

A Systems Engineering Approach to Managing Engineering Student Retention Efforts at a HBCU

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Abstract— the pipeline for minority engineers has seen some recent growth, but remains narrow, especially when compared to the increasing need for engineers in the current U.S. workforce. The demand for engineers in America has increased in recent years, with President Obama in 2011, calling for increasing the number of engineers graduated by 10,000 per year. In 2010, NSF reported that minorities made up only 31 percent of the U.S. engineering and science workforce, with African Americans accounting for only 5 percent of the workforce whilst accounting for 13 percent of the population. According to ASEE, only 4.3% of all Engineering Bachelors' degrees in 2013 were awarded to African American students. As a result of this disparity in the representation of minorities in the engineering workforce there have been several initiatives and programs that have been funded by government and private sources to address these needs.

A recent study done by the American Society for Engineering Education (ASEE) cataloged several strategies and practices for retaining engineering and technology students in American universities, however, none of the institutions were a Historically Black Colleges and Universities (HBCU). HBCU institutions face different types of obstacles to majority institutions, and whilst the strategies and practices are helpful, there is no way of knowing whether or not they are transferrable to an HBCU environment. HBCU institutions have employed several programs and strategies in order to improve retention and persistence, and to increase graduation rates of engineering students for years, however, there is little evidence systematic approach to the management of the efforts in order to streamline the efforts and maximize their effects.

This paper addresses the differences between the factors affecting retention at HBCU and majority institutions, and provides a framework for developing a systems engineering approach to managing retention efforts at a HBCU institution.

Index Terms—HBCU, underrepresented minority student, student retention, STEM education, systems engineering.

September 3rd, 2014.

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I. BACKGROUND

A. Definition of terms

Retention Rate: the percentage of first-time, full-time students who remained enrolled at the same institution in subsequent fall semesters [4].

Graduation Rate: the percentage of students who remained and graduated from the campus at which they initially enrolled, as well as those who transferred to and then graduated from any of the four-year colleges or universities, including independent institutions within six years of initial enrollment [4].

Sustainability: the ability of a system to successfully withstand the test of time.

B. Introduction

Studies show that the demand for professionals in Science Technology Engineering and Mathematics (STEM) fields is increasing, with a projected increase of 11.35% [1]. Here in the U.S., the jobs of the future are STEM and the demand for professionals in STEM fields is projected to outpace the supply of trained workers and professionals, with a recent federal report estimating that there will be one million fewer STEM graduates than will be needed by U.S. industries over the next decade [2]. To this end, the U.S. government has dedicated itself to providing funding to assist with attaining these goals.

Minority engineers remain underrepresented in the engineering workforce, accounting for only 31 percent of the U.S. engineering workforce in 2010 [3]. When further investigating the minority population, African Americans accounted for only 5% of the engineering and science workforce in 2010 [3]. Furthermore, the percentage of Bachelor's degrees awarded to African Americans in engineering majors showed decline between 2005 and 2011, with African Americans only representing 4.2% of awarded Bachelor's degrees in 2011, as compared to 5.3% in 2005.

The demand for engineers is increasing; the government has identified this and is providing increased funding and initiatives to create more engineers, yet African Americans make up only

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4.2% of awarded undergraduate degrees, whilst accounting for 13% of the U.S. population [3]. There have been numerous studies that have provided different approaches to the STEM minority conundrum yet it remains clear that minorities remain underrepresented in the U.S. engineering workforce. The literature, though replete with research regarding factors affecting minority student retention, and with programs and initiatives that can be used to address the low retention, is lacking in engineering approaches to the issue. Additionally, there currently little discussion regarding the sustainability of retention programs and initiatives. With the proliferation of retention programs and initiatives (RPAI's) it is imperative that across an institution, these RPAI's are effectively managed in such a way that they are sustainable. This means that the retention management at the institution should be able to define success for the RPAI's, should be able to identify key aspects or emphases of the RPAI's and should be able to readily retrieve information regarding historical data of the RPAI's.

This paper will address the differences between retention factors at majority institutions and a Historically Black College and University (HBCU), and will suggest a framework for the efficient management of the retention efforts at an HBCU.

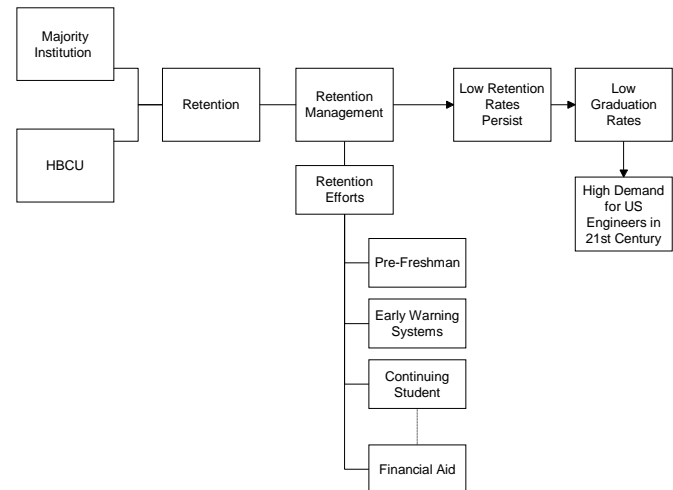
II. PROBLEM DEFINITION

There is an increasing demand for engineers and a concurrent decreasing output of African American engineers. The U.S. government recognizes this and has provided all institutions, including HBCU's with the opportunity to receive funding for retention programs and initiatives. How can these programs and initiatives be effectively managed at an HBCU to maximize their effectiveness?

III. CURRENT RETENTION ENVIRONMENT

The current environment in Retention, as depicted in Figure 1, shows that low retention rates leads to low graduation rates, which feed in to a high demand for U.S. engineers. Both majority institutions and HBCU's employ retention efforts such as pre-freshman programs, the use of early warning systems, continuing student programs and financial aid programs amongst others. However, despite the resources being placed into the RPAI's, the low retention rates persist at both majority institutions and HBCU's. As discussed earlier, African Americans are severely underrepresented in engineering, and thus provide the potential for great growth in terms of engineering student retention and graduation. Consequently, the choice was made to focus on the African American demographic and more specifically, an HBCU, in order to capture an environment where the student population was largely representative of African American students.

Figure 1. Current Retention Environment



A. Retention Management

Currently retention is often viewed as a collaborative and on-going process between different departments at an institution, but there is little research and application regarding the identification of the retention environment at a HBCU as a system and the subsequent analysis of the system's inputs, outputs and key contributors. Though there has been significant research in the field of student retention over the past 40 years, the practice of the research leaves many RPAI's as add-ons to existing university activity instead of being integrated with the mainstream of institutional academic life [5]. Though there is much data in the art regarding the relative merits and implementation of individual RPAI's, there is little discussion regarding the management of these RPAI's by the institution.

B. Retention Programs and Initiatives

A study conducted by the American Society for Engineering Education (ASEE) on the best practices for retaining engineering students highlighted three key areas of retention; namely student-focused, faculty-focused and institutional and departmental-focused RPAI's [6]. The RPAI's ranged from student research/work experience to student programs and financial aid, institutional/educational research and change in institutional/departmental policy and faculty development. The literature mentioned RPAI's focusing on faculty training and student preparation for graduate school the least [6]. The ASEE report, however, was devoid of HBCU's. According to Tinto, this approach lacks complexity since by drawing studies of largely residential universities and students of majority backgrounds, the experiences of students in other types of institutions and students of different races, ethnicities and incomes are largely ignored [5].

Students at HBCU's typically have very different academic backgrounds to students at majority institutions, typically entering the institutions with lower standardized test scores. In Maryland, the average SAT score (math and critical reading) of entering freshmen students for the years 2012-

2013 for the majority institutions was 1125 as compared to 888 for the HBCU's. This different level of college readiness affects the type of RPAI's that can be done at many HBCU's since the RPAI's must cater to the institution's demographic in order to be successful. RPAI's cannot simply be copied from majority institutions to HBCU's, but there must instead be careful analysis of the RPAI's to determine whether their emphases are congruent with the demographic of an HBCU and if not, if and how the emphases can be shifted to address the HBCU demographic.

IV. IN-PROGRESS WORK

This paper represents an in-progress research study that has two main points of emphasis; Retention Management and a Retention Management System (RMS), and Retention Practices and Initiatives.

A. Retention Management and Retention Management System

Currently research is being done to accurately define the Retention Management environment at the HBCU. This involves the application of Systems Engineering to gathering an understanding of the roles and relationships played by all the components of the Retention Management efforts at the HBCU, and the creation and analysis of a system involving these components. As depicted in Figure 2, the Systems Development Lifecycle is heavily dependent on input from stakeholders in order to provide an understanding of the problem or basis to be addressed by the system. In our specific case, Joint Application Design (JAD) sessions are being held with representatives of all of the stakeholders of the HBCU's retention environment. This includes meeting with students, faculty, administrators, program coordinators and sponsors in order to determine if and how they interact with each other to provide RPAI's at the institution.

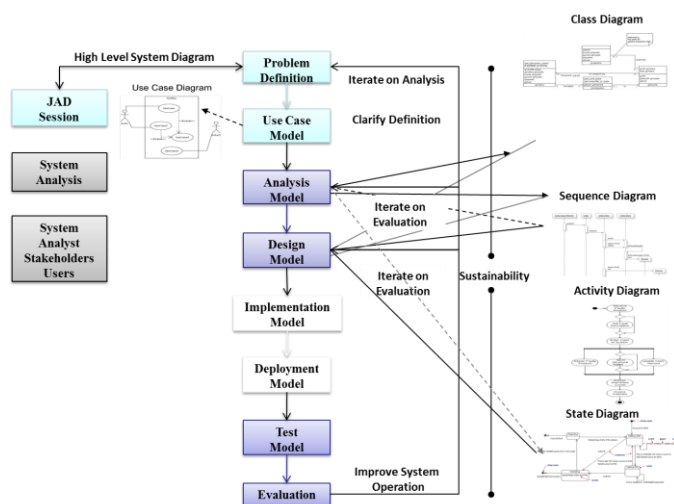


Figure 2. System Development Lifecycle

Once the Retention Management Analysis Model has been created, it will provide guidance for the creation of the RMS. We envision the RMS as a framework and complete set of

formal requirements analysis for a system that is able to be integrated with existing student management and informational systems at the HBCU. The goal of the RMS is to provide the Retention Management Office at the HBCU with a tool that simplifies the task of tracking all the RPAI's at the institution, and uses integration with existing student management to provide indications of success or failure of the RPAI's for each student. The RMS will also proactively suggest different RPAI's for students based on correlations between student information and historical data regarding the effectiveness or lack thereof of the RPAI's.

B. Retention Practices and Initiatives

Research is also currently being performed with respect to the cataloging of the RPAI's at the HBCU. Through qualitative methods, the JAD sessions are also being utilized to determine the major emphases of each of the RPAI's, and the RPAI's are then qualitatively being assessed on their effectiveness by using student achievement as a predictor of success. The major emphases are analyzed where they occur in different RPAI's in order to determine best practices for their implementations. This analysis is being used as inputs to the RMS in order to provide matching of students' to RPAI's.

V. CONCLUSION

Though the research is still in progress, the literature clearly shows that there is an underrepresentation of an already underrepresented population. Namely, there is little data about actual implementation and management of the implementation of best practices in retention at HBCU's.

VI. FUTURE WORK

After the completion of the testing and evaluating of the RMS, the actual native coding of a software application will be undertaken. This will move the RMS from a formal specification language such as the Z Specification Language to an actually coded software program using an object-oriented programming language such as Java.

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