

## **Developing a Pipeline for Students from Rural High Schools into Engineering Technology and Mechatronics at a Two-Year College (NSF-ATE Projects)**

### **Dr. James E. Payne, Orangeburg-Calhoun Technical College**

Jim Payne has been with Orangeburg-Calhoun Technical College for ten years after retiring from South Carolina State University as Professor of Physics and Associate Vice President for Academic Affairs. He serves as STEM Program Developer for the College and as a Principal Investigator and project manager. He is currently managing the NSF-ATE RAMP project and a Nuclear Regulatory Commission (NRC) Scholars project. He also assists with new grant development and serves as a member of the physics instructional team.

### **Dr. Linda Lawson Payne, Orangeburg-Calhoun Technical College**

After receiving an undergraduate degree in mathematics from Converse College and a masters degree and doctorate from Clemson University in experimental physics, Dr. Payne taught physics and conducted research for 20 years at South Carolina State University. She then assumed leadership for 22 years of a regional STEM center dedicated to improving K-12 education in SC. She currently works as a grant writer for Orangeburg-Calhoun Technical College, a position she has held since 2008.

### **Mr. Charles Richard Murphy, Orangeburg-Calhoun Technical College**

Richard Murphy is the program coordinator for the Electronics Engineering Technology program at Orangeburg Calhoun Technical College. He also teaches PLC programming, instrumentation, and engineering programming courses within the department. He also serves as dean of the Engineering and Advanced Manufacturing Technologies Division. With an applied science in engineering technology, he spent over 20 years in industry before accepting a position at OCtech in 2008. He is completing a Bachelor of Science in Technology Leadership through Fort Hays State University in May 2017.

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### A. Abstract:

Three NSF-ATE projects have resulted in the successful efforts by Orangeburg-Calhoun Technical College (OCtech) to develop pathways for students from rural high schools in South Carolina into post-secondary programs in STEM in the areas of engineering technology and mechatronics. Each of these awards has included as at least one objective related to establishing pathways into the STEM programs at the College. The projects included extensive collaboration and articulation agreements with K-12 systems in the region. The first project involved developing pathways utilizing dual enrollment from Project Lead the Way (PLTW) courses in the area high schools into the Engineering Technology programs at the College. The second project developed and made available alternative energy modules to both secondary schools and colleges. These modules could be incorporated into existing courses or used as components of an alternative energy course. The current project includes professional development in robotics for K-12 teachers, summer camps for middle and high school students, and the development of two courses in robotics that are curriculum components of the Middle College for high school students and the College's Mechatronics program. Resources developed include models of curriculum pathways, programs of study, Middle College programs with connections to STEM education both at the College and at the state and regional level and an e-learning platform hosted by the College to provide dissemination of the resources for K-16 instructors and students both statewide and nationally.

### B. Introduction:

Each of the NSF-ATE projects at Orangeburg-Calhoun Technical College has worked closely with other two-year colleges and with K-12 schools in the College's service area along with K12 systems throughout the state to develop and/or enhance the pipeline from K-12 into STEM programs. The first project in this series of three (*Diverse Engineering Pathways: Curriculum Innovation and Best Practice for Recruitment, Retention and Advancement of Engineering Technology Majors*) was designed to promote access to STEM careers and provide courses for under-prepared students, especially women and underrepresented minorities. Strategies included high school STEM career majors and STEM College Academies that built on national models, such as Project Lead the Way; middle school STEM exploration activities and summer camps; high school Individual Graduation Plans; program revision to include secondary and postsecondary faculty and student cooperative projects and mentoring using a technology platform for remote equipment and process diagnostics and collaboration; faculty development; and broad industry involvement in curriculum development, internships and co-op opportunities, scholarships, and Foundation support. The second project (*Curriculum Infusion: A Modular and*

*Online Approach to Train Renewable Energy Technicians and K-12 Teacher*) strove to enhance the pipeline from K-12 through the introduction of renewable energy topics including providing K-12 professional development using the alternative energy modules developed as a part of the project modules for teachers who would then implement the South Carolina Department of Education's Green Technology program. The project also developed in conjunction with the K16 partners, an articulated 2+2+2 Renewable Energy Pathway which included the renewable energy modules aggregated into both a certificate program and dual credit offerings. The information concerning both content and processes has been made available to the 16 South Carolina technical colleges and their service area high schools through the e-learning system hosted by Orangeburg-Calhoun Technical College. The current project (*Advanced Technological Education in Robotics and Automated Manufacturing Program (ATE-RAMP)*) addresses the critical need for workers with knowledge and skills in STEM subjects within the area serviced by the college to increase awareness of opportunities in STEM disciplines for women and underrepresented minorities through the development of programs and activities involving robotics and automated manufacturing. The project will enhance students entering the pipeline from K-12 by introducing opportunities for underrepresented groups to have access to programs involving robotics and automated manufacturing, providing dual-credit courses in robotics and automated manufacturing for students in grades 9-12, and expanding the course offerings in the computer engineering curriculum at OCtech to include robotics and automated manufacturing and sharing developed resources with K-12 institutions and other colleges.

### C. Results/Accomplishments

The accomplishments of each project are summarized in this section.

#### 1. *Diverse Engineering Pathways: Curriculum Innovation and Best Practice for Recruitment, Retention and Advancement of Engineering Technology Majors*

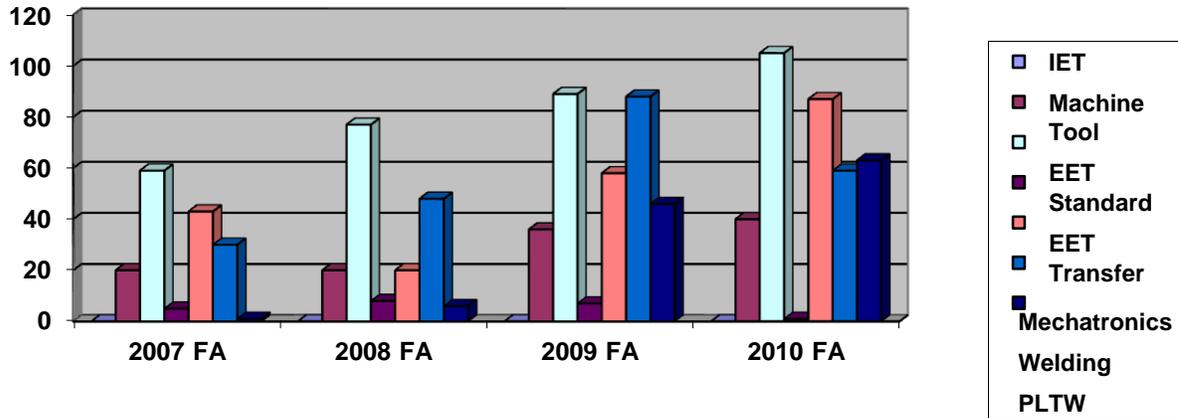
Initiatives under the Diverse Engineering Pathways Project embraced area students, K-12 teachers and guidance counselors, college faculty and neighboring employers.

Major results are:

- As a result of the Diverse Engineering Pathways there were 1353 students in area high schools who declared a STEM major on their IGP (Individual Graduation Plans), as captured by data collection and communication through database and technology tools, i.e. Palmetto Pathways Career System, Palmetto Pathways IGP System.
- Over the life of the project, approximately 180 PLTW certified K-12 and postsecondary instructors participated in one-day on-going trainings hosted by OCtech
- The Project provided professional development to 100% of area guidance counselors, career development facilitators, and principals regarding the use of the ACT World of Work map and ACT assessment system products for use in career development and college readiness.
- OCtech faculty members participated in PLTW Virtual Academy training and in the annual training activities.
- The total new enrollees in OCtech STEM programs during the project's third year reached 375 students, more than doubling baseline data and a 44% increase over the

project's prior year. This suggests that OCtech will be instrumental in increasing the pipeline of stem-ready employees.

The following graph shows the success of the project in enhancing the pipeline into STEM programs.



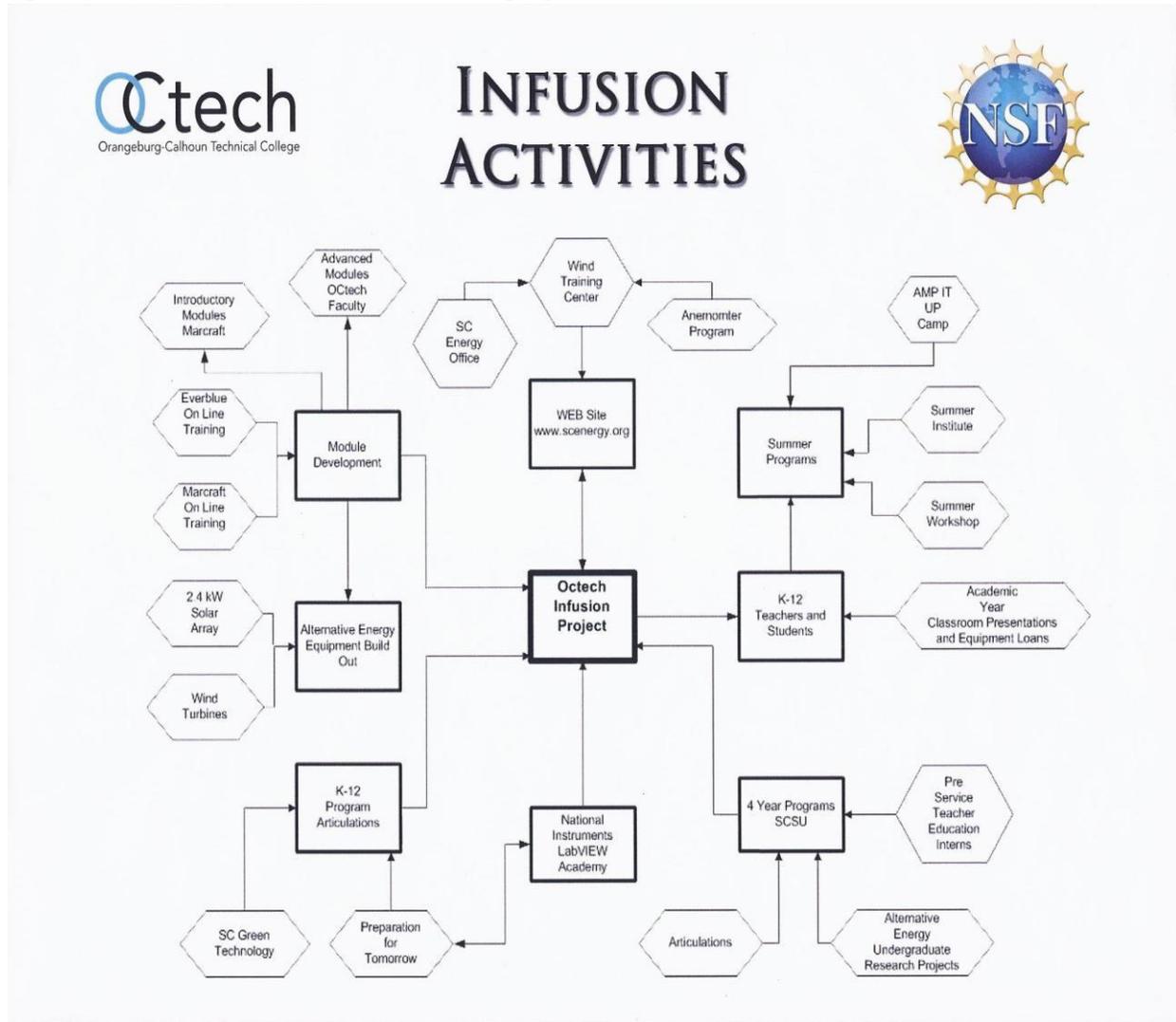
Of significance to funding agencies is the determination of “what works.” The Diverse Engineering Pathways Project has contributed to the body of knowledge about what works through the development of the Personal Pathways system for housing IGPs that will follow high school students to college. Pertaining to instructional methodology, the Project assisted all service area school districts in identifying majors (4-course sequences) in Engineering Technology, Mechatronics and other STEM area pathways, as well as Complementary Coursework and Suggested Extended Learning Activities. And, by being designated as an authorized vocational training center for North America by the FESTO Corporation and their Learning Systems Division, OCtech is recognized as a leader in preparing students for engineering and engineering-related professions.

## 2. Curriculum Infusion: A Modular and Online Approach to Train Renewable Energy Technicians and K-12 Teachers

The goal of the project was to respond to the demand for trained renewable energy technicians in South Carolina counties surrounding the institution. As a result of *Curriculum Infusion*, OCtech developed 22 renewable energy modules (with an equal or greater number of activities) for infusion into existing courses and programs at the institution and K-12. OCtech expanded the reach of the modules by making them available to individuals beyond the college's physical boundaries. Modules are housed on the OCtech Learning Management System (LMS). With that access, technical colleges can then provide the materials to high schools in their service area. Also, a high school class could be given direct access to the LMS.

Outreach, engagement and training were at the core of this project. To elevate interest in renewable energy and to enhance the pipeline from K-12, over 250 K-12 teachers and students, and college/university instructors/assistants/interns were trained in module use via professional development offerings. Over 400 students enrolled in courses where the green technology modules were pilot tested or implemented, 32.1% of whom were African American. These offerings included summer camps for K-12 teachers and students, workshops, institutes, and

academic year equipment loans. Feedback gathered from surveys unanimously conveyed appreciation from K-12 participants who used the modules with their students and for learning how to collaborate with colleagues in other disciplines when teaching about renewable energy topics. The activities associated with the project are shown below.



### 3. *Advanced Technological Education in Robotics and Automated Manufacturing Program (ATE-RAMP)*

This 3-year project is currently in its second year and has as its goal to increase awareness of opportunities in STEM disciplines for women and underrepresented minorities through the development of programs and activities involving robotics and automated manufacturing. Among the project objectives are two related to pipeline issues. These are: 1) Introduce opportunities for underrepresented groups to have access to programs involving robotics and automated manufacturing and 2) Provide dual-credit courses in robotics and automated

manufacturing for students in grades 9-12 will impact the pipeline for K-12 students into STEM programs. The project has supported summer camps for students in middle school and high school, workshops and public presentations that have reached more than 500 students in the first year. Teacher professional development workshops are held each summer to empower teachers to offer robotics options to students in middle and high school. OCtech faculty continue to provide support to the participating teachers during the school year. Two courses in robotics, AMT 105 and AMT 205, have been developed and offered in both the middle college and programs at the College. The AMT 205 also offers students in K-12 pipeline an opportunity to receive the Kuka robotics nationally recognized certification.

#### D. Dissemination

The *Engineering Pathways* project produced a model for utilizing the Project Lead the Way (PLTW) courses to provide students beginning in ninth grade a way of obtaining college credit. The model has been disseminated throughout the state and has been adopted by PLTW programs in other states. The programs were also presented at the South Carolina Education and Business Summit and at the national NSF-ATE PI conference in Washington, DC.

Through various strategies, *Curriculum Infusion* information has been disseminated via the local community newspaper, public service radio announcements, and on the college website and Facebook page. “Teaching with Energy,” an article featuring an interview with members of the *Curriculum Infusion* Leadership Team appears in the International Innovation Journal, Issue #126. Moreover, the project leadership team has participated in the annual NSF ATE national principal investigator’s conference, sharing project information during Showcases and round table discussions. Developed modules are housed within the OCtech Learning Management System and are accessible to a broad audience.

During the 2016 ATE Principal Investigators Conference (October 26 – 28, 2016 in Washington, DC, *ATE-RAMP* leadership disseminated project information to Conference attendees during the Conference’s Showcase Session. Project leadership submitted a manuscript (“Development of Hybrid Courses Utilizing Modules as an Objective in ATE Projects”) to the *Community College Journal of Research and Practice* and the manuscript has been published. The *ATE-RAMP* Leadership Team also submitted an abstract to the American Society for Engineering Education (ASEE) which has been accepted as a poster presentation at its Annual Meeting (June 2017 – Columbus, Ohio).

#### E. Acknowledgement

This paper was made possible through funds from the National Science Foundation under grant numbers DUE-1501828. Any opinions, findings, and conclusions or recommendations expressed in this paper are those of the authors and do not necessarily reflect the views of the National Science Foundation.

