A Qualitative Look at African American Students' Perceptions of Developing Engineer of 2020 Traits Through Non-curricular Activities

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Introduction and Motivation

The National Academy of Engineering's publication *The Engineer of 2020: Visions of Engineering in the New Century* identifies 10 attributes necessary for engineering graduates: (1) strong analytical skills; (2) practical ingenuity (skill in planning, combining, and adapting); (3) creativity; (4) communication skills; (5) principles of business and management; (6) principles of leadership; (7) high ethical standards; (8) professionalism; (9) dynamism, agility, resilience, flexibility (the ability to learn new things quickly and apply knowledge to new problems) and (10) lifelong learning[1]. The development of these traits is becoming increasingly important for training engineering students nationwide in that these traits help students persist and excel in their chosen engineering disciplines. At the same time, full curricula and the rising cost of education have placed pressure on institutions to reduce the credits needed for an engineering degree. As such, there is not enough space in the curriculum to that ensure all the necessary learning occurs in the classroom. In addition, there is little understanding as to how out-of-classroom experiences might be critical sources of learning for engineering undergraduates. Shrinking budgets are worsening the problem as institutions now find themselves in a constant struggle to maintain their diversity efforts.

The results of our prior qualitative work suggest that participation in Black Greek-lettered organizations positively influences the educational experiences[2] and supports the development of *Engineer of 2020* traits in African American students[3]. We therefore launched a project focused on students and alumni who participated in at least one of the following types of organizations: Black Greek-lettered Organizations (BGOs), Minority in Engineering Programs (MEPs), and the National Society of Black Engineers (NSBE).

Our prior quantitative research results[4] show that African American engineers perceive their participation in NSBE, BGO, and MEPs as supportive of the development of six of the ten *Engineer of 2020* traits: strong analytical skills, communication, business and management, leadership, professionalism, and ethical standards. Respondents found that the implications of the development of these skills include increased job preparation and self-directed learning. We now turn to qualitative methods in order to gain a greater depth of understanding of how African American students construct meaning between their participation in NSBE, BGOs and MEPs and their development of the *Engineer of 2020* traits. A qualitative approach allows us to collect data about specific incidences contributing to trait development in participants' own words.

Research Questions

Our work addresses the following research questions: (1) How does participation in NSBE, BGOs, and MEPs contribute to African American student and alumni development of the attributes of the *Engineer of 2020*, and what are the unique

contributions of each?

Methodology

We used a constructivist grounded theory methodology[5] in collecting and analyzing the data for this study. Grounded theory has been described as "a way of thinking about data with the intent to conceptualize it"[6].

Sampling and Participants

We selected prospective participants utilizing stratified, purposive sampling from a database (N = 290) of students and alumni who completed an initial questionnaire/survey[4]. The following strata were used for the initial round of sampling:
1. African American students and alumni who attended predominantly White institutions (PWIs) as undergraduates.
2. participation in the three non-curricular activities (BGOs, MEPs, NSBE)
3. reported scores related to overall connection between involvement and development of *Engineer of 2020* traits; that is, responses indicating that their involvement had an influence on development of *Engineer of 2020* traits at a level of medium, high, or very high influence on a Likert scale of no influence to very high influence.

The first group of potential participants were involved in all three activities at predominantly White institutions and had overall scores of three or higher. Of the 25 identified prospective participants from our database, four participated in semi-structured interviews. As part of the first round of theoretical sampling, an additional participant (P5) who did not participate in NSBE during his undergraduate years was included, for a total of five participants (see Theoretical Sampling section). This sampling strategy yielded participants that were engaged in a variety of professional roles as summarized in Table 1. Some participants were still enrolled in engineering study as graduate students, while others had earned their B.S. degrees in engineering many years ago.

Data Collection

The first author (Julie) conducted the semi-structured critical incident interviews[7-10] via video phone calls. Interviews lasted approximately one hour, and all participants received a $25 Amazon.com card for their participation. We utilized a semi-structured interview guide exploring the connections between participants' involvement in NSBE, BGOs and MEPs and their perceptions of if and how their participation contributed to developing of *Engineer of 2020* traits. Interviews were audio recorded and professionally transcribed verbatim. The data corpus consisted of approximately ten hours of digital interview recordings and 130 pages of transcript data. Additionally, we used a form focusing on the timeline of each participant's involvement in various organizations.

Table 1.

Summary of Participants

	MEP	BGO	NSBE	Years since UG graduation	Current role
P1 (Male)	x	x	x	18	Professional: university professor
P2 (Male)	x	x	x	27	Professional: non-profit organization
P3 (Female)	x	x	x	1	Graduate Student
P4 (Female)	x	x	x	19	Professional: operations consulting
P5* (Male)	x	x		4	Graduate student

Note: *Participant P5 was included as part of the theoretical sampling described later

Participants were asked about their school experiences prior to entering college; in particular, we asked about their decision to attend college and how they first developed an interest in engineering. We asked about their transition into the college environment and specifically their experiences as an engineering student throughout their undergraduate years. We discussed each *Engineer of 2020* trait and asked participants if their participation in one of the three types of organizations helped them to develop that particular trait; if the participant responded positively, we asked them to give a specific example (a critical incident).

Reflexivity

Following the lead of Pawley and Phillips[11] in maintaining transparency and reflexive engagement of the researchers as instruments[12] that occurs during interpretive research, we offer the following reflections regarding our backgrounds, "conceptual baggage"[13] and insights related to this research.

Julie's career vision is to be a national catalyst for increasing the diversity of students in engineering, and to help all students—particularly those who are underrepresented— achieve their academic, professional and personal goals. She is a faculty member at a predominantly White institution, where she has taught large-enrollment freshman and sophomore level engineering courses. In her previous position at a diverse institution, she was the founding women-in-engineering program director and director of recruitment and retention. Her student affairs and teaching experience, combined with her research expertise built on her career goals gives Julie a unique perspective on underrepresented students' experiences. Starting the project, she had concerns about whether the study participants would accept her commitment to diversity as genuine because she is a White woman. She was also concerned about the possibility that participants may not be completely forthcoming in their responses to her questions about topics

dealing with their experiences as African American students at predominantly White institutions. One way the project team dealt with this was to include photos of Julie and Stephanie in the invitation to participate in an interview, along with some text below each picture describing their motivations for conducting the research and their relevant experiences. We also included a sentence about how Julie and Stephanie met in 2007 and had been colleagues and friends ever since. We hoped this would ensure that no one was caught off guard by Julie's race during the video interviews. Admittedly, conducting interviews for this project has at times been a challenge for Julie as a White person. Throughout the interviewing process, she continually debriefed with Stephanie and Stacey about ways to word certain questions so that they were not perceived as overly intrusive and to ensure that her knowledge of the structural and cultural elements of BGOs and NSBE were sufficient to ask relevant follow-up questions.

Stacey has experience as a student affairs professional and member of a Black, Greek-lettered organization at predominantly White institutions. It was important to Stacey to document her thoughts and beliefs about the participants' experience that came from assumptions she made based her own experiences in order to separate them or find evidence of them in the data collected. As a result of her experiences living on campus and managing campus housing, we pursued lines of inquiry with participants that explored how their housing arrangements influenced their college experience. Stacey also has experience as an undergraduate member of a BGO and was able to interpret responses from participants and provide reasoning for additional questions related to the BGO connection to *Engineer of 2020* traits. Her experiences as a student and professional at PWIs framed the context of the Black student experience that we used to analyze the data. Throughout conversations with Julie and memo writing through the analysis, Stacey was able to articulate the perspective from which she was reviewing the data.

Stephanie has a keen understanding of and familiarity with the process of educating all students but especially those from underrepresented populations. As an undergraduate, she attended a predominantly White institution and was a recipient of the services her local MEP Office provided, but ultimately graduated from an HBCU. As a student, she was elected to the national executive board of NSBE and presently serves on the National Advisory Board. She is a lifetime member of the organization. She is also a lifetime member of a BGO and has been a member for over 20 years. Additionally, she has served on the Advisory/Executive Board for a number of organizations committed to improving diversity in STEM (i.e. NSBE, WEPAN, the National Consortium Graduate Degrees for Minorities in Engineering and Science (GEM)). Stephanie been instrumental in providing context and clarification for this project as we seek to understand and interpret the results.

Jamora is a peer mentor in the MEP at a predominantly White institution. She used her personal experiences to relate to the participants, and also memoed about the differences she saw in participants' experiences compared to those of her own. Jamora and Julie met regularly during the memo writing and coding process to discuss Jamora's observations from the data and develop conclusions. Jamora also contributed to the project by developing follow-up questions for the each participant based on their initial interviews. Julie used these questions, among others, when she interviewed participants for a second time.

Analysis

Grounded Theory

Stacey conducted the data analysis utilizing the grounded theory approach[5] outlined by Charmaz. This inductive approach included the following steps 1) initial review of transcripts for general understanding, 2) line-by-line coding for cross-comparison, 3) identifying common experiences for initial themes, 4) supplementary review of transcripts for confirmation of themes and development of a proposed model/initial theory, and 5) memo-writing to acknowledge the ideas and thoughts related to the context of the experiences of the participants. While we have listed the steps in grounded theory here, this was a non-linear process that involved comparing statements within and between interviews and checking one's ideas with the data.[5]

Throughout the interviewing and analysis process, Julie and Stacey met regularly to discuss interpretations, salient themes and theoretical gaps in understanding. Periodic peer debriefing with the Stephanie helped hone the wording of interview questions, better understand participant responses and provide additional context for the developing themes. After analysis of the first four transcripts, we created an initial model to describe the connections between involvement and development of *Engineer of 2020* traits.

A Priori Coding

Jamora used deductive coding based upon the framework of Cultural Perspective on Student Departure[14]. The codes were based on major tenets of the theory: 1) cultural meaning-making system, 2) relationship between cultures of origin and college attendance, 3) cultures of origin as cultural capital, 4) relationship between cultures of origin and cultures of immersion, 5) cultural distance, 6) time spent in cultures of origin, 7) socio-cultural connections to academic programs and affinity groups, and 8) belonging to cultural enclaves. The code "high school transitions" emerged during analysis and three codes related to cultures of origin as cultural capital, relationship between cultures of origin and cultures of immersion, and time spent in cultures of origin did not present significant findings. The results of the *a priori* coding informed the second round of participant interviews and aided in the grounded theory analysis.

Theoretical Sampling

As we identified theoretical holes in our first version of the model, the original four participants were invited for a second, follow-up interview during which common and individualized questions were asked. We created an individual interview guide for each participant based on his or her responses during the first interview. The interview guides for the second round of interviews included clarification questions and questions that addressed gaps in the connections to trait development. In particular, we noticed that in the first round of interviews, connections between BGOs and MEPs and the *Engineer of 2020* traits were weak in comparison to connections made to NSBE participation. Participants with high levels of NSBE involvement, primarily referred to NSBE when answering questions about the traits. Thus, we engaged in follow-up interviews with some of the initial participants to more directly explore the

connections to BGO and MEP experiences, asking participants to specifically think about their BGO and MEP experiences and any connections they could make to the traits.

Additionally, because the initial interview questions were not designed to be chronological in nature, we asked each participant to complete a questionnaire that specifically outlined the timeline and level of involvement in these and other organizations to ensure that our interpretations of the chronology of the transcript data were accurate. Other follow-up questions included participants' reasons for engaging in ethnic-specific organizations, how participants were introduced to the organizations and to the minority student community, if/how they viewed their housing situation as influencing their undergraduate experiences, and how their involvement with MEPs, BGOs and NSBE compared to their involvement in the larger campus community.

In addition to follow-up interviews with the original four participants, we included an interview conducted with one participant who did not report being a member of NSBE. So much of our data in the initial round of interviews related to the NSBE organization that we felt it was necessary to include a participant who was not a NSBE member in our initial model. As a result of the theoretical sampling and follow-up interviews, we were able to make more direct connections between the timeline of experiences and understand how our participants initially became involved with MEPs, BGOs and NSBE. Additionally, we were able to better understand that the process of developing these traits happened over time throughout the college experience. We created a preliminary model using grounded theory analysis of our current dataset consisting of eight interviews with five participants and the involvement timelines completed by participants, as well as the *a priori* coding analysis.

Preliminary Model Based on Results to Date

Figure 1 depicts our preliminary model, which is a synthesis of verbatim data, coding, and memo writing[5]. Charmaz says that "diagrams allow you to see the relative power, scope and direction of categories in your analysis as well as the connections among them"[5]. We consider the model presented here to be preliminary in nature, as we have yet to reach theoretical saturation. The model is not meant to be exhaustive of all possible student experiences. African American students have the opportunity to connect with other African American students through university- or department-sponsored events or general peer interactions that are not covered in our model.

Students move through the model left to right over the span of time of their undergraduate experience. We learned through our interviews that Black students had two entry points into their undergraduate experience: participation in a MEP-sponsored summer bridge/transition program (Entry Point #1) and traditional access (Entry Point #2). According to participants, MEP summer bridge programs served as an introduction to college life prior to the start of their first academic year. These bridge programs provided opportunities for participants to meet other minority students, stay in residence halls and take class for credit during the summer before their freshman year. We have interpreted MEPs as a gateway or introduction to the Black/minority student community at PWIs.

Some of our interview participants did not attend summer bridge programs; these students described entering their college experience via Entry Point #2. Those entering via traditional access still had access to MEP activities, and described being introduced to minority-serving organizations (including NSBE and BGOs) through organization fairs when they first arrived on campus (e.g. during orientation). Additionally, some interviewees indicated that they already knew about BGOs prior to entering college due to familial or community involvement.
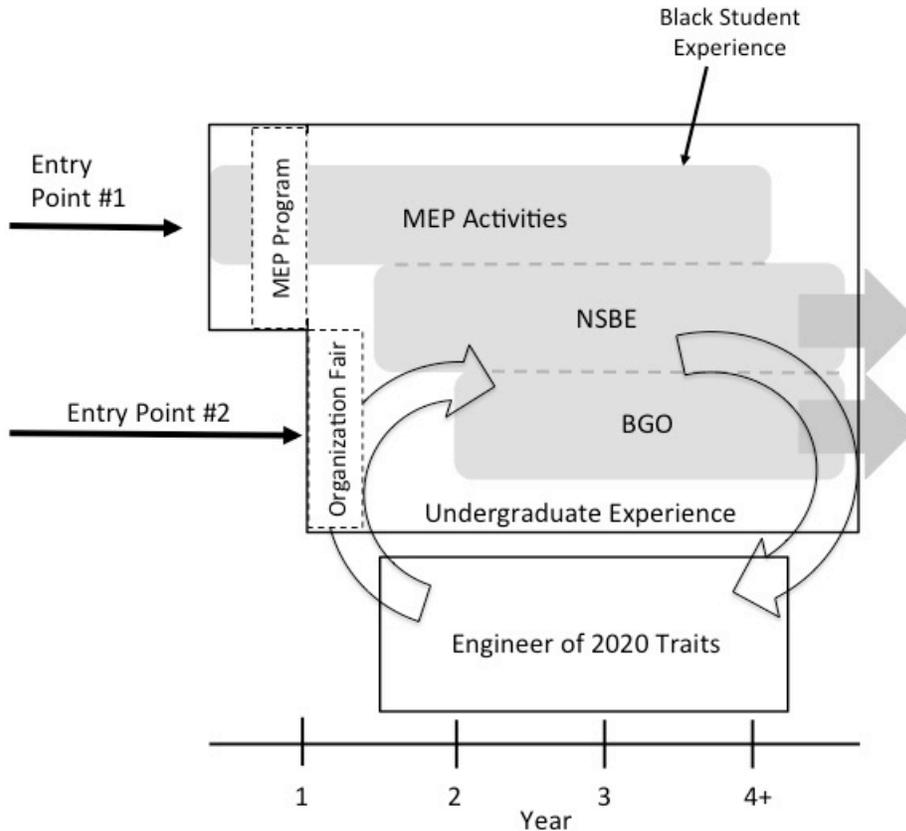
Figure 1. Preliminary model of African American involvement in MEPs, NSBE and BGOs at predominantly White institutions

Participants described MEPs, NSBE and BGOs as serving the purpose of connecting them to Black, upper-division students and other students of color. Participant responses indicated that their involvement in NSBE and BGOs resulted in a cyclical relationship between these non-curricular activities and the development of *Engineer of 2020* traits. The arrows following NSBE and BGO represent the potential for continued organizational involvement upon completion of the undergraduate degree.

The non-curricular experiences in our model occurred within the Black/minority student community, or the "Black student experience." We define the Black student experience in this context as interactions between Black students and students of color within a predominantly White setting. Guiffrida acknowledges that minority student organizations assist with the social integration of minority students at PWIs by helping students find a place in the larger context[15].

Thompson and Fretz highlight that African American students generate a sense of identity as a result of group membership with other African Americans[16]. The Black student experience is seen in this research study through the social and educational experiences as separate from, but situated within, the majority student experience.

Interview results revealed that students joined the three types of organizations for different reasons and participated at different levels. Some students served as mentors in the same MEP-sponsored bridge programs that led them to college. Some students served as local, regional, and national officers for NSBE or their BGO. The boxes highlighting those organizations are staggered along the time continuum to highlight the different timing of participation. The MEP involvement could start prior to enrollment or any time during the undergraduate experience. Generally, participation in a MEP waned as graduation approached, but was confined to the college years. NSBE membership could start at any point beginning in the student's first year and the level of involvement generally evolved over time to higher levels. In contrast, BGOs have strict membership eligibility guidelines. Our participants primarily joined after a BGO their first year and their levels of involvement varied over time. NSBE and BGOs are structured to promote and allow for membership and service long past the undergraduate experience. This is represented by the arrows at the end of those boxes in Figure 1.

The development of *Engineer of 2020* traits occurred in a cyclical manner of involvement in MEPs, NSBE, and BGOs over time. Membership in these non-curricular activities facilitated trait development and as different traits were enhanced, participants utilized them in their activities, which furthered the development of the same or different traits. We see that *Engineer of 2020* traits were developed in varying ways. Charmaz advocates for visually organizing data, including the use of charts to help "tease out relationships" while constructing analyses and to "demonstrate these relationships in … completed works"[5]. Table 2 highlights the connections participants made between involvement and trait development as interpreted and summarized by the researchers.

Table 2. *Engineer of 2020 traits developed via involvement in NSBE, BGOs and MEPs*

Engineer of 2020 Trait	NSBE involvement	BGO involvement	MEP involvement
Strong analytical skills	-Consideration for various stakeholders when planning events	-Planning events	-Provide academic and emotional support to persist in skill development
Practical ingenuity	-Adapting to changes while executing events	-Adapting to new expectations -Quick thinking and response during events when something unpredicted happens	-Preparation for different things and confidence to handle it was provided
	Utilizing resources and synthesizing their application to use in multiple settings -Multiple participants blended their experiences from different organizations when citing examples of development		
Creativity	-Thinking outside of the box to find ways to move the organization forward	-Finding new ways to deliver information and keep an audience engaged	-No examples provided
Communication skills	-Written and oral skills developed for use with different target audiences	-Leading and interacting with peers effectively -Resolving conflicts with peers within the organization	-Breaking down barriers in order to build relationships
Principles of business and management	-Hands-on experience running a business as a chapter, regional, or national officer	-Learning how to execute the tasks to meet the priorities established by a higher ranking officer	-Appropriate management of resources
Principles of leadership	-Training workshops developed officers to develop members	-Running meetings efficiently -Representing the organization positively in the campus environment	-When leading peers, finding the balance between leader and friend
High ethical standards	-Bring trustworthy enough to manage the finances of the organization; being accountable	-Being a good representative of what the organization stands for -Being mindful of one's own reputation and impact on the organization	-Received training around this topic, in order to manage the business of the organization
Professionalism	-Participants attended workshops specifically on this topic including presentation of self and first impressions	-Executing events and practicing the skills and tips learned in the classroom	-Follow through on commitments and high quality events
Dynamism, agility, resilience, flexibility	-Learning my current, cutting edge information from conferences than the classroom -Making connections between projects and adapting lessons learned for new problems as a practitioner, but lesson learned in NSBE	-Making connections between experiences to current life situations -Finding motivation to push through tough situations	-No examples provided
Lifelong learning	-Continued improvement as a leader through additional officer responsibilities -Being around others that were continuing their education providing motivation to do the same	-In order to provide relevant quality events, you may have to teach yourself about the concept in order to host an event around that topic	-Exposure and encouragement to participate in research activities

Implications for Practice

When considering the application of these results, we feel that university administrators and faculty members have an opportunity for increased partnerships in support of these non-curricular activities. These activities are enhanced when faculty and staff members cross the divisional barriers that often prevent collaboration. For example, MEP-sponsored summer programs serve as an entry point for Black students in this model. If MEPs housed in Academic Affairs were to partner with admission counselors, marketing for those programs could reach students as they prepare to attend college. Additionally, faculty members can suggest participation in MEP activities as a way to build leadership skills and give back to the community through mentoring or tutoring younger students.

MEPs, NSBE chapters and BGO chapters are separate entities, usually with oversight from very separate areas of campus. However, students experience college in its entirety not in silos of activities and classroom experiences. The connections between Academic Affairs and Student Affairs can support the Black student experience. Black students will find their way into a cultural enclave in order to find the community with a community at PWIs. If practitioners can meet students where they are, the academic and social development will be enhanced. Cross-references between academic resources (MEPs and NSBE) from staff members and social resources (BGOs) from faculty members will encourage students to participate in these non-curricular activities. Participation will then aid in the development of the *Engineer of 2020* traits.

The goal of this research study is to provide a data-driven model to practitioners that can be used to support and advise Black students at predominantly White institutions. Non-curricular activities (MEPs, NSBE, and BGOs) contribute to the development of *Engineer of 2020* traits in African American students. Our future work will include further refinement of the model as our study reaches theoretical saturation. Additionally, we have begun to interview students that participated in non-curricular activities and attended a Historically Black College or University in order to compare and contrast the experiences of African American students in different college settings.

Acknowledgments

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