AC 2012-5525: THE CONTINUATION OF THE MINORITY OUTREACH EFFORTS OF THE CULTIVATING ADOLESCENTS IN SYSTEMS ENGINEERING HABITS (CASH) PROGRAM

Dr. Carl White, Morgan State University

In 1987, Carl White joined Morgan State University's School of Engineering in Baltimore, Md., as an Assistant Professor. He is currently the Associate Dean for Research and Development and Graduate/Professional programs, as well as a Full Professor in the Department of Electrical Engineering. White has more than 10 years of experience in the management of funded research, both technical and educational. White's most recent award was from NASA's University Research Center program to establish the Center of Excellence in Systems Engineering for Space Exploration Technologies. As the Associate Dean for Morgan State University's School of Engineering, White's primary tasks are to provide support for the research endeavors conducted by faculty and associate researchers within the School of Engineering, to oversee the quality of the graduate program offerings and to manage recruitment and retention programs in order to establish and sustain a pipeline of quality engineering graduate students and research professionals.

Mr. Clifton Sean Martin, Innovative STEM Foundation and Bluford Drew Jemison STEM Academy

The Dean of STEM and Academic Programs at Bluford Drew Jemison (BDJ) STEM Academy is Clifton Martin, who received his bachelor's of science degree and master's of science degree in electrical engineering from Morgan State University and is presently working on his doctorate degree in STEM education. Martin has worked at NASA Goddard Space Flight Center and the Nuclear Regulatory Commission (NRC) as a Power System Engineer. He has taught high school mathematics in the Baltimore City Public School System as well as mathematics at several colleges and universities. Just before coming to BDJ, Martin worked for the Maryland State Department of Education as a Regional Coordinator for Career and Technology Education, where he assisted many local school systems with their implementation and management of pre-engineering and technology programs. Martin is also the President and a founding member of the Innovative System Foundation (ISF). This non-profit organization is dedicated to increasing the number of under-represented minorities in the STEM pipeline.

Mr. Givon Forbes, Innovative STEM Foundation

Givon Forbes is the Communications Ofcer for the Innovative STEM Foundation (ISF). He is currently an engineering major at Morgan State University's School of Engineering. He graduated from the Science and Technology program at Eleanor Roosevelt High School in Prince George's County, Md.

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Charles Clark is a senior in the Industrial and System Engineering program at Morgan State University with a focus on engineering education. Clark serves as the Director of the Academic Training Management Organization (ATMO), an engineering education research and service center. Clark also serves as the night time director of a pre-freshman accelerated curriculum in engineering program called "PACE" in the summer.

Mr. Joseph White, Innovative STEM Foundation

Joseph White is the Outreach Director for the Innovative STEM Foundation (ISF), where he is responsible for working with principals and teachers to create, develop, implement, and sustain STEM programs for students in grades 3-12. He develops partnerships with scientists, professors, engineers, inventors and corporate companies to create internships and field study opportunities.

Mr. Albert Edward Sweets Jr., iSTEMS

Albert Edward Sweets, Jr., is a Senior Engineer/Scientist with 15 years of experience and increasing responsibility in high volume Electronic Manufacturing Service (EMS), development, and customer environments. He has several leadership experiences that include 21 years of Military Service (honorably discharged), being an Entrepreneur Lead Engineer, and being an educator. He has a broad engineering

background that encompasses project engineering, process engineering, test engineering, quality engineering/assurance, customer satisfaction, design/development, engineering education, and project management. Sweets has successfully project managed more than 100 worldwide projects/programs that resulted in meeting customer requirements, industry announcements, more than $100 million in savings, and more than $1 billion in revenue. He matrix managed a team of more than 200 engineers in nine different countries. He has excellent interpersonal skills and is highly motivated, flexible, an effective communicator, goal oriented, and skilled in team building.

The Continuation of the Minority Outreach Efforts of the Cultivating Adolescents in Systems Engineering Habits (CASH) Program

Rationale

America's need to increase the numbers of quality STEM (Science, Technology, Engineering, and Mathematics) professionals that it produces has become more critical with each passing year. If the country is unable to adequately address this problem, then it runs the risk of losing its status as an innovation center of the world and as a global technological leader in the international arena.

In addition to increasing the production of U.S. citizens attaining STEM degrees, there is also a need for diversifying the STEM industry. There is a startling lack of diversity represented amongst the country's STEM professionals. According to the most recent U.S. Census, African-Americans, Hispanic Americans, and Native Americans, as a whole, comprise more than a quarter of the U.S. population; however, statistics from the National Science Foundation (NSF) show that they earn just 15% of the bachelor degrees, 10% of the master's degrees, and 5% of the doctorate degrees in science and engineering. The U.S. STEM pipeline has been shrinking over the past 30 years, and with the looming issue of national security, it is imperative that America produces a substantial STEM workforce of U.S. citizens.

The United States' minority population, including racial minorities, women, and disabled individuals, are an untapped resource that can be used to address its issues of STEM pipeline shortage and diversity. However, these are populations that are historically underrepresented in STEM fields, so devising new methods of outreaching, preparing, and recruiting these individuals to STEM majors and careers is critically important

Program History

In 2009, the Cultivating Adolescents in Systems engineering Habits (CASH) program was formulated by the Innovative STEM Foundation (ISF). CASH was developed as an innovative, educational, and captivating STEM summer program for middle school students (Grades 6^{th} – 8^{th}). Since the program's inception, ISF has partnered with the Center of Excellence in Systems Engineering for Space Exploration Technologies (CESET) within the School of Engineering at Morgan State University in Baltimore, Maryland to offer CASH to interested students. CESET is a NASA-funded University Research Center (URC) and one of the center's goals is to offer educational programs in systems engineering. CESET has identified CASH as one of the pipeline outreach activities for students. As the program's co-sponsor, CESET provides resources in the form of system engineering expertise, undergraduate and graduate students, and funds to support several of the program's activities.

Program Format

CASH is a month long summer program for middle school students, primarily rising 7^{th} and 8^{th} grade students. As the name suggests, the program's aims to help students improve their problem

solving skills by instructing them on how systems engineers approach problems and the habits they employ when they do so.
Systems engineering was chosen as a focus for the program because it is a field of engineering that utilizes a multi-disciplinary approach to solving problems. The educational community in America is shifting towards a more integrative disciplinary approach, and the K-12 academic environments are becoming more project-based and problem-based. Focusing this program around system engineering would equip the participants with the skills and tools to be successful in this new academic environment and in their overall approach to their personal lives, as well.

During those four weeks, the students are engrossed with valuable content knowledge, as well as stimulating hands-on projects that require them to apply the lessons they have learned. Throughout the program, participants are exposed to intriguing STEM concepts, an academic research environment, and professionals in the STEM industries.

Each day is comprised of two segments, **Instruction** and **Lab**. During the **Instruction** portion of the day, students are instructed on the fundamentals of system engineering, basic critical thinking principles, financial literacy, and math reinforcement. The instructional half of the day is delivered in a traditional classroom-setting. This segment always precedes Lab, and is conducted during the first half of the day. The goal of Instruction is to ensure that students receive content knowledge, which they will be able to use in their everyday lives, as well as, apply to their projects in the Lab segment.

During the **Lab** segment, students are placed in a hands-on, out of the classroom learning environment. This portion begins after lunch when the students are more likely to have increased levels of energy and are more apt to getting out of their seats and moving around in the classroom. Participants are given interactive, hands-on projects that allow them to apply the problem-solving lessons, system engineering concepts, and systems thinking techniques that they have learned during the Instruction segment. Students are taken on field trips to local STEM institutions and research laboratories so that they can witness STEM professionals in various environments. Participants typically work in groups, and are given the opportunity to develop their team-working skills and utilize their creativity to accomplish their goals. For the past two summers, several of their hands-on activities during Lab were based on NASA's Juno mission. Juno is a five year cruise to the planet Jupiter. Important dates on the Juno mission timeline include the Launch on August 2011, its Jupiter Arrival in July 2016, and the end of the mission in October 2016. CASH created three separate phases to coincide with these dates, which will be discussed and explained in this paper.

<u>Phase 1: Pre-Launch (2010-2011)</u>

Beginning in 2010, the program partnered with the outreach division of NASA's Juno mission, which is operated by the NASA-Jet Propulsion Laboratory (JPL) in Pasadena, California. Through this partnership, hands-on projects based on the Juno mission were developed specifically for CASH participants. This gave students the feeling that they were completing projects that were relevant and had real-world applications. This proved quite helpful in trying to build student confidence and belief that they could one day join the STEM pipeline, as engineers and scientists, themselves.

Phase 1 was conducted the past two summers and prior to the launch of Juno. This Phase featured projects that were centered on exposing participants to NASA, its mission, and primarily the Juno mission. The majority of these projects allowed students to become more familiar with Juno, Jupiter, and the mission rationale. Numerous projects were based on Solar Technology and Telecommunications, two technological areas of importance in the Juno mission.

Both summers during Phase 1, students interacted with NASA-JPL scientists and engineers via a video teleconference. Participants were able to speak directly with the Juno personnel who were instrumental in the development of the mission. This was an aspect of the program that the CASH students particularly enjoyed, because they were able to video teleconference with STEM professionals in California from the other side of the country in Baltimore, Maryland.

Phase 1 culminated with a field trip to NASA Goddard where students were able to witness the live launch of the Juno mission on August 5, 2011.

Phase 2: Interplanetary Flight (2012-2016)

Phase 2 is aligned with the flight of the Juno satellite to the planet Jupiter. This will commence with the upcoming CASH program, during the summer of 2012. CASH will use mission updates to incorporate accurate, relevant information into the projects and activities, yearly.

Each cohort will be invited to return each year that they are eligible, (Grades 6^{th}-8^{th}). Using the CASH database, tracking of each participant will be conducted and efforts made for them to continually engage in other STEM experiences so that they can be retained in the STEM pipeline.

Phase 3: De-Orbit (2016-2017)

Juno is scheduled to arrive at Jupiter in July 2016, which is approximately the same time that the CASH program will start that year. The mission is scheduled to end and de-orbit into Jupiter in October 2017. There will be two summers of the CASH program during this period, which will compose Phase 3.

Phase 3 will consist of revamped projects based on the updates from the Juno satellite during its orbit of Jupiter. There will also be a comprehensive look at the program's impact through a Juno Review. All program cohorts will be invited to return for a five to seven year reunion. The original participants will likely be in college or close to college-age, and this will be a great opportunity to see whether they will, in fact, enter the STEM pipeline. This reunion will coincide with the official de-orbit of the Juno satellite.

Assessment

The CASH program has been assessed according to the impact it has had on increasing student's interest in future STEM experiences. The belief is that if students can continue to be engaged and excited about STEM-related experience, while in middle and high school, they will eventually consider pursuing STEM majors and careers.

These assessments are conducted through pre- and post- surveys administered to the program participants. Analyzing the results from these surveys serve to indicate the program's effectiveness on the students.

Conclusion

CASH has proven to be effective in increasing participants' exposure and interest in STEM. Over the last two years, based on pre- and post- program surveys, more than 85% of participants rated the overall program favorable. Around 40% of participants indicated that they are interested in being involved in future STEM-related experiences. One of the most compelling program features of the past few years has been the interaction with the Juno mission. Phase 1 of this partnership has been completed, and the following two phases will coincide with the future growth of the program.

In the future, CASH will expand to include other locations for the summer program within Baltimore City. Additionally, a Saturday program is currently in development to continue the activities, fundamentals, and concepts with the students during the academic year.

Bibliographic Information

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