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## **AC 2012-4183: ALIGNING FLORIDA'S MANUFACTURING PROGRAMS WITH EXTERNAL STANDARDS: CLOSING THE LOOPS**

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Marilyn Barger is the Principal Investigator and Executive Director of FLATE, the Florida Regional Center of Advanced Technological Education, funded by the National Science Foundation and housed at Hillsborough Community College in Tampa, Fla., since 2004. FLATE serves the state of Florida and its region and is involved in outreach and recruitment of students into technical career pathways, curriculum development and reform for secondary and post-secondary Career and Technical Education programs, and professional development for technical teachers and faculty focused on advanced technologies. She earned a B.A. in chemistry at Agnes Scott College and both a B.S. in engineering science and a Ph.D. in civil engineering (environmental) from the University of South Florida, where her research focused on membrane separation science and technologies for water purification. She has more than 20 years of experience in developing curricula for engineering and engineering technology for elementary, middle, high school, and post secondary institutions, including colleges of engineering. Barger serves on several national panels and advisory boards for technical programs, curriculum, and workforce initiatives, including the National Association of Manufacturers Educators Council. She is a registered Professional Engineer in the state of Florida, a Fellow of the American Society of Engineering Education, and a charter member of both the National Academy and the University of South Florida's Academy of Inventors (holds one licensed patent). Barger is a licensed Professional Engineer in Florida.

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Richard Gilbert is a professor of chemical and biomedical engineering at the College of Engineering at the University of South Florida. Gilbert's research interests include electric field mediated drug and gene delivery. He is an author on dozens of papers and holds more than 15 patents in this area. His interests in engineering education include a long-term NSF-funded effort to develop and standard the engineering technology degree that is now implemented by the Florida Department of Education and in use within the Florida State College System.

### **Mr. Eric Owens**

# **ALIGNING FLORIDA'S MANUFACTURING PROGRAMS WITH EXTERNAL STANDARDS – CLOSING THE LOOPS**

## **Abstract**

In 2006, the Florida Advanced Technological Education Center (FLATE) completed the design and creation of an Engineering Technology Associate of Science Degree program and in 2007, this program was installed within the Florida Department of Education and adopted by three colleges within the Florida State College System. The program of study for the degree is a traditional “one-plus-one” design with the core courses in the first year and eight specialization tracks for focused technical study in the second year. This core course of study incorporates the unique feature of being aligned to an external industry standard with credential articulated credit. Today, the degree program is offered by 10 state colleges in Florida and is still growing. It has become an award-winning national model cited as a best practice by the National Association of Manufacturers (NAM) and the national Automotive Manufacturing Technology Education Collaborative (AMTEC) for career pathways. The program’s credential-based articulation supports a variety of strongly connected pathways for students to the manufacturing workforce in Florida. With this expansion and recognition comes the expectation that the program maintain relevance to career pathways and to employers. FLATE is supported by the National Science Foundation as an Advanced Technological Education Center of Excellence, and works with its partner colleges, manufacturers, and manufacturing associations to establish the clear value of the degree to workers and validates the credential-curriculum alignment using multiple approaches.

## **Background**

The Florida Department of Education (FLDOE) delegated the Florida Advanced Technological Education (FLATE) Center to review and suggest reforms for the statewide Curriculum Frameworks which govern the content of A.S. degree curriculum. FLATE’s effort has redefined manufacturing and related curriculum in Florida at the state level. FLATE, working with FLDOE Division of Career and Adult Education, Florida community and state colleges, and Florida industries, created a new degree program in 2006, with a FLDOE assigned Classification of Instructional Program (CIP) number in 2007 (1,2). Today, this unique A.S. degree program in Engineering Technology (ET) supports eight second-year specialization tracts, 15 technical college credits, and is the only statewide 2-year degree which also articulates 15 credits toward graduation to anyone holding a Manufacturing Skills Standards Council (MSSC) nationally recognized workforce credential. The 15 technical college credits can be used by workers as credit bearing stackable credentials. They provide education and training for defined skill sets needed by employers as well as convenient “stops” along the way to an A.S. Degree. Details of the ET Degree specialization tracks, college credit certificates, as well as colleges which offer the various programs can be found on FLATE’s “Made in Florida”

web site, <http://madeinflorida.org/engineering-technology-degree/e-t-overview/> and <http://www.fl-ate.org/projects/Stackable-Credentials-Aligned-Certificates.html>. (1, 2).

### MSSC Certified Production Technician

The MSSC Certified Production Technician (MSSC-CPT) credential was developed by the same named council and grew out of the US Department of Labor efforts in the 1990's to develop a credential for manufacturing front line or entry level employees. The skill sets for a CPT are built on the industrial engineering principles and practices for production which are common to all manufacturing and production enterprises. Thus, the credential is portable and applicable to all manufacturing sectors. These foundational skills and knowledge are bundled into four broad areas common to the manufacturing sector: Manufacturing Processes & Production, Quality Practices and Measurement, Maintenance Awareness, and Safety. The skill sets are also aligned with the US Department of Labor Advanced Manufacturing Competency Model (5).

After a number of years of working with industry across the United States, the MSSC credential team developed the certification exam structure as the final step before launching the credential. The test questions were developed from critical skills identified by industry professionals. Several rounds of nationwide beta testing of the exams helped refine the final sets of questions for each of the four required certification categories. Successful completion of all four of these tests generates the CPT credential which is valid for five years, at which time every credential holder has to renew his or her credential (6).

### One-Plus-One MSSC National Certification Alignment Strategy

The premise of the ET degree's "one-plus-one" approach is to structure year-one for general education courses and a specific invariant technical "ET Core" curriculum. As suggested above, this statewide ET curriculum technical core is aligned to the nationally recognized MSSC-CPT external industry standard. FLATE, with its college partners, have crosswalked the ET A.S. degree's FLDOE Curriculum Framework standards (competencies that students enrolled in a particular program are expected to acquire) to the MSSC skill standards. The crosswalk document validates that competencies in the MSSC standards are included in the Engineering Technology degree program and that students taking the ET Core should be well prepared to successfully pass the MSSC certification tests. This crosswalk alignment document supports the basic justification for the statewide articulation agreement which provides college credit for a valid MSSC credential and is posted on the FLATE website (4).

The specific detailed knowledge and skills of a CPT are covered in five of the 6 ET Core courses. (Computer aided design is not covered in the MSSC tests, but is required in the ET Core, making the ET Core 18 hours, of which only 15 are articulated via the MSSC CPT. The remaining academic courses (those which are aligned to various MSSC standards are: electronics, instrumentation and testing, quality, safety, and manufacturing processes and materials. A student is expected to be able to pass the four CPT exams

upon completion of the “ET Core” and a CPT from anywhere in the country that matriculates into the ET degree program in any college in the Florida State College System articulates 15 credits of this 18 credit hour core.

The second year, the “plus one” year, of the ET degree program focuses on specific technical skills in various specialization tracts (24-27 credit hours), all of which build on the ET Core skills. Each of these 8 tracks have both required and elective courses. Each college is free to adopt any or all of the specialization tracts and certificates depending on their local industry needs. The current FLDOE approved specialization tracts are: Advanced Manufacturing, Advanced Technology, Alternative Energy, Biomedical Systems, Digital Design and Modeling, Electronics, Mechanical Design & Fabrication, and Quality. Two new specializations are expected to be added in 2012. Of the 10 Florida colleges that offer the Engineering Technology degree, six support multiple specialization tracts.

### The Florida Technical Education Plan

The A.S. Engineering Technology degree is part of a much larger statewide unified curriculum project, the Florida Plan, which embraces high school technology programs, career academies, worker training programs, apprenticeships and bachelor degree programs. A model example of the Florida Plan is built around the CPT certification. By embedding the MSSC Skill standards into the ET degree, FLATE has constructed an industry-relevant articulation pathway that can be executed by individuals at any stage of their career.

For high school students preparing to enter the workforce, Florida now has an academy structure as well as traditional secondary career programs that address these same industry-identified MSSC skills. The MSSC-CPT exams are included as an assessment tool in many of these programs and successful students can use their CPT credential to articulate 15 credit hours into the ET degree. The CPT designation also provides a pathway for Florida’s incumbent workers to efficiently enter or continue their formal education. Experienced manufacturing or production employees who have acquired the CPT skill set through work experience can take the test, acquire the CPT certification, and enroll in the ET degree program with 15 credit hours under their belt. Finally, various Workforce Florida programs provide CPT skill set training opportunities to unemployed workers. Although their primary objective is to make a person work ready and immediately employable, a trainee who achieves the CPT credential also acquires a pathway to an A.S. Degree which, in itself, provides a pathway to a better lifestyle.

The implementation of the CPT pathway for unemployed and incumbent workers was straight forward. Workforce Florida recognizes the merit of the CPT and provides funds to support specific CPT certification training. The development of the CPT pathway was a more involved process. Curriculum frameworks for a new program of study had to be written and aligned to the MSSC standards so high school students in that program (Automation and Production Technology) would be prepared for the MSSC tests during their course of study. High school curriculum frameworks in Florida define the program of study for 3 or 4 years, define teacher credentials, outline standards by year/course, and

align programs to occupational codes. The approved curriculum frameworks provide high school opportunities which directly align programs to the ET A.S. Degree by utilizing the FLATE-crafted, first-of-its-kind Statewide Articulation Agreement based on an industry certification. This statewide agreement was ratified by the college partners and approved by the FLDOE Articulation Committee in 2007. It has since become a model for other career education programs in Florida as well as in other states.

Figure 1 illustrates the pathway options associated with the ET degree. The entrance possibilities are shown on the left and top portion of the graphic while exit options are on the bottom and right. The diagram also clarifies the “one-plus-one” nature of the degree. The general education and “ET Core” are under year 1 while the specific specialization options are itemized under year 2. The figure also suggests “learn and earn” and lifelong learning possibilities. Students may elect to leave the program after their first year of study. Such students will be eligible for the CPT exam and the enhanced employment opportunities the CPT provides. These students can return to any state college in Florida that offers the degree to complete their second year at any time in the future. These students can also continue their course of study while they are working. Finally, the completion of the ET degree opens up lifestyle changing employment opportunities as well as an articulated pathway into B.S. Engineering Technology degree programs and various Bachelor of Applied Science degrees available at many Florida State Colleges. The ET degree with its options is a model of the Florida Plan for technical education and has been endorsed by the National Association of Manufacturers in their Skill Certification System (SCS).



Figure 1: The Florida A.S. Engineering Technology Degree with Entrance and Exit Options.

## Closing the Loops

Closing the success and sustainability loops for the ET degree program is linked to past, present, and future degree related activities. In the beginning, FLATE reviewed and analyzed frameworks for current relevancy, coordinated the statewide curriculum teams, developed the statewide CPT credential based articulation agreement, hosted and facilitated working team meetings, solicited and consolidated industry input, developed the frameworks and justification for the engineering technology degree, interfaced with FLDOE leadership, and facilitated completion of the FLDOE required forms and paperwork. Today, with the degree available to any college in the Florida State College system, FLATE assists colleges through their local academic processes to transition to or adopt as new the Engineering Technology A.S. degree and/or any of the degree supported technical college certificates, provides statewide branded marketing materials for all colleges offering the degree, supports a common website portal to ET degree information, offers colleges \$30,000 hardware grants for the hands-on components of the ET Core courses, and assists high schools to align career programs to the MSSC CPT skill expectations. Finally, free and stipend-based professional development which addresses degree related technologies is available from FLATE for high school and college ET related program administrators, faculty, instructors and teachers.

The degree related future activities are anchored to the degree related past activities. The “ET Core” with its crosswalk to the CPT skill sets and the 15 credits articulation for anyone who holds a valid MSSC-CPT credential is the degree’s sustainability cornerstone. A CPT might be attained by a student who attended a high school program which is aligned to MSSC standards, an incumbent worker who passed the CPT exam because of industry experience, or an unemployed worker who attended a special certification training program. In any case, CPT skill alignment with the ET Degree curriculum frameworks drives future activities for program sustainability.

Unfortunately the industry verified CPT skill to ET curriculum alignment document does not ensure that the competencies are taught by faculty or mastered by students in today’s college classrooms. This small bitter dose of reality is the crux of FLATE’s ET degree “close the loop” activities. Faculty commonly uses standard text books and text book driven academic course syllabi along with their own experiences and case studies to formulate classroom lessons. Sometimes, as individuals exercise their own teaching pedagogy, the requirements of the Florida Plan certification alignment triangle illustrated in Figure 2 are not completely satisfied. The figure indicates the intended alignment, but gaps can occur between the FLDOE Curriculum Frameworks (I.) and the academic course(s) (II.) chosen by colleges to support the frameworks or between either or both of these and the External Standard (III.) The end result can be that the skills and knowledge needed to pass the MSSC certification test (III.) may not be covered adequately by the instructors or mastered by the students.

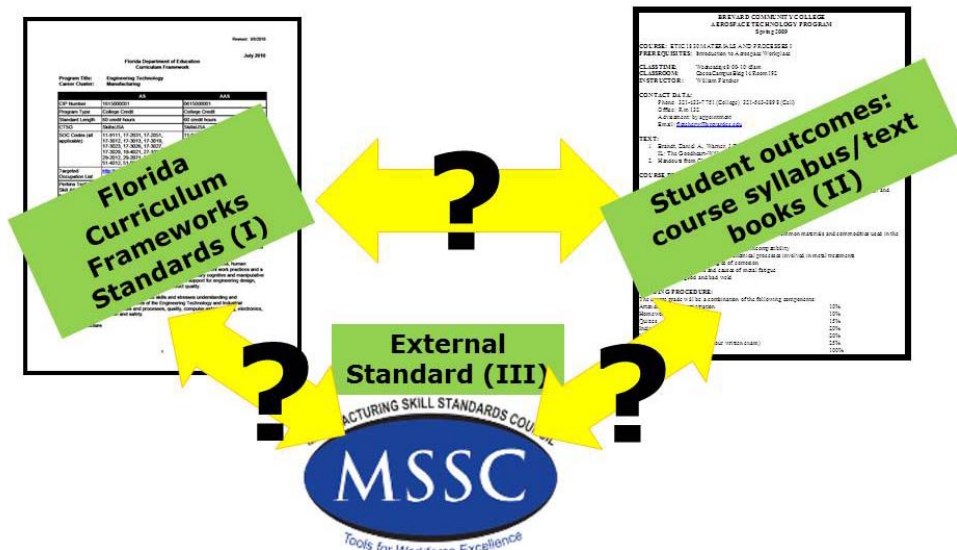


Figure 2: Alignment Triangle for ET Degree

In Florida, the closing the alignment loop task is a bit tricky. It is certainly true that the degree is statewide and its curriculum is governed by defined FLDOE standards and an informal statewide agreement among faculty. However, each participating college is still a vigorous standalone autonomous entity with its own local customs and customer base. Imposing a particular “packaged” or “test prep” curricula would be simple but largely ineffective and probably not sustainable. A better approach is to have the colleges develop a pride of ownership in the degree and the technicians it produces by building a community of practice among the ET degree granting colleges where they openly define and share standards, alignments, course materials, etc. The result of this FLATE built and supported community provides for the personal and professional growth of individual participants as well as the collective group.

FLATE’s strategy is to emphasize that the definition of success includes the requirement that ET graduates are also CPT certified. It is this combination of the ET degree and the MSSC credential that really identifies a “Made in Florida” technician. To help instill this sense of pride in the ET degree product, it is essential that the “ET Core” effectively and consistently assures high CPT test results. FLATE has mounted a two prong approach to achieve this objective. First, student MSSC test results are being acquired and synchronized to the semesters the student took the aligned ET Core courses. To establish a statistically significant data set and reduce bias in this data set, FLATE is covering the test fees for every ET degree matriculated student in the state when the MSSC certification testing event is aligned to an ET Core Course completed that semester. The results to date are reported below for three of the four MSSC certification tests. FLATE will continue supporting college student testing until the data statistically confirms that the integrated knowledge provided in the academic ET core courses prepare students for the aligned MSSC test or indicates any gaps in that curriculum.

<b>MSSC Test</b>	<b>n (through 9/2011)</b>	<b>% passing</b>
Quality Practices & Measurement	30	76%
Manufacturing Processes & Production	29	69%
Safety	42	88%

Table 1. MSSC scores for students taking aligned ET Degree Core courses (2009-2011).

To date, students from five colleges have participated in this study and we have accumulated over 100 scores. Test score results collected by FLATE as of Sept. 2011 suggest possible gaps between lessons taught and performance demonstrated by MSSC exam results. Marginal test scores indicate that targeted curriculum development and/or professional development activity may be needed for skills development in the Manufacturing Materials and Processes MSSC- CPT category. However, more test data needs to be collected to define if and where a gap occurs. Additional student testing is underway to confirm these observations.

The second and parallel approach to instill faculty pride in the ET degree is to work directly with Engineering Technology faculty to develop common student outcome statements for each of the ET Core courses. Working together in a set of structured workshops, faculty compare student outcomes among the common courses and discuss their similarities and differences. Each workshop is separately dedicated to each of the MSSC skill collections and the courses which service these skills. Workshop results at this point include MSSC aligned student outcomes (required to be stated in each college's course syllabus) which are now agreed upon for four of the ET Core courses. The college faculty in all ET Degree colleges will add these MSSC aligned common student outcomes to their course plans and syllabi in 2012. The workshop documentation package includes the alignment of each student outcome to both the Florida Department of Education Curriculum Frameworks and the MSSC standards and recommended types of assessment for each student outcome. Fundamentally, the approach is to forge faculty individuality which is a healthy element of a vibrant program with the mutually developed sense of direction and organized purpose for the ET degree program. Faculty agreement on the execution of the "ET Core" combined with positive results as reinforced by student success with the CPT exams make the ET degree greater than the sum of these parts.

### Déjà Vu All Over Again

The Florida Plan for technical education incorporates the FLDOE Career and Adult Education's policy that all Curriculum Frameworks are reviewed for rigor and relevance on a three year cycle. The Engineering Technology A.S. curriculum framework together with its supported technical college credit certificates are scheduled for review in 2012. FLATE is coordinating this effort among the degree offering State and Community Colleges. Discussions among faculty across the state involved with the degree will cover the current status of their program, expectations from their program advisory committee, and local quirks in program execution. The actual FLDOE appointed review committee is 8 to 12 members strong with at least half of that membership directly from industries



directly affected by the degree program. The Committee specific deliverables to FLDOE return to the same items FLATE addressed at the beginning: a review of analyzed frameworks for current relevancy, the coordination of the degree program curriculum statewide, and the program's relevance to the CPT credential it articulates.

## Summary

Over the last few years, there has been a lot of hype about the might of stackable credentials in technical education. Their implementation is not an easy task. There will always be continuing expense associated with support, evaluation, and testing that cannot be sustained unless faculty, industry, and students all buy in to the credential's value added benefit. A useful stackable credential implies the selection and identification of a well-known and industry-valued credential. Its credit hour assignment must be determined, agreed upon by the college program, and authorized by the governing body. The decision to add credentials to a program must go beyond the inclusion of "test prep" activities. It requires the careful alignment of the industry standards to tightly focused training for a delimited band of skills within clearly stated course learning outcomes of the existing academic program. Finally, it requires program administrator vigilance to maintain the alignment and verification of student success in both their academic and credential programs.

## References

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