

AC 2009-1641: BRIDGES TO ENGINEERING RESEARCH 2020: A NATIONAL WORKSHOP FOR ENGINEERING RESEARCH PARTNERSHIPS

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Bridges to Engineering Research 2020: A National Workshop for Engineering Research Partnerships

ABSTRACT

This paper reports on a very successful workshop held in March 2009 at North Carolina A&T State University under the sponsorship of the National Science Foundation (NSF). The workshop sought to address the building of meaningful bridges among minority institutions and research-intensive universities in the United States, in emerging areas of engineering research. This was the first such workshop that the NSF has sponsored under the initiative of diversity in engineering research. The 205 attendees represented 56 universities and 15 corporations; 62 faculty and administrators from minority institutions and 66 faculty and administrators from majority universities attended and participated in the workshop. The workshop included 3 plenary talks by two provosts of leading universities and the head of the Engineering Directorate at NSF. The program also included presentations on successful research partnerships in six areas, four panel discussions (with Deans and Associate Deans as panelists) addressing K-14 education relevant to research, research partnerships, research at minority institutions, and industry partnerships. This paper reports on the planning, conduct, and important outcomes of this workshop.

PLANNING FOR THE WORKSHOP

Planning for the workshop began immediately after the workshop sponsorship award was received from the National Science Foundation in August 2007. The following committees outlined in the proposal were constituted: Arrangements Committee, Technical Committee, Report Committee, Invitees and Publicity Committee, and Conference Operations Committee. The members chosen for these committees were administrators, faculty, and staff drawn from the College of Engineering and the Division of Research. A website (<http://www.eng.ncat.edu/event/NSF2008/nsf2008.htm>) was also set up for the workshop.

VENUE

The venue for the main events in the program were a set of four buildings on the campus of NCA&T. The buildings were chosen to enable the participants to see the students and researchers at NCA&T in their usual setting; this was further enabled by the fact that classes were in session at the time of the workshop. The luncheon was arranged in a large cafeteria catering to students, again to enable the participants to see the student population.

The housing for the participants, the reception, and banquet was arranged in the Proximity Hotel in Greensboro, NC. This hotel is currently one the top five American green buildings and was built to get the US Green Building Council (USGBC) Leadership in Energy and Environmental Design (LEED) platinum rating. This hotel was chosen to reflect the futuristic vision for research partnerships that this workshop sought to provide.

PROGRAM

The final program largely resembled the program outlined in the proposal to the National Science Foundation. The main elements were: three plenary talks by eminent engineers: Dr. Kristina Johnson, Provost at Johns Hopkins University, Dr. Priscilla Nelson, Provost at New Jersey Institute of Technology, and Dr. Richard Buckius, Assistant Director of National Science Foundation's Engineering Directorate. Ms. Chineta Davis, a Vice President at Northrup Grumman was the luncheon speaker, and Dr. Carlo Montemagno, Dean of College of Engineering at University of Cincinnati was the dinner banquet speaker. A video recording of the plenary talks is available from the Workshop organizers at NCA&T.

Six technical tracks in Advanced Materials & Nanotechnology (two tracks due to significant interest in this area and the strength of NCA&T in this area), Energy & Environment, Modeling & Simulation, Sensors, and Transportation & Healthcare. Thanks to the efforts of Dr. Mary Juhas, Program Director for Diversity & Outreach at National Science Foundation, each of the 105 minute tracks had a presentation from one National Science Foundation Division Director with responsibility for an area with some relevance to the track. The participation of the Division Director was organized for the mutual benefit of the workshop attendees and the Division Directors. The slides for most of the presentations is available from the Workshop organizers at NCA&T.

A laboratory tour and poster presentation to showcase the equipment and accomplishments of several Historically Black Colleges (HBCUs) was included in the program. Some of the HBCUs had virtual tours via presentations on computers while NCA&T had tours of selected laboratories. A video recording of the poster presentations is available from the Workshop organizers at NCA&T.

Another important element in program was a set of four panel discussions with panelists drawn from the administration of both majority and HBCU schools. The four topics addressed were: Engineering Research Landscape at HBCUs, Industry-University Engineering Research Partnerships, Inter-university Engineering Research Partnerships, and Human-Capital for Engineering Research – the K-16 Context. A summary of the panel discussion is included in Appendix. In addition a video recording of the panel discussion is available from the Workshop organizers at NCA&T.

A complete list of abstracts and biographies for the plenary talks, technical sessions, poster session, and panel discussion are available from the authors.

Three brainstorming sessions were organized to address the following issues: Industry-University Engineering Research Partnerships, Inter-university Engineering Research Partnerships, and Human-Capital for Engineering Research – the K-16 Context. A summary of these sessions is included in Appendix.

ATTENDEES AND PARTICIPANTS

The participants were primarily invited by the organizers; a small number attended or participated in the workshop after finding out about it. The invitees included

administrators at majority universities and HBCUs: provosts, Deans, and Associate Deans. Two provosts were invited to deliver plenary talks. Deans and Associate Deans were invited to participate in the panel discussions. The number of Deans who attended the workshop represent only about 10% of those contacted. Faculty members from majority universities and HBCUs were invited to present at the technical sessions and in a few instances to attend the sessions. Some of the invited faculty and their students also participated in the poster sessions. As the host university, a large number of faculty members and graduate students from NCA&T attended and participated in the workshop. Another group of invitees were corporate research personnel; included in this group were national corporations and a few small regional research corporations. Personnel from National Science Foundation, a few state of North Carolina organizations, and department of defense formed the representation from Federal and State agencies.

Table 1 provides data on the affiliations of the attendees by category. Table 2 shows the gender mix of the attendees. Table 3, 4, and 5 provides lists of universities, corporations, and federal/state agencies, respectively, represented among the attendees. Table 6 provides the list of administrators and senior personnel among the attendees.

Table 1. Attendees by Category

HBCU/ MI Faculty	Majority Univ. Faculty	HBCU /MI Admin	Majority Univ. Admin.	Federal & State Reps	Students	Corp. Reps	Staff	TOTAL
48	43	14	23	14	34	21	8	205

Table 2. Attendees by Gender

Cat.	Participants		Attendees		TOTAL	
	Male	Female	Male	Female	Male	Female
Number	102	31	53	19	155	50
%age	77	23	74	26	76	24

Table 4. Large Corporations Represented among Attendees

	Corporation		Corporation		Corporation
1	ADVAERO Technologies, Inc	6	Lockheed Martin	11	Northrop Grumman
2	Cummins, Inc.	7	Lotus Engineering Inc.	12	The Boeing Company
3	General Motors Corporation	8	Materials Innovation Technologies	13	VX Aerospace Corporation
4	HDR Architecture, Inc.	9	Medtronic	14	Wal-Mart Stores, Inc.
5	*IEEE	10	nCoat, Inc.	15	Xerox Corporation

Table 3. Universities Represented among Attendees

	University		University		University
1	Alabama A&M University	20	North Carolina State University	39	University of Dayton
2	Alabama State University	21	Northwestern University	40	University of Florida
3	Arizona State University	22	Old Dominion University	41	University of Illinois at Urbana-Champaign
4	Auburn University	23	Penn State University	42	University of Maryland
5	Carnegie Mellon University	24	Prairie View A&M University	43	University of Massachusetts Amherst
6	Duke University	25	Purdue University	44	University of Minnesota
7	East Carolina University	26	Rensselaer Polytechnic Institute	45	University of New Hampshire
8	Edmonds Community College	27	Rutgers University	46	University of North Carolina at Charlotte
9	FAMU-FSU	28	Southern University	47	University of Notre Dame
10	Florida International University	29	Texas A&M University	48	University of Pittsburgh
11	Georgia Tech	30	The Johns Hopkins University	49	University of Puerto Rico - Mayaguez
12	Hampton University	31	The Ohio State University	50	University of South Florida
13	Howard University	32	Tuskegee University	51	University of Utah
14	Michigan State University	33	University of Alabama at Birmingham	52	University of Wisconsin-Madison
15	Missouri University of Science & Engineering Management and Systems	34	University of Arkansas	53	Villanova University
16	Morgan State University	35	University of Buffalo	54	Virginia Tech
17	New Jersey Institute of Technology	36	University of California at San Diego	55	Wake Forest University
18	North Carolina A&T State University	37	University of Central Florida	56	Winston Salem state university
19	North Carolina Central University	38	University of Cincinnati		

Table 5. State / Federal Agencies Represented among Attendees

	Agency		Agency		Agency
1	Air Force Institute of Technology	3	Oak Ridge National Laboratory	5	North Carolina Community College System
2	National Science Foundation	4	US Army Research Office	6	Guilford County Schools

Table 6. Administrators and Senior Personnel Represented among Attendees

Name	Affiliation	Name	Affiliation
Dr. Eyad H Abed	University of Maryland	Dr. Shield B Lin	Prairie View A&M University
Dean Ilesanmi Adesida	University of Illinois at Nano-CEMMS	Dr. Michael Lovell	University of Pittsburgh
Dr. William A Baeslack	The Ohio State University	Mr. Matthew Meyer	North Carolina Community College Systems
Dr. Ragu Venkataramanan	Purdue University	Dean Habib P Mohamadian	Southern University
Dr. Rajan Batta	University of Buffalo	Dean Joseph Monroe	North Carolina A&T State University
Dr. Harvey Borovetz	University of Pittsburgh	Dean Carlo Montemagno	University of Cincinnati
Mr. Greg Bowers	ADVAERO Technologies, Inc	Dean Trent V Montgomery	Alabama A&M University
Dr. Richard O. Buckius	National Science Foundation	Dr. Bryant M Moore	Medtronic
Mr. Christopher Bronson	Guilford County Schools	Dr. Jerrilee Mosier	Edmonds Community College
Mr. Paul Clayson	nCoat, Inc.	Dr. Kesh S Narayanan	National Science Foundation
Dr. William Craft	North Carolina A&T State University	Dr. Nat C Nataraj	Villanova University
Ms. Chineta Davis	Northrop Grumman Corporation	Provost Priscilla P Nelson	New Jersey Institute of Technology
Dean. Eugene M. DeLoatch	Morgan State University	Dr. Alfonso Ortega	Villanova University
Mr. Dennis M Elking	The Boeing Company	Mr. Manuel Peace	General Motors Corporation
Dr. Joycelyn S. Harrison	National Science Foundation	Dr N Radhakrishnan	NC A&T State University
Dean Gerald D Holder	University of Pittsburgh	Dr. Judy A Raper	National Science Foundation
Ms. Gwen Jackson	Lockheed Martin	Dr. Sohi Rastegar	National Science Foundation
Dr. Shaik Jeelani	Tuskegee University	Mr. George W Reynolds	Northrop Grumman Corporation
Provost Kristina M Johnson	The Johns Hopkins University	Mr. Geoff Sease	Wal-Mart Stores, Inc.
Dean Robert E. Johnson	UNC Charlotte	Dr. Allen Soyster	National Science Foundation
Mr. Andy Jones	Xerox Corporation	Ms. Sonya V. Stewart	Lockheed Martin
Ms. Lisa E Jones	The Boeing Company	Mr. Jim Stike	Materials Innovation Technologies
Mr. Raymond Jones	VX Aerospace Corporation	Dr Usha Varshney	National Science Foundation
Dr. Mary C Juhas	National Science Foundation	Dr. Gregory Washington	The Ohio State University
Mr. Ronald B. Lannan	Cummins, Inc.	Dr. Alan R Wiechman	The Boeing Company

FEEDBACK FROM ATTENDEES AND PARTICIPANTS

A survey was administered to the participants. The response rate was about 15%. A summary of the feedback received is provided in Tables 7, 8, 9, and 10. Tables 7 and 8 provide summaries of feedback from the program events on Day 1 and Day 2 of the workshop, respectively. Table 9 provides the summary of feedback on the entire workshop and Table 10 summarizes the written responses received.

Table 7. Feedback for Day1 Program

March 13, 2008	Excellent	Very Good	Satisfactory	Not Satisfactory	Did Not Attend
Plenary Session I: Look Ahead from leaders Engineering 2020 -	22	5	1	-	2
Technical Session: Advanced Materials & Nanotechnology I	9	6	2	-	10
Technical Session: Sensors	4	6	2	1	11
Technical Session: Transportation & Healthcare	3	4	2	1	11
Technical Session: Advanced Materials & Nanotechnology II	7	6	1	-	10
Technical Session: Energy & Environment	3	4		1	12
Technical Session: Modeling & Simulation	4	5	2	1	11
Plenary Session II: Look Ahead from leaders Engineering 2020 -	15	10	1	-	4
Panel Discussion: Engineering Research Landscape at HBCUs & MIs	12	12	6	-	-
Panel Discussion: Industry - University Engineering Research Partnerships 2020 - Potential and Challenges	13	10	5	1	1
Panel Discussion: Inter - University Engineering Research Partnerships 2020 - Potential and Challenges	15	8	3	-	1

Table 8. Feedback for Day 2 Program

March 14, 2008	Excellent	Very Good	Satisfactory	Not Satisfactory	Did Not Attend
Plenary Session III: Engineering Research and Education Perspectives for FY09	14	14	-	-	1
Panel Discussion: Human-Capital for Engineering Research - 2020 - The K-16 Context	16	11	-	-	1
Guided Brainstorming: Construction Plan for the Interchanges	12	7	3	1	3
Summary of Group Brainstorming and Discussion	7	6	2	-	1

Table 9. Feedback for Entire Workshop

	Excellent	Good	Needs Improvement
Objectives of the Workshop were met	18	8	1
Well Organized	13	11	3
AV Materials/handouts	18	7	1
EVENING FUNCTIONS			
Reception (3/12)	19	4	1
Banquet (3/13)	21	5	-
MEALS/BREAKS	14	9	1
HOTEL	23	2	-

Table 10. Written Comments

- Need more time for break-out sessions (and separate room for each group within each area)
- Improve microphone adjustment (feedback) - Make sure that animations work
- Well planned, well organized, great sessions. Did not understand much but learned a lot.
- Excellent conference
- Objectives of workshop not clear. Did not see connection between many presentations and state objective of Bridge in education. For a workshop, there wasn't much work. We were mostly talked to. Still not clear, what product really was. Tried to schedule too tightly. Poor scheduling.
- Very well organized. Technical sessions could be shorten and assign more time to panel discussions.
- Looking at waste elimination in the workshop would improve things. Start on time, do not delay for everyone to show up. It will get things started in subsequent sessions sooner. Use more paralleled sessions if you need extra time.
- Water for the speaker during presentations. More control on schedule.
- Great Work.
- This feedback could have been carried out periodically. After sometimes it is difficult to remember every event.
- Providing of list of attendees would be appreciated along with contact information (e-mail address, tel. no.)
- We would like to get copies presenters materials (hard copy of power point presentation or electronic files)
- A little too much packed into Thursday, non-stop and did not allow time for questions and additional comments. We should have assigned actions along the way to ensure positive results from this meeting.
- The workshop was very beneficial and extremely well organized. The content could have been spread over three days.. Keep things moving
- Stay on schedule.
- Some of the panel discussions were a bit dry, needed some excitement to get things moving a bit. Not enough time allocated for brainstorming.

LESSONS LEARNED

Overall Bridges to Engineering Research 2020 was a successful conference facilitating networking and engagement of minority-serving institutions and research-intensive universities in the US. The positive aspects of the conference include the ability to provide a venue for researchers, administrators, and industry to view the capabilities of HBCU/MSI institutions such as NCA&T. Participants indicated that the panel discussions, breakout sessions, and presentations were informative and rewarding.

The success of the conference can be attributed to the early planning efforts by the conference team and the faculty/staff who were involved in organizing the event. NCA&T is fortunate to have an administrative unit within the Division of Academic Affairs which specializes in facilitating and coordinating conferences. This unit played a large part in creating the on-line registration, leading transportation, hotel, and facilities

logistics, and management of the conference administrative areas. The Division of Research & Economic Development Director, Vice Chancellor for Research Dr. N. Radhakrishnan and his staff invested substantial effort to make sure that the conference would be successful. The College of Engineering faculty team, in particular, Dean Monroe, Dr. Bala Ram, Dr. Diana Vass, Dr. Stephanie Luster-Teasley, Dr. Christopher Doss, and the Dean's staff were instrumental in organizing the content and securing additionally funding for event activities. Weekly planning meetings and individual workgroups were used to develop the agenda.

One of the largest challenges for the conference was time management. The complete agenda included six technical research tracts; NCA&T laboratory tours; a poster session; virtual tours of other HBCU/MSI; four panel discussions; and three brainstorming sessions. The agenda could have been improved by limiting the number of conference activities and providing additional free time between sessions. The schedule of planned events was too condensed for a 2-day conference. The number of activities could have been reduced thus providing additional time for conference participants to network between presentations, panels, tours, conference activities, and to ask questions following presentations, panel discussions, and breakout sessions.

NEXT STEPS

The principal investigators will undertake to do the following:

1. Present the experiences of this workshop at an appropriate conference in the near future.
2. Disseminate the video recording of the plenary talks and panel discussions held at the workshop to the Deans who were contacted but could not attend the workshop.

APPENDIX 1: PANEL DISCUSSION SUMMARY

Note: This is only a brief synopsis of the panel discussions; please contact the workshop organizers for a video recording of the panel discussions.

Panel: Engineering Research Landscape at Historically Black Universities and Minority Serving Institutions

Moderator: Leonard Uitenham, Chair, Department of Mechanical & Chemical Engineering, North Carolina A&T State University

Panelists: Shaik Jeelani, Tuskegee University Samuel Awoniyi, FAMU-FSU College of Engineering Clay Gloster, Howard University Shield B. Lin, Interim Associate Dean, Prairie View A&M University, Habib P. Mohamadian, Southern University, V. Trent Montgomery, Alabama A&M University.

Broader landscape in the US shows the United States is falling behind in the number of PhDs in the STEM fields. HBCU and MSIs serve an important role in increasing the number of minorities in these areas. This panel discussed the efforts conducted at HBCUs and MSIs. What are the activities occurring on MI and HBCUs to increase the number of students in STEM?

- Colleges and Universities Represented by the panel: Howard University, Prairie View A&M, Florida A&M, Tuskegee, Southern University at Baton Rouge, Alabama A&M
- The HBCUs and MSIs are aggressively pushing research, collaborations, proposals, and the formation of Centers. They are also focusing on producing high quality research.
- Research conducted at Howard: School of Medicine is the flagship for research geared for human genome, gene and protein sequencing, Engineering research includes the CREST Nanotechnology Center, Mobile Lab for Nanotechnology, Physics – NOAA Center for weather prediction modeling, Reconfiguring Computing
- Research conducted at Prairie View: Data Communication/Signal Processing, Army Battlefield Center for Communication, New PhD program, SPACE radiation center from NASA which may lead to a Crest, Sensors research
- Research conducted at Florida A&M: Engineering research includes Materials and Robotics; Centers Power Systems; Composite Manufacturing
- Research conducted at Tuskegee: Research in all five colleges; Engineering research for Environmental, Robotics, Microelectronics, Sensors, Advanced Materials
- Research conducted at Southern: The research focuses on several strategic research areas. Examples include Material Science and Engineering, Composite Materials, Structures, Civil, Electrical Engineering, Energy, Center for Environmental Engineering, Sensors,
- Research conducted at Alabama A&M: Microelectronics, Nano-electronics, Sensors, SBIR, FTR
- The HBCUs and MSIs are working toward building their research infrastructure and PhD programs.

Panel: Industry-University Engineering research Partnerships

Moderators: Paul Stanfield, Chair, Department of Industrial & Systems Engineering, North Carolina A&T State University and George Reynolds, Northrop Grumman

Panelists: James H. Aylor, University of Virginia William "Bud" Baeslack III, Ohio State University Michael Lovell, Associate Dean for Research, University of Pittsburgh Manuel Peace, General Motors Alan Wiechman The Boeing Co. Greg Shultz , Wal-Mart Paul Clayson, nCoat Inc. James E. Stike, Materials Innovation Technology

- Ohio State and Ohio is active in industry; One of the first ERC programs; Comprehensive partnerships are necessary (ex. with Honda – schools pay a role in research, cost sharing, day to day solutions for practical problems); Faculty/Student Teams working with Industry, and Industry working directly with University; NSBE Jr Chapters,
- Following trends which need benchmark research to push the technology. Multiple methods need to be used to work with companies for success; NSF provides a good template for forming partnerships with companies; Master Research Agreements signed for 5 years at a time and only re-negotiate the scope of work and agreements on a case by case basis is necessary
- IDS Aerospace area research money is primarily provided to the larger companies (Lockhead, SBIRs help facilitate fostering long term partnerships; there are concerns with IP and industry needs to funnel money to foster Universities
- Prototyping, research, and testing are needed to help companies. Statement of work and legal issues help to negotiate work that can be done between Industry and Universities. If companies are able to use research for profit in the company this becomes an issue where the University should also benefit.
- Key is to have a defined project with defined time lines due to the slower pace in academia compared to industry.
- Small start-up companies benefit from SBIR and working with Universities. Treat the company like they are the “customer” for the University which lead to a good collaboration
- “Think Win Win” opportunities for new trends in society (ex. gasoline, energy crisis) where Universities can complete the research projects. Interaction between industry and university can lead to students working with the company upon graduation.
- Universities are legally bound to not give away their intellectual property for free.
- Companies have excess money that can be accessed for research
- Emerging Companies need to pay attention the bottom line, increase franchise value, handle ownership for research funded by Companies prior to work.
- Universities may need to consider creating the best value and market themselves.

Panel: Inter-University Engineering Research Partnerships

Moderators: Jagannathan Sankar, Distinguished University Professor, North Carolina A&T State University Gregory Washington, Associate Dean for Research, Ohio State University

Panelists: Ilesanmi Adesida, University of Illinois - Urbana Champaign V. Ragu Balakrishnan, Associate Dean of Engineering for Research, Purdue University Gerald D.

Holder, University of Pittsburgh Rajan Batta, Associate Dean for Graduate Education, State University of New York at Buffalo Richard Benson, Virginia Polytechnic Institute and State University Robert Johnson, UNC – Charlotte.

How partnerships are formed between universities for research?

What successes have your institutions had with working with other universities?

- Pittsburgh: Inter-University partnerships provide international opportunities and a partnership with NCA&T resulted in the submission of an ERC. Collaborations have increased diversity in Pittsburgh
- Illinois: Has an initiative to form partnerships with institutions such as NCA&T and Clark Atlanta. The key is to form equal partnerships for research, education, and student exchange. Find the right partner and form a team.
- Purdue: Partnerships need to form a relationship and history such as faculty exchanges and student summer research experiences. A collaboration has to be organically there and not formed only as part of a response to a proposal announcement.
- VA Tech: Partnerships for researchers who have relationships work for long term success. This builds the foundation for future work. One project in particular at VA Tech uses the mixing of teams from US, Mexico, China, and Germany to build diversity and working across the universities to bring people together.
- SUNY Buffalo: Interdisciplinary faculty helps with building partnerships
- UNC-Charlotte: Research Centers have provided opportunities for researchers across the world to come to UNC-Charlotte for research partnerships. Recommends NSF to consider expanding the GOALI program to exchange faculty.

Panel: Human-Capital for Engineering Research 202 the K-16 context

Moderators: Devdas Pai, Associate Director, Center for Advanced Materials & Smart Structures, North Carolina A&T State University Eyad H. Abed, Director, Institute for Systems Research, University of Maryland

Panelists: H. Borovetz, Chair, Bioengineering, University of Pittsburgh Eugene DeLoatch, Morgan State University Jerilee Mosier, Vice President, Workforce Development and Training Edmonds Community College Ralph Rogers, East Carolina University Matthew Meyer, Director, NC BioNetwork, North Carolina Community College System Christopher Bronson, Guilford County Schools

- Pittsburgh: There is a health revolution which is about to occur for which we need a workforce. Focus on biology as a critical science. Forward thinking to introduce Bioengineering Departments in Engineering schools.
- Enmundson: Partnerships with public schools and universities are key to integrating core topics into science education. Two year degree programs which focus on the core competencies needed for specific industries. Summer camps for middle school and high schools to increase interest in STEM. More partnerships are needed with 4-year universities. Minorities and women provide a rich pool for the workforce that need to have strong partnerships between Engineering programs and community colleges.

- NC-Community Colleges (BioNetwork): P – 16 work to make sure students and parent understand options for education. Science needs to be integrated into education from early education. Associate degrees are viable options for students interested in bio-based careers. There is a need to modernize how we educate students. Focusing on novel education methods (ex. 3-D virtual environments) as opposed to lecture and traditional labs.
- Morgan State: HBCUs provide a foundation for which a number of successful African American scientists and engineers have had opportunities for STEM education that they may not have received without these institutions. HBCUs are critical in the education of minorities. Access and opportunities need to be available for all students to become scientists and engineers. HBCUs should be considered a vital partner in collaborations. Deans in Maryland have discussed establishing a 2-year program at the community college level that can transfer into 4-year college.
- Guilford County: K-12 education reform for inquiry and unguided exploration in the classroom. Engage, Explore, Explain, Elaborate, Evaluate is a motto that is being integrated in classes. Engineering as a discipline needs to be introduced to families as something exciting as opposed to something fearful because of the science and math courses. Families and students need to be in contact with engineers in the classroom to show that any student can consider engineering in their future. Robotics programs with K-12 and introducing engineering to middle school students.
- East Carolina: One-on-One discussions with students to make them interested in Engineering as something they want to do in their future. Show students what they can do as an Engineer.
- MESSA is a model that appears to be very good for K-16 education. This program identifies students who have high STEM capabilities and provide extra STEM based activities.

APPENDIX 2: GUIDED BRAINSTORMING SESSION SUMMARY

Partnerships with K-14 Education in STEM disciplines

Opportunities:

- Larger pool of students
- Better prepared students
- Potential for diffusion of university course content to K-12 students and teachers
- Appropriate graduate program for K-12 teachers

Barriers:

- Rewards for K-14 involvement by engineering faculty
- Engineering college rankings are linked to graduate education not undergraduate education
- Engineering degree is not currently a pathway to K-12 teaching
- K-12 teachers are constrained by mandated curriculum and extensive assessment
- Student awareness of engineering
 - Looking for role models
 - Understanding opportunities
- Student perception of engineering is boring
- Negative university perception of community colleges
- Physical accessibility

Recommendations:

- Formalize relationships between community colleges and engineering schools
 - Faculty exchanges
 - NSF supplements for community college/ engineering faculty exchanges
- Advertise societal impact of engineering research to make it more appealing
- Improve reward system to strengthen recruitment into engineering
- Generate public interest in engineering through the mass media:
 - TV shows
 - Gaming industry
 - Competitions with industry support
- Formal arrangements for students to return to high school to teach a K-12 class
- Create master's degree for K-12 teacher that emphasizes developments in engineering
- Seek certification of engineering undergraduates to teach K-12 classes
- Joint programs between NSF and professional societies to make engineering profession more visible
- Federal (NSF?) programs for research-appropriate after-school activities
- Federal (NSF?) program to initiate national discourse on engineering "life"
 - National marketing
 - Drive: "Engineering is Fun"
 - Prepare national roadmap
 - Gather stories from present mentors, living legends

Engineering Research Partnerships among universities

Potential:

- Increase diversity of student and faculty participation in research
- Access to research resources such as special equipment, especially for HBCU/MI faculty
- Access to researchers at HBCU/MI , especially for major research institutions

Barriers:

- Location / Professional separation
- Lack of familiarity with HBCU/MI environments
- Promotion and tenure metrics do not encourage such collaborations
- HBCU/MI students are not adequately prepared for research

Recommendations:

- Summer research experience for student/faculty teams from HBCU/MIs
- Seminars by major research institution faculty at HBCU/MI campuses
- Workshops for formal exchanges among faculty from HBCU/MI and major research institutions
- Formalize sub-meetings similar to “Bridges to Engineering Research Workshop” as a part of larger professional meetings
- A webpage (“facebook”) for researchers

Engineering Research Partnerships between universities and industry

Potential:

- Collaborations can establish better industry-university relationships
- Workforce training

Barriers:

- Differing calendars
- Intellectual property and legal issues
- Communication

Recommendations:

- Use university for training
- Industry can provide access to data
- Industry support letters: implementation, collaboration
- “Take a professor to industry day” and vice versa
- University and Industry can together present the engineering profession to K-12