links:

November 2009 - http://www.qem.org/QEM_ENGMentoringWkshpAgendaFinal.htm

May 2011 - http://www.qem.org/QEM-EngineeringFacultyWorkshopAgenda.htm
VI. Appendices

Appendix A – Agenda for the November 2011 Workshop

QUALITY EDUCATION FOR MINORITIES (QEM) NETWORK
PROFESSIONAL DEVELOPMENT WORKSHOP FOR UNDERREPRESENTED MINORITY
MASTER’S AND DOCTORAL ENGINEERING AND MATERIALS SCIENCE STUDENTS AND
THEIR FACULTY/STAFF ADVISORS
Four Points by Sheraton • 7032 Elm Road • BWI Airport • Baltimore, MD • Tel. 410/859-3300
NOVEMBER 18-19, 2011

AGENDA

Purposes:
(1) To provide master’s and doctoral engineering and materials science students from underrepresented minority groups with information, resources, and networking opportunities to increase their success in graduate school and in transitioning to engineering or materials science careers in academe, government, or industry; and
(2) To increase awareness among faculty members of potential challenges that underrepresented minority students may face as they prepare to enter engineering and/or materials science careers.

THURSDAY, NOVEMBER 17

PM
7:00 Early Registration and Networking Reception

FRIDAY, NOVEMBER 18

AM
8:00 Registration and Continental Breakfast

8:30 Opening Plenary Session
Welcome, Purpose, and Introductions
Shirley McBay, President, QEM Network

Broadening Participation in Engineering and Materials Science
Opening Remarks: Ian Robertson, Division Director, Division of Materials Research Directorate for Mathematical and Physical Sciences (MPS)
National Science Foundation (NSF)
Omnia El Hakim, Program Director of Diversity and Outreach Directorate for Engineering (ENG), NSF

9:00 21st Century Achievements and Grand Challenges in Engineering
Introduction of Speaker: Omnia El-Hakim, NSF/ENG
Keynote Speaker: Thomas Peterson, Assistant Director, NSF/ENG

9:30 Navigating the Engineering Graduate Education Pipeline
Transitioning from Classes to Research and Preparing a Research Plan
Panelists: Clara Nieto-Wire, Louis Stokes Alliance for Minority Participation (LSAMP)
Bridge to the Doctorate Recipient, City College of New York
Lufthansa Kanta, Lecturer/Post-doc, Department of Civil Engineering
Texas A&M University
Monica Cox, Associate Professor, Engineering Education, Purdue University

10:15 Questions and Comments from Audience

10:30 Coffee Break

11:00 Financing Graduate Education in Engineering/Materials Science
- NSF Graduate Research Fellowship (GRF) Program
- Graduate Research Diversity Supplement (GRDS) program in Engineering

Opening Remarks: Ian Robertson, Division Director, MPS/Division of Materials Research
Panelists: Gilbert John, Program Director, Graduate Research Fellowship Program (GRFP)
Division of Graduate Education, Directorate for Education & Human Resources (EHR)
Omnia El-Hakim, Program Director of Diversity and Outreach, ENG

11:45 Discussion Groups: (Roundtables, by Major Engineering/Materials Science Disciplines)
Topic: Networking: How to Do it and With Whom
Introduction of Topic: DiOnetta Jones, Associate Dean for Undergraduate Education and
Director, Office of Minority Education
Massachusetts Institute of Technology

PM
12:30 Working Luncheon
Topic: Preparing Students to Meet Expectations and Tomorrow’s Challenges
Introduction of Speaker: Shirley McBay, QEM Network
Keynote Speaker: Wesley L. Harris, Charles Stark Draper Professor of
Aeronautics and Astronautics, and Associate Provost for Faculty Equity
Massachusetts Institute of Technology (MIT)

1:30 Concurrent Breakout Sessions

Topic: Preparing Graduate Engineering/Materials Science Students to Meet Academic
Requirements and Professional Expectations

Group I: Master’s Level
- Academic requirements: fundamentals, design, and practice
- Interacting effectively with your advisor
- Working on an interdisciplinary research team
- Exploring external summer research opportunities
- Learning to teach engineering/materials science
- Understanding the global impact of engineering/materials science decisions

Discussion Leaders: Neville Parker, Herbert Kayser Professor of Civil Engineering and
Director, CUNY Institute for Transportation Systems
City College of New York, CUNY
Arturo Bronson, Professor, Department of Mechanical Engineering
University of Texas at El Paso, and QEM Consultant

Group II: Doctoral Students – First and Second Year
- Learning to teach engineering
- Finding a thesis advisor and identifying a dissertation topic
- Interacting effectively with your advisor
- Developing a research agenda
- Communicating engineering/materials science problems and solutions
Preparing for and taking the PhD qualifying examination

**Discussion Leaders:** Monica Cox, Associate Professor, Engineering Education, Purdue University, and QEM Consultant
Garrick Louis, Associate Professor, Department of Systems & Information Engineering, University of Virginia, and QEM Consultant

**Group III:** Doctoral Students – Third Year or More
- Mentoring younger students
- Writing the dissertation
- Defending the dissertation
- Identifying post-doctoral opportunities and building collaborations
- Developing a portfolio and personal profile
- Getting involved in proposal development / seeking external support
- Learning to teach engineering/materials science

**Discussion Leaders:** Tequila Harris, Assistant Professor, Department of Mechanical Engineering, Georgia Institute of Technology, and QEM Consultant
Percy Pierre, Professor, Department of Electrical and Computer Engineering, Michigan State University, and QEM Consultant

2:45 *Coffee Break*

3:00 *How to Succeed in Graduate School*
**Speaker:** Christine Ortiz, Dean for Graduate Education and Professor, Department of Materials Science and Engineering, Massachusetts Institute of Technology (MIT)

3:30 *Questions and Comments from Audience*

3:45 *Tools for Assessing Graduate Engineering/Materials Science Programs and Student Outcomes*
**Presenter:** Joanne Bechta Dugan, Professor, Department of Electrical and Computer Engineering, University of Virginia

4:15 *Career Pathways in Engineering/Materials Science*
**Presenter:** Andrea Stith, AAAS and Howard Hughes Project Consultant

4:45 *Concurrent Sessions on Career Pathways in Engineering/Materials Science*
{Guest speaker, 15-20 minutes; discussion of topics, 55-60 minutes}

**NOTE:** THESE SESSIONS WILL BE REPEATED TWICE ON SATURDAY TO ENABLE EACH STUDENT TO ATTEND A SESSION ON EACH CAREER OPTION

**Group I:** Engineering/Materials Science Careers in Academe
**Speaker:** Janet Rutledge, Vice Provost and Dean of the Graduate School, University of Maryland, Baltimore County

**Discussion Co-Facilitators:** Tequila Harris and Arturo Bronson, QEM Consultants

**Topics:**
- Post-doctoral appointments
- Research; NSF’s BRIGE/CAREER Programs
- ERC and MRSEC opportunities
- Publishing; Portfolio Development
- Promotion and Tenure Process
- Balancing Research and Teaching
Group II: Engineering/Materials Science Careers in the Government
Speaker: Artis Hicks, Senior Program Manager, Office of Naval Research (ONR) Program
American Society for Engineering Education (ASEE)
Discussion Co-Facilitators: Guebre Tessema, Program Director, Materials Research, NSF/MPS
Kemi Ladeji-Osias, Associate Professor, Department of Electrical and Computer Engineering, Morgan State University

Topics:
- Post-doctoral appointments
- Program Officers; Rotators; other Civil Service Opportunities
- Bridging Engineering and Public policy
- National Research Laboratories

Group III: Engineering/Materials Science Careers in Industry
Speaker: Samuel Miller Allen, Professor, Department of Materials Science and Engineering
Massachusetts Institute of Technology (MIT)
Discussion Co-Facilitators: Juan Figueroa, Program Director
Division of Industrial Innovation and Partnerships, NSF/ENG
Percy Pierre, QEM Consultant

Topics:
- Industry Partnerships/SBIR/IIP Program
- Entrepreneurship
- Research and Development/Engineering Project Management
- R&D Portfolio Development
- International Collaborations

6:00 Working Dinner: Meeting Society’s Needs through Engineering
Speakers:
- Ethical Considerations in Engineering Research and Practice
  Deborah G. Johnson, Anne Shirley Carter Olsson Professor of Applied Ethics
  Department of Science, Technology, and Society
  School of Engineering and Applied Science, University of Virginia
- Engineering Students without Borders Project
  Garrick Louis, University of Virginia, and QEM Consultant

7:30 Adjournment, Day One
Networking Lounge available 7:30 – 11:00 pm

OVERNIGHT ASSIGNMENT: Each institutional team is to discuss the focus and effectiveness of current institutional efforts to recruit and retain underrepresented minority students in engineering/materials science at both the undergraduate and graduate levels. A team representative should be identified who will summarize the discussion at the 1:30 pm Closing/Next Steps session on Saturday.

SATURDAY, NOVEMBER 19

AM
8:00 Breakfast Buffet

8:30 Plenary Session: Review of Day One and Overview of Day Two
8:45  What to Ask/Expect of Your Mentor
Panel: Annie Weathers, Doctoral Student, Mechanical Engineering
The University of Texas at Austin
Ibraheem Muhammad, Doctoral Student, Mechanical Engineering
North Carolina A&T State University
Gilda Barabino, Professor and Associate Chair of Graduate Studies
Department of Biomedical Engineering, Georgia Institute of Technology

Intended Outcome: A candid discussion of mentoring experiences by each Panelist and
Potential Strategies for Maximizing Benefits from the Mentoring Relationship

9:30  Concurrent Sessions on Career Pathways in Engineering (Repeat of Day One Sessions)
{Guest speaker, 15-20 minutes; discussion of topics, 55-60 minutes}

Group I: Engineering/Materials Science Careers in Academe
Speaker: Tequila Harris, Georgia Institute of Technology, and QEM Consultant
Discussion Facilitators: Garrick Louis, University of Virginia and QEM Consultant, and
Muhammad Dawood, Assistant Professor
Klipsch School of Electrical and Computer Engineering
New Mexico State University

Topics:
-Post-doctoral appointments
-Research; NSF’s BRIGE/CAREER Programs
-ERC and MRSEC opportunities
-Publishing; Portfolio Development
-Promotion and Tenure Process
-Balancing Research and Teaching

Group II: Engineering/Materials Science Careers in the Government
Speaker: James Turner, Director, Office of International Affairs and Senior Advisor to the
National Oceanic and Atmospheric Administration (NOAA) Administrator
U. S. Department of Commerce

Discussion Facilitators: Stephanie Adams, Virginia Polytechnic Institute and State University
(Virginia Tech) and QEM Consultant
Shamsuddin Ilias, Professor, Department of Chemical Engineering
North Carolina A&T State University

Topics:
-Post-doctoral appointments
-Program Officers; Rotators; other Civil Service Opportunities
-Bridging Engineering and Public policy
-National Research Laboratories

Group III: Engineering/Materials Science Careers in Industry
Speaker: Percy Pierre, Michigan State University, and QEM Consultant
Discussion Facilitators: Monica Cox, Purdue University and QEM Consultant, and
Gerson Beauchamp, Professor
Department of Electrical and Computer Engineering
University of Puerto Rico at Mayaguez

Topics:
-Industry Partnerships/SBIR/IIP Program
-Entrepreneurship
- Research and Development/Engineering Project Management
- R&D Portfolio Development
- International Collaborations

10:45  *Coffee Break*

11:00  **Concurrent Sessions on Career Pathways in Engineering (Repeat of Day One Sessions)**

{Guest speaker, 15-20 minutes; discussion of topics, 55-60 minutes}

**Group I:** Engineering/Materials Science Careers in Academe  
**Speaker:** Sheldon Weinbaum, Emeritus CUNY Distinguished Professor  
Biomedical and Mechanical Engineering, City College of New York  
**Discussion Facilitators:** Monica Cox, Purdue University, and QEM Consultant  
Gregory Murphy, Associate Professor and Chair  
Department of Electrical Engineering, Tuskegee University

**Topics:**
- Post-doctoral appointments  
- Research; NSF’s BRIGE/CAREER Programs  
- ERC and MRSEC opportunities  
- Publishing; Portfolio Development  
- Promotion and Tenure Process  
- Balancing Research and Teaching

**Group II:** Engineering/Materials Science Careers in the Government  
**Speaker:** Stephanie Adams, Virginia Tech and QEM Consultant  
**Discussion Facilitators:** J. Arthur Jones, Senior Associate, QEM Network, and  
Norman Munroe, Associate Professor  
Department of Mechanical and Materials Engineering  
Florida International University

**Topics:**
- Post-doctoral appointments  
- Program Officers; Rotators; other Civil Service Opportunities  
- Bridging Engineering and Public policy  
- National Research Laboratories

**Group III:** Engineering/Materials Science Careers in Industry  
**Speaker:** Arturo Bronson, University of Texas at El Paso and QEM Consultant  
**Discussion Facilitators:** Lijun Qian, Associate Professor  
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Marc Karam, Associate Professor  
Department of Electrical Engineering, Tuskegee University

**Topics:**
- Industry Partnerships/SBIR/IIP Program  
- Entrepreneurship  
- Research and Development/Engineering Project Management  
- R&D Portfolio Development  
- International Collaborations

**PM**  
12:30  *Working Luncheon – Meeting the Challenges and Opportunities*

**Introduction of Speaker:** Althea Burns, Associate and Conference Coordinator, QEM Network  
**Keynote Speaker:** Eugene DeLoatch, Dean, School of Engineering, Morgan State University
1:30  **Closing Plenary Session**
Institutional Team Representatives summarize key points from Overnight Discussion of the Focus and Effectiveness of Current Institutional Efforts to Broaden Participation in Engineering/Materials Science at the Undergraduate and Graduate Levels

2:45  **Reflections and Closing Comments**

3:00  **Adjournment**
Appendix B – List of Workshop Participants

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<table>
<thead>
<tr>
<th>Name</th>
<th>Role</th>
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