Florida's Engineering Technology Associate of Science Degree Program: A Model for Technical Workforce STEM Based Education

Marilyn Barger, Richard Gilbert and Marie Boyette

Abstract

Florida's Associate of Science (AS) Engineering Technology degree program addresses the state's critical need to create an engineering technician career pathway to support and strengthen engineering-based science, technology, engineering, and mathematics (STEM) operations in Florida's public and private sectors. FLATE, a National Science Foundation Advanced Technological Education Center of Excellence in Florida, in partnership with the Florida Department of Education (FLDOE), high school career academies, colleges in the Florida college system, Workforce Florida, and the Florida manufacturing sector, developed and implemented the engineering technology program to meet this critical technical workforce deficiency. This multiple entry, maximum potential AS Engineering Technology degree includes a structure that supports college credit for stackable industry certificates, college certificates, and the potential to articulate to bachelor degree programs. This paper relates the history, strategies, practices, and processes leading to a complete reconstruction of engineering technology education in Florida's college system. This curriculum reform, advocacy, and collaborative partnership effort provides an evidence-based, illustrative change model for statewide Florida Department of Education AS degree programs. The model represents a transformative approach that employs a systemic, statewide implementation methodology and is a suitable model for adaptation to other degree programs in Florida as well as in other states.

1. Background: Genesis for Florida's AS Engineering Technology Program

By the end of the 20th century, it was clear to engineering and engineering technology educators in Florida's higher education system that the system was barely producing the BS and AS technical workforce needed to support the state's diverse engineering requirements. The need for the new technical workforce required to support Florida's public and private expanding engineering-, manufacturing-, and technology-based infrastructure was not being met. Improvement in STEM education to support the anticipated expansion of engineering technology and associated advanced manufacturing technologies for Florida was not only articulated at the state level but was also a nationally recognized need (US Dept. of Commerce 2011; White House 2011a). In 2004, as a National Science Foundation designated and supported Advanced Technological Education Center of Excellence, FLATE became an early advocate for STEM reform. FLATE assembled a partnership that included the Florida Department of Education (FLDOE) Division of Adult and Career Education and the Workforce Florida, Inc. Division of the Department of Labor. Program administrators and senior faculty representing technology and engineering degree programs within Florida's higher education system joined the coalition with a goal of restructuring Florida engineering technology education.

The inspiration for the "Florida Plan" essentially began with the Career and Professional Education Act (CAPE) for Florida's high school career academies, defining what they needed to do. The legislature called for an academic structure that included industry certifications and articulations, using those certifications along with new learning and teaching strategies such as learning communities, problem-based learning, and hands-on, skills-based learning for 21st century careers. After high school, students would apply their skills and learning in college and careers to support Florida's advanced manufacturing workforce. As the engineering technology (ET) degree program was developing, it proved to be a best practice example of the Florida Plan to align and articulate AS degree programs from high school to college and support college and career readiness through a statewide coordinated effort. Thus, while CAPE legislation generated the motivation, FLATE provided the ways and means example of a visible, viable, and fully articulated statewide degree as the model program for this Florida Plan.

The driving force behind this effort is Florida's manufacturing sector, which is dominated by small manufacturers, many working in components and custom parts. Advanced manufacturing is critical to the state and national economy. The State of Florida has the fourth largest population in the country, with a current estimate of 18.5 million persons. Its annual high tech export value is ranked third in the nation. By 2008, 24,515 high-tech firms supported over 290,000 high tech state workers. The total value of Florida-originated exports totaled nearly $46.9 billion in 2009; 85% of Florida's exports are manufactured goods (Enterprise Florida 2010). Florida led the Southeast in high-tech employment and ranked fourth nationwide, and its high-tech workers earned an average wage of $68,159, 72% higher than the statewide average private sector wage. By the end of the decade, Florida was among the top 10 US states in electronic components manufacturing (11,874 jobs), semiconductor manufacturing (8,259 jobs), electro-medical equipment manufacturing (3,540 jobs), and consumer electronics manufacturing (846 jobs). Nationwide, it has been observed that the educational attainment of the manufacturing workforce has been increasing; more than half of manufacturing workers have completed some college (US Department of Commerce July 2012).

From its inception in 2002, FLATE recognized that executing a total reconstruction of the AS degree-based system to reflect engineering technology, advanced manufacturing, and related technology sectors required an innovative approach to technical education as well as partnership and commitment from statewide stakeholders. A key component of that commitment strategy was to put mechanisms in place that would help stakeholders contribute to this mission.

In 2010, FLATE's innovative program was recognized at the annual NSF-supported High Impact Technology Exchange Conference (HI-TEC) for contributing "a significant innovation, which has led to a positive impact on student enrollment, retention, and/or advanced technology education." FLATE's statewide AS Engineering Technology degree program and educational pathways (Figure 1) was subsequently recognized nationally as an important technical education model (American Association of Community Colleges 2011).

In summary, the initial focus of reform and expansion of engineering technician education was planned to support the critical workforce needs of Florida manufacturers, as well as support for emerging technology business sectors. Legislation for career education was passed to meet this statewide workforce requirement. FLATE's flexible college and career pathway (Figure 1) was created for Florida students and workers to prepare them with the education, skills, and credentials to support both small and large manufacturers and to create a robust, responsive long-term workforce pipeline. For Florida's economy, this is now a significant resource for the current industry as well as new business enterprises considering locating in the state. Restructuring the AS degree for engineering technology education statewide required directly addressing significant challenges connected to student recruitment, curriculum content, and relevant professional development. The complexity of this higher technical education transformation is discussed in two sections. The first part, "putting it together" includes three distinct phases of research and design, development, and implementation. The second part, "keeping it together," includes the topics of sustainability and evaluation. Each phase provides a systemic and integrated process for FLATE's engineering technology education model that continues to expand geographically, grow enrollment, increase academic and industry partnerships, and ensure engineering technicians are ready to

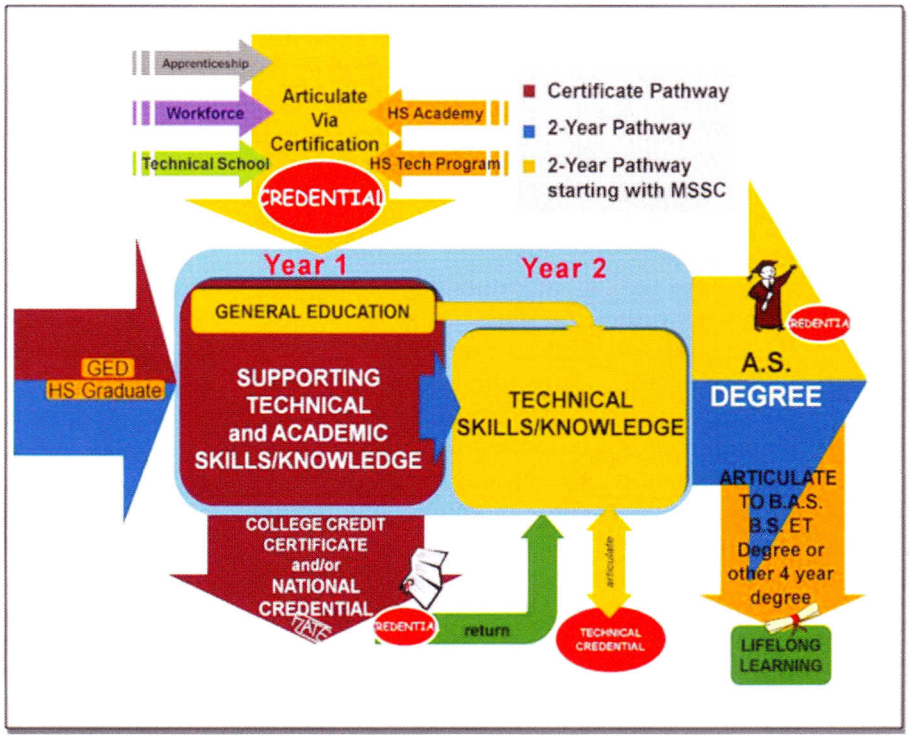

Figure 1. Engineering Technology flexible college and career pathway.

work in today's advanced technology industry sectors. The phrase "Florida Plan" was coined to capture the synergy and robust nature of this integrated process. The AS ET degree program is the first comprehensive implementation of the plan in the state.

2. Part One: "Putting it Together"

2.1 Phase 1: Research and Design

The first phase of any new program development is research and design. For the ET degree, this phase required cooperation with and statewide action by the FLDOE Division of Adult and Career Education, the division holding programmatic curriculum frameworks. A delegation composed of the Florida Department of Education, industry, educators, and the Florida Advanced Technological Education (FLATE) Center of Excellence was formed to review, critique, and suggest reforms for the statewide curriculum frameworks as the first step. The readjustment and consolidation of course numbers within the statewide course numbering system to match a course's new or modified knowledge and skills deliverables was a subsequent activity. The result of the latter was a significantly pared down, reorganized, and articulated prefix (PFX) and number (NUM) system for engineering technology courses offered across the state. The streamlining of course numbering simplified the framework to clarify course alignment, clarify the numbering system significantly, enhance ease of adoption by colleges, and aid student transfer and evaluation of courses among state colleges, providing enhanced service to potential and existing students and colleges adopting and implementing the program and industry stakeholders wanting to use the program "products."

A Florida curriculum framework governs the content of an entire program, jobs and occupations it prepares students for: 21st century skills, appropriate extracurricular student organizations, aligned industry certifications as well as indicators that define what academic courses within the state course numbering system (SCNS) can be used to meet standards and benchmarks. Outcomes within the frameworks must align to the actual courses listed in SCNS to be effective. AS degree or certificate programs, as well as high school and occupational career and technical (PSAV) programs, must each align the program's framework-required knowledge and skill expectation with actual course content. This is reflected in a set of standards supported by specific, well-defined benchmarks.

FLATE's effort focused on redefining engineering technology, advanced manufacturing, and related technologies for curriculum reform in Florida at the state level, consolidating programs with significant overlap of student outcomes. At the same time, FLATE recognized and responded to industry observations and expressions of workforce needs: a workforce with fundamental knowledge and skills in multiple technical areas. The emerging need of cross- cutting basic technical skills reflected the reality of today's modern manufacturing environment. The impact of engineering and the implementation of advanced technologies in this sector had outstripped the Florida college system's ability to graduate the technical workforce needed to fill manufacturing workforce needs. Working with the FLDOE Division of Adult and Career Education, industry advisory boards of technical programs within the state college system, and directly with major manufacturers, technical worker skill gaps and desired new proficiency levels were determined to support crafting the new framework.

2.2 Phase 2: Development

The second phase of "putting it together" is actual development of the degree program. An early realization in 2006-2007 gleaned from pre-degree research was the manufacturers' desire to connect nationally recognized industry-based certifications to higher education STEM-based programs and courses. This idea could build the bridge/connection between nationally accepted training programs and technical education degree programs. Manufacturers realized that their workforce attributes were changing and that many of their needs could be met with workers who have a mix of certified skills and the ability to integrate those skills into shifting and more integrated manufacturing practices. Thus, the premise behind Florida's new AS Engineering Technology degree program follows a one-plus-one structure, where the technical core in the first year defines foundational and transportable technical skills common to all high technology sectors.

The blend of knowledge-plus-skill acquisition modes represented an optimal investment of manufacturers' resources, college program content, and technical program duration. This degree program optimization would be particularly beneficial to the many Florida manufacturers who provide direct support to community and state college system technical programs that address their needs in a timely fashion. To address this manufacturer-stated desire to integrate industry certifications with academic programs and to produce work-ready graduates, FLATE elected to initially integrate the Manufacturing Skills Standards Council (MSSC) Certified Production Technician (MSSC-CPT) as its model-articulated, industry-recognized certification at the entry level skill domain and to craft an articulation process for this new characteristic into the statewide system. This strategy provides for articulation directly from high school programs that are aligned to MSSC through a FLDOE curriculum framework. This pathway also directly supported the CAPE legislation and defined a best practice for integrating additional certifications into AS degree programs.

The Manufacturing Skills Standards Council developed its credential in response to US Department of Labor efforts in the 1990s to develop a credential for manufacturing front line or entry-level employees. The skill sets for a CPT are built on industrial engineering principles and practices for production, which are common to all manufacturing and production enterprises. An attractive feature of this certification is its set of nationally vetted examinations in safety, quality practices and measurement, manufacturing processes and production, maintenance awareness. These required exams are orientated to practical knowledge that indicates defined skill expectations. Thus, the credential is nationally applicable, portable, and relevant to all manufacturing sectors.

The MSSC tested skill sets align with the US Department of Labor Advanced Manufacturing Competency Model, and the MSSC CPT was included in the charter credentials recognized by the National Association of Manufacturers Manufacturing Institute's Stackable Certification System in 2009 as a credential that embodies common core skills for all manufacturing workplaces. FLATE's challenge was to effectively blend this credential into a college technical degree program and avoid narrowing that program to just a set of training courses for the exams. The implementation of the FLDOE adoption of FLATE's recommended one-plus-one national credential alignment strategy to structure a set of first-year specific technical core courses, which support the MSSC-CPT expectations as integrated components that blend with the FLDOE defined competences for each of these core courses, met this challenge. Such an alignment facilitates students sitting for the CPT certification examination, defines the specific program course credit articulation for technical workers holding an MSSC-CPT entering an engineering technology college degree program, and still prepares students to address the focused and concentrated content in the ET degree's second-year specialization courses in specific technologies. The alignment of the technical core standards and benchmarks to the MSSC standards also provided the colleges with a national lens through which their industry partners could view their own basic technical workforce needs.

With the core courses design in place, the development element now included identifying advanced technical knowledge and skill requirements of various engineering technology disciplines as specializations within the second year of the degree program, to build on the technical foundations as well as MSSC-CPT skills embedded in the first-year core. This practice identified ET degree specializations that intensify the desired skill and knowledge set to industry-defined needs, unified course instruction statewide, and facilitated the identification and articulation of additional nationally recognized credentials for program articulation. The next phase, the implementation phase, includes ways that colleges individualized the program while maintaining agreed-upon core course alignment statewide and teaching the specialization technical skills to meet FLDOE standards and benchmarks defined to support specific technologies such as advanced materials, automation, electronics, and machining.

2.3 Phase 3: Implementation

The final phase of "putting it together" is implementation. The complexity rooted in this engineering-based higher education transformation was the diversity of programs and degrees offered at that time throughout the state. And so the first challenge of this phase was to make directors of existing college programs recognize that a shift to the new integrated industry credential and academic program approach was a win-win situation for all. Implementation of the ET degree program in any college had to begin with a formal college program review and rationale for existing and new programs. Colleges and program directors were given background information to support the benefits of transitioning to the new ET degree from whatever collection of programs they currently offered. ET program degrees and certificates would be streamlined, and the flexible design allowed for easier changes and additions in response to changing industry needs. The programs would offer multiple and employable training and education on and off ramps, address many supporting manufacturer needs, provide statewide recognition of the degree and its core skill set, produce work-ready graduates in the minimal time possible; and align programs to nationally defined skills and knowledge. Finally, a unified degree across the state would simplify the articulation from associate to bachelor degree programs.

The structure behind the Florida AS Engineering Technology degree is a one-plus-one approach, where in Year 1 a student takes general education courses and a strong technical core curriculum that aligns with the MSSC-CPT credential. The 18-credit hour ET core courses include computer-aided drafting, introduction to electronics, manufacturing materials and processes, mechanical measurements and instrumentation, quality, and safety. Year 2 of the degree focuses on a specialization track. The ET core curriculum is common to all Florida colleges offering the degree.

FLATE, with its many college partners, aligned the ET AS degree's FLDOE curriculum framework standards (competencies that students enrolled in a particular program are expected to acquire) to the nationally recognized MSSC-CPT external industry standard. Figure 1 addresses the MSSC-CPT certification and a set of 24-27 credit hour specializations that deal with particular knowledge and skill set expecta-

Table 1. List of Engineering Technology specializations and certificates.

Specializations	College Credit Certificates (16)
Advanced Manufacturing	Automation (12 credit hours) Lean Manufacturing (12 credit hours) Mechatronics (30 credit hours) Pneumatics, Hydraulics & Motors for Manufacturing (12 credit hours)
Advanced Technology	Applied Technology Specialist (16 credit hours) Composite Fabrication and Testing (12 credit hours)
Alternative Energy Systems	Alternative Energy Systems Specialist (18 credit hours)
Biomedical Systems	Medical Quality Systems (12 credit hours)
Digital Design and Modeling	Computer-Aided Design and Drafting (12 credit hours)
Electronics	Electronics Aide (12 credit hours)
Mechanical Design and Fabrication	CNC Machinist (12 credit hours) Computerized Woodworking (12 credit hours) Mechanical Designer / Programmer (12 credit hours)
Quality	Lean Six Sigma Green Belt (12 credit hours) Six Sigma Black Belt (12 credit hours)
Non-specific	
ET Core (MSSC CPT aligned)	Engineering Technology Support Specialist (18 credit hours)

tions, focusing on specific technologies defined by manufacturers. It also meets the Florida general education AS degree requirements, designed to prepare students to think broadly, experience teamwork, make relevant connections, experience leadership, and refine the mathematics, verbal, and written communication skills learned in high school.

Table 1 addresses the Year 2 focus on optional specialization tracks, each of which has some required and some elective skills and knowledge of supporting topics. Each college is free to adopt any or all of the specialization tracks and certificates depending on local industry needs. The currently FLDOE-approved specialization tracks are advanced manufacturing, advanced technology, alternative energy, electronics, mechanical design and fabrication, quality, digital design and modeling, and biomedical systems. The degree supports local manufacturing industries with program options designed to be flexible and responsive. This flexibility presents career path opportunities to address a wide range of students from high school to incumbent workers, providing access to the skills, degrees, and credentials needed for high-wage, high-skill occupations. ET college credit certificates (CCC) identify career pathway benchmarks for both traditional college students and incumbent workers alike. CCCs include the new alternative energy systems specialist and most wanted skills targeted by industry, such as lean manufacturing, machining, and Six Sigma Black Belt.

As suggested in the last row of the table, the Engineering Technology Support Specialist CCC is directly aligned with both the engineering technology college core curriculum as well as with the MSSC-CPT. An ET CCC in general but the ET engineering technical support specialist in particular is an excellent on/off ramp to technical training. Students learn the skills they need now to obtain a good job by earning a college credit certificate and then apply the certificate later for course credit toward the ET degree using, when available, an employer's tuition reimbursement plan to cover the remaining cost of the degree.

Another challenge in the implementation phase is the effect on faculty delivering the curriculum content associated with the degree: faculty are asked to deliver new content to satisfy specific requirements identified by industry within the college's service region. To minimize this issue, FLATE implemented a professional development program to assure that as the ET degree with its college-selected specializations rolls out across Florida, college faculty are aware of the new technologies, best practices, and skill expectations that accompany the curriculum reform. Professional development opportunities provided by FLATE refine or certify faculty knowledge base within manufacturing and/or its related enabling technologies. Educational pedagogies are offered locally and statewide via several vehicles that include engineering technology summer institutes, industry-connected technical workshops, and special events conducted around the state High school faculty in AS degree feeder schools and programs are also included: FLATE's "Summer Camps for Teachers" help K-12 educators connect their academic-driven STEM curriculum to real-world tech-

nical examples. During the school year, FLATE provides professional workshops evenings and teacher workdays as requested by college administration and/or local school boards. Topics are wide, ranging from 3-D modeling to engaging girls in STEM curriculum, and designed as high tech and hands-on learning opportunities with online curriculum support provided to make transfer of skills and knowledge to students both timely and relevant. Another effective mechanism for faculty development and collaboration is the Engineering Technology Forum (Barger et al. 2008).

An important implementation step within the Florida Plan is the creation of a regular faculty-driven information exchange meeting. The ET Forum is an example of this statewide cooperative model centered on engineering technology and related AS programs. The forum was awarded a "Best Practice" by the Association of Florida Colleges Occupational and Workforce Commission in 2010 and provides an exemplary collaboration model. Engineering technology faculty, staff, and college administrators meet twice a year at different Florida colleges with a flexible agenda that addresses time-sensitive issues affecting the AS degree programs such as recruitment, funding, FLDOE directives, economic development, long-term curriculum plans, and industry needs. Resources are shared to avoid duplication of effort and to explore best practices among participating colleges. As a part of each ET Forum, FLATE provides a professional development workshop for attending ET faculty focused on ET curriculum. Faculty share and discuss program outcomes, develop and agree on curriculum and consistent testing practices, and bring issues and success stories to the table. Forum collaboration includes active discussion of issues, FLDOE interaction, platforms for sharing by local industry, and workshops and/or short courses on technical and education topics important to technical AS degree programs.

One recent ET Forum collaborative outcome was the development of a Wiki site as an online resource where ET faculty share course offerings, syllabi, new ideas, and offer support to one another. Thus, the ET Forum represents an academic community of practice promoting partnership, sharing, and friendship; it has assisted greatly in the adoption, adaption, and acceptance of the engineering technology program around the state.

Finally, it is also important to Florida industry that during the first year of their studies all ET degree graduates statewide receive training on state-of-the-art equipment. To implement this directive, FLATE offered equipment grants to colleges that have implemented the degree to specifically support skills defined in the core courses. The funds help colleges establish "hands-on" labs, update older equipment, and fill equipment-training gaps identified in their regions, ensuring that all ET students were being trained in the same core technologies. Collectively, this statewide uniformity represents an important component of the degree's sustainability.

3. Part Two: "Keeping it Together"

3.1 Sustainability

Two important features of any robust academic program are sustainability and outcomes defined by a program evaluation plan. The sustainability of the ET degree required the creation of an effective single degree program that met the structural requirements identified by the FLDOE and the skills and knowledge content requirements of Florida manufacturers. If these requirements are met, the ET degree will grow and be sustained by the local colleges and their industry service base throughout the state. Thus, the program's broad acceptance within the Florida college system is critical for its sustainability. That acceptance trend is indicated by the FLDOE enrollment (Figure 2) and completion (Figure 3) data in ET and related programs. Specific program-based data are requested by FLATE and provided by the FLDOE annually. Using this reliable state-level database, it is clear that both enrollment and completion statistics show steady program growth since 2009. Detailed data include student gender and ethnicity, breakdown by college, and similar

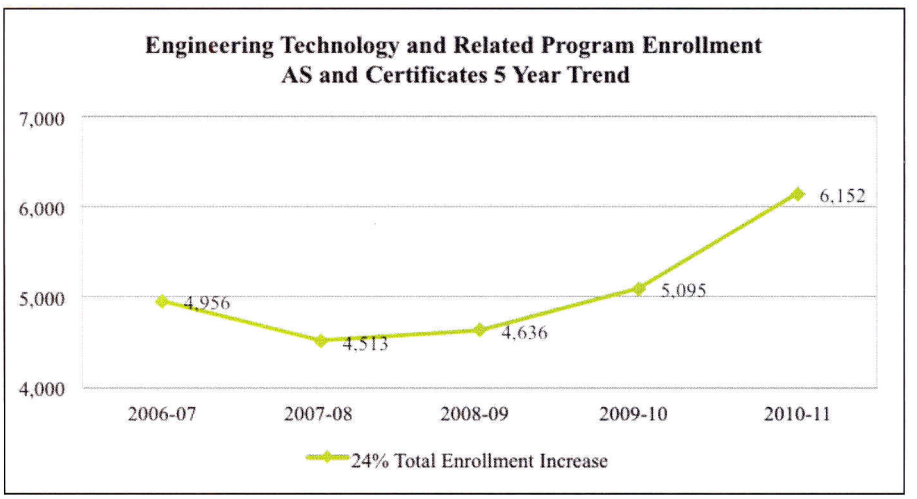

Figure 2. Engineering Technology and related program enrollment for AS and certificates—5 year trend.

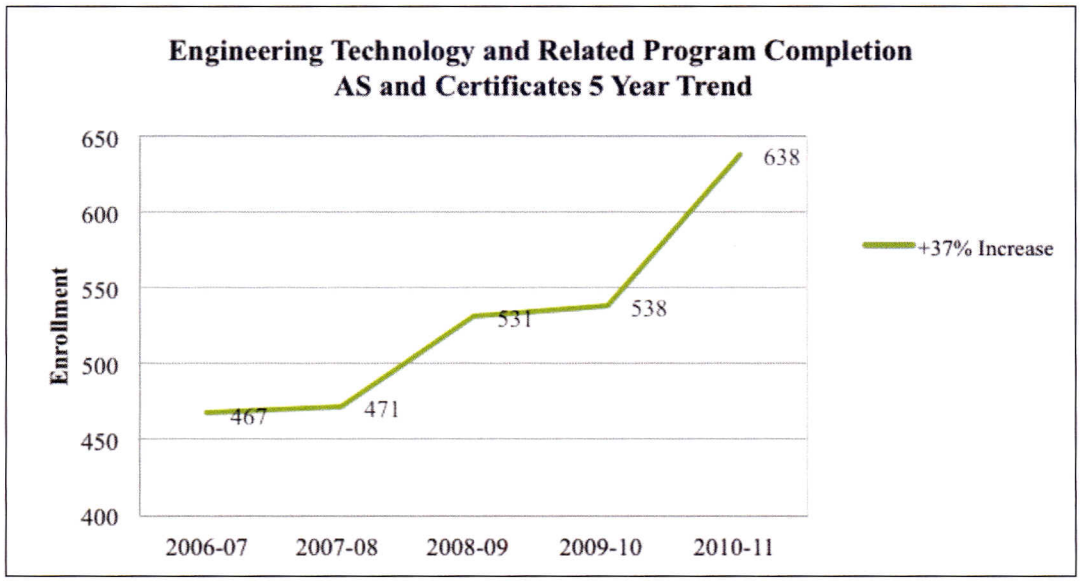

Figure 3. Engineering Technology and related program completions for AS and certificates—5 year trend.

data from related high school and PSAV programs. FLATE uses this information according to FLDOE guidelines for trend analysis and career path research. Program growth in both enrollment and adoptions validate the ET degree structure as well as content. Enrollment and completion data can also be used as an indirect measure of employment.

Increased enrollment in ET degree CCCs and degree completers is one element of degree sustainability while expansion of the degree throughout Florida is the other indicator. Figure 4 shows the current set of colleges that have the ET degree in place. Several more colleges are considering adoption of the ET degree in 2014. By the onset of 2013, 50% of the 28 state and community colleges in Florida had adopted the program. Table 2 summarizes degree specializations offered at the various locations identified in Figure 4.

Sustainability is also reflected in the administrative practices of colleges offering the degree. Adoption of additional specializations and certificates by ET colleges as well as expansion of the degree to new campuses support the value of the degree structure. New applications from colleges to the Department of Education for new ET degree specializations and certificates from the ET network colleges endorse the degree's flexibility. New specializations also validate the technical core, since all specializations build on fundamental technical industry skills in the core courses. Evidence of this continues to build. In spring 2013, the FLDOE will approve two recently submitted applications for new tracks, increasing the number of specializations from 8 to 10, and the total number of certificates offered to 18.

Meeting industry needs in terms of graduates being hired into internships or permanent positions is also a factor of sustainability. FLATE will be implementing some new strategies to determine employer satisfaction within the next year. Additional exposure of the commonality of the degree across the state has been an important feature for industry (that is not restricted to college-defined geographic areas when hiring). A

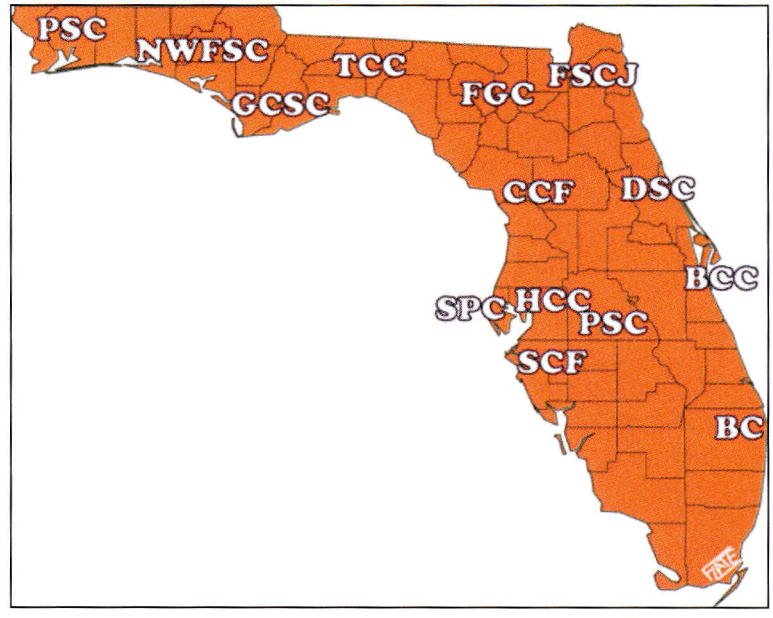

Figure 4. 2012 FLATE Engineering Technology college network.

Table 2. Statewide college offerings of Engineering Technology.

ET Specializations	Implementing Colleges and Locations	
Quality	College of Central Florida	Ocala
	St. Petersburg College	Clearwater
	Tallahassee Community College	Tallahassee
Electronics	Brevard Community College	Cocoa, Palm Bay
	Broward College	Coconut Creek
	Northwest Florida State College	Niceville
	State College of Florida	Venice
	St. Petersburg College	St. Petersburg
Advanced Manufacturing	Florida Gateway College	Lake City
	Florida State College	Jacksonville
	Gulf Coast State College	Panama City
	Hillsborough Community College	Tampa
	Polk State College	Lakeland
	Tallahassee Community College	Tallahassee
Mechanical Fabrication and Design	Gulf Coast State College	Panama City
	Florida State College	Jacksonville
	Polk State College	Lakeland
	Northwest Florida State College	Niceville
	Tallahassee Community College	Tallahassee
Advanced Technology	Brevard Community College	Cocoa, Palm Bay
	Tallahassee Community College	Tallahassee
Biomedical Systems	Broward College	Coconut Creek
	St. Petersburg College	Clearwater
Digital Design and Modeling	College of Central Florida	Ocala
	Gulf Coast State College	Panama City
	State College of Florida	Venice
	St. Petersburg College	St. Petersburg
	Tallahassee Community College	Tallahassee
Alternative Energy Systems	Brevard Community College	Cocoa, Palm Bay
	Broward College	Coconut Creek
	Gulf Coast State College	Panama City
	Tallahassee Community College	Tallahassee

secure pipeline and partnerships with the secondary and post-secondary technical educational institutions is important for growth and sustainability, and those connections are also targeted for support from FLATE in the coming year. Finally, program evaluation is very important to "keeping it in place" and is discussed in the next section.

3.2 Evaluation

Evaluation is a critical component for sustainability of the engineering technology program and, as an essential phase of the Florida Plan for technical education, incorporates the FLDOE Adult and Career Education's policy that all curriculum frameworks are reviewed for rigor and relevance on a three-year cycle. The review of Engineering Technology AS curriculum frameworks together with its supported technical college credit certificates began in 2012. FLATE is coordinating this review effort among the degree-offering state and community colleges. Discussions among participating faculty across the state 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, with at least half of that membership directly from industries affected by the degree program. The committee-specific deliverables to FLDOE reflect the same three items FLATE addressed at the beginning of its ET curriculum reform process: review and analyze frameworks for currency and relevancy, coordinate the degree program curriculum statewide, and make the program relevant to the industry credential it articulates. Highlights of the 2012 review of the ET core standards and benchmarks include

- Adding 12 benchmarks (11 standards & 127 benchmarks)
- Focusing 7 of the new benchmarks on sustainability-related (green) skills
- Restructuring/revising over 45% of existing benchmarks for clarity
- Deleting 12 benchmarks as obsolete or no longer needed

Validation of the ET degree's core course of study to its signature MSSC-CPT credential is a key evaluation factor that connects the ET degree to industry-de-

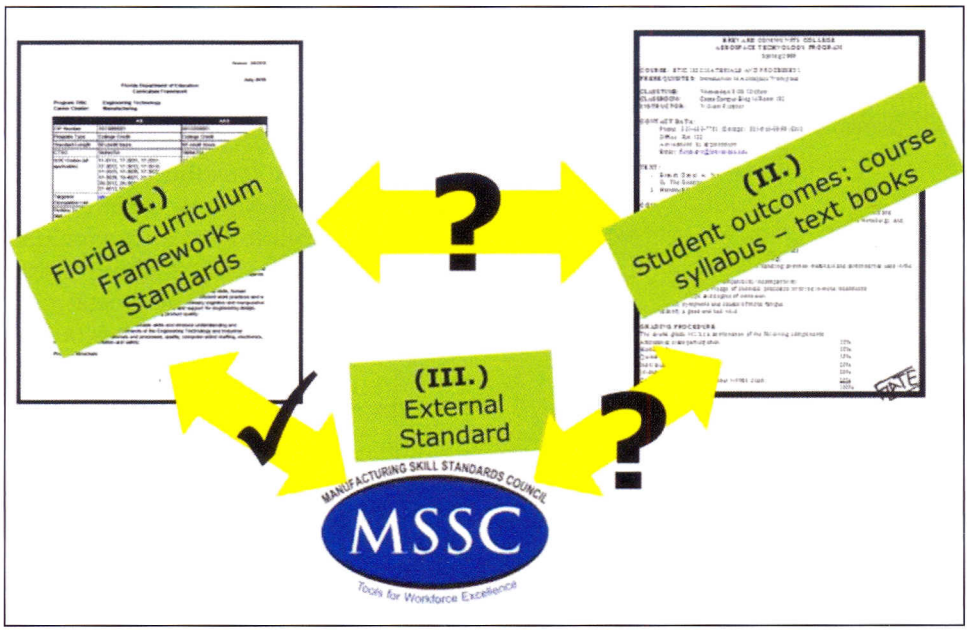

Figure 5. MSSC curriculum frameworks and outcome alignment testing.

fined needs. A strong alignment promotes acceptance of the degree program by Florida manufacturers and high technology employers and strengthens the degree's sustainability attributes. The alignment process factors with the key linkages noted are outlined in Figure 5.

Three official documents independently define what students learn in the ET degree core courses, as illustrated in Figure 5: item I is the FLDOE degree framework standards and benchmarks; II, the student outcomes defined in each college's course syllabi; and III, the MSSC standards. FLATE has aligned the MSSC standards (III) to the ET degree framework standards (I) in a matrix published on its FLATE website. However, this official alignment does not ensure that the standards from either are taught in the classrooms. To better secure this and ensure that students enrolled in the ET core courses would be well prepared to pass the four MSSC assessments, FLATE developed two independent strategies. First, it worked with its college partners to define a set of course level student outcomes (II), aligned to both the frameworks and to MSSC standards, that colleges would adopt for specific core courses and include in the course syllabi. To ensure student success when taking the MSSC assessments, a recommended guideline indicating when these ET students would be adequately prepared was developed by ET degree faculty and facilitated by FLATE for optimal student success. This effort has unified the colleges, developed a stronger knowledge base among the faculty about the MSSC standards and the ET core alignment to MSSC, and overall helped support the growing community of practice among ET degree practitioners. The second strategy is to have students in core courses around the state sit for the MSSC assessment at the end of the aligned academic course. If students achieve the defined outcomes, their MSSC test score results at the end of aligned academic core courses would establish a strong bottom line connection between the degree and its industry certification. Table 3 summarizes the set of test score results collected through 2011 for the MSSC quality and safety tests, respectively.

Table 3. MSSC test score collection for quality and safety exams, 2009-2011.

MSSC Test	n (through 9/2011)	% passing
Quality Practices & Measurement	31	77
Safety	61	90

FLATE follow-up research and documentation related to the colleges that participated in this testing activity confirms that competencies in the MSSC standards are included in the engineering technology degree program and that students taking the ET core at those institutions were well prepared to successfully pass the MSSC certification tests (Barger et al. 2007, 2012). FLATE supplements student test fees across the state in order to collect these data, and results are provided to testing locations, shared in an environment of open access, and discussed at consortia with educators for continuous improvement. Statistically significant marginal test scores focus FLATE's attention to possible statewide curriculum modification and/or specific faculty professional development activity needed to correct the situation. Additional student testing continue in the other two MSSC skill areas, manufacturing processes & production and maintenance awareness, to close the loop between the degree and its certification pathway. Periodic testing will follow this evaluation phase activity to confirm the continued integrity of the curriculum alignment to the external standard.

4. Status of the ET Degree

The steady and rapid growth in the number of Florida

institutions offering the engineering technology degree includes 56% of the state and community colleges that offer any programs related to the technologies in question. This growth provides strong evidence of the degree's importance and impact on creating the engineering technician population available to Florida's manufacturing and production related industry sectors. Ultimately, this statewide single degree structure with its common set of core courses facilitates student transfers among Florida colleges, when a student move is necessary, but strengthens the likelihood that ET graduates will not leave the state for employment. Future technicians raised and educated in Florida will stay and work in Florida, and the ET degree will provide the credentials for that successful technical career path.

The path toward the implantation of the ET degree has also generated an important model for AS degree success in general. This effort exemplified the necessity to create a community of practice among colleges, manufacturers, economic development organizations, Workforce Florida, and the Florida Department of Education to effectively address the challenges in each of the multiple phases of the process. Figure 6 illustrates the interactive structure of this community and highlights FLATE's role as a connecting pathway among the organizations needed to accomplish the task. Each of the organizations within the community contributes value added, while FLATE assures that these contributions are integrated into the final product, the ET degree.

The process begins with manufacturers and manufacturer associations identifying their employee skill set needs. With that information, FLATE, working under the quality guidelines of its Baldrige Sterling Evaluation Model, interacts directly with education institutions to determine if these skills are currently within a CCC or degree structure. Follow-up activities with the FLDOE establish the existence of state-approved frameworks and supporting benchmarks for identified skills plus interactions with Workforce Florida to establish the occupational needs and options future technicians with these skills will have. Finally, FLATE, with continued input from all of these stakeholders, develops the innovations needed to meet industry and Workforce Florida needs.

5. The Future of the Florida Plan

The development and adoption of the Florida Plan requires a constant, consistent target and steady course of action. It is not a static enterprise. The FLDOE is using the ET degree with its core course system as a somewhat revolutionary model program to push AS degree target skill sets further into the academic program framework and broaden the level of applications that can stem from a core course of study approach to include industry and college credit certificates as either entry or exit strategies. This new practice facilitates both preparation for AS degree programs and cross training in the workplace, elevating the statewide relevancy of the degree program.

Growing enrollment for college and careers in technology sectors from the high school level helps provide a badly needed positive impact addressing the public perception of manufacturing. This change in the image of manufacturing is needed to help grow the manufacturing industry and bolster the American economy (National Association of Manufacturers 2012). The Florida Plan in general and the ET program in particular create a foundational model for career pathways and stackable credentials that is a resource for colleges, technical training organizations, and the Department of Labor as a tool for development of new programs, grants, and initiatives. As this educational structure is integrated into colleges, the Florida Plan continues to evolve as a viable system. The principles, processes, and practices used to develop the ET degree program are being evaluated and

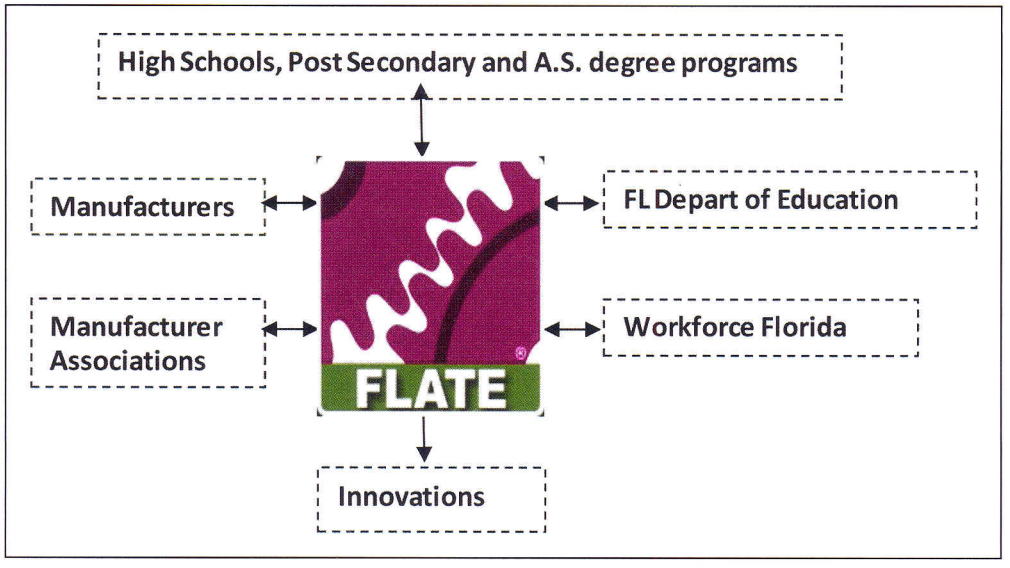

Figure 6. FLATE's community of practice.

assimilated for use by the building and architecture and information technology clusters, and the biomedical equipment AS degree programs in Florida. In addition, as the model behind the Florida Plan, the ET degree program has been recognized nationally by the US Department of Labor and directly addresses the national call for "credentialing 500,000 community college students with skills certifications aligned to manufacturers' hiring needs" (White House, 2011b). The model's strength is also supported by the number of colleges around the country adopting it as a viable, flexible academic structure for AS programs, providing on and off ramps to education, easy articulations from K-12, simplified 2 + 2 articulations into four-year degree programs, and increasingly important industry credential alignments. The systemic change for technical education embodied by the Florida Plan is based on articulated need from the user community as well as the statewide cooperation required to put the processes in place to satisfy that need. The Florida Plan brings together resources and partnerships, creating a community of practice grounded in buy-in and stakeholder feedback, empowering users, and growing grassroots support for sustainability. With the national lens now strongly focused on manufacturing and innovation, the community of practice established and developed by FLATE around the engineering technology degree and career pathway options established have become essential for the development and education of Florida's new engineering technician workforce.

References

American Association of Community Colleges. 2011. "DOL Official Urges Credit for Short Term Training." *Community College Times*. Accessed August 1, 2012. http://www.communitycollegetimes.com/Pages/Landing/Homepage.aspx.

Barger, M., R. Gilbert, and E. Owens. 2012. "Aligning Florida's Manufacturing Programs with External Standards: Closing the Loops." *ASEE Annual Conference Proceedings*. Paper presented at the annual meeting of the American Society for Engineering Education, San Antonio, TX, June 10-13.

Barger, M., R. Gilbert, E. Roe, and B. Jenkins. 2008. "Florida Engineering Technology Forum: A Vehicle for Change." *ASEE Annual Conference Proceedings*. Paper presented at the annual meeting of the American Society for Engineering Education, Pittsburgh, PA, June 22-25.

Barger, M., R. Gilbert, R., and E. Roe. 2007. "Engineering Technology Reform in Florida."*ASEE Annual Conference Proceedings*. Paper presented at the annual meeting of the American Society for Engineering Education, Honolulu, HI, June 22-25.

Enterprise Florida. 2010. "The eflorida.com Knowledge Center." Accessed August 28, 2012. http://www.eflorida.com/.

Florida Department of Education. 2012. "Florida Career and Professional Education Act (CAPE) Technical Assistance Paper." Accessed August 28, 2012. http://www.fldoe.org/workforce/pdf/CAPE-Act-TechAssist.pdf.

US Department of Commerce, Economics and Statistics Administration. 2012. "The Benefits of Manufacturing Jobs." ESA ISSUE Brief.

US Department of Commerce, Economics and Statistics Administration, July 2012. "STEM: Good Jobs Now and for the Future." ESA ISSUE Brief. Accessed August 28, 2012. www.esa.doc.gov/sites/default/files/reports/.../stemfinalyjuly14_1.pdf

White House. 2011a. "President Obama and Skills for America's Future Partners Announce Initiatives Critical to Improving Manufacturing Workforce." Office of the Press Secretary. June 3, 2011.

White House. 2011b. "President Obama Launches Advanced Manufacturing Partnership." Office of the Press Secretary. June 24, 2011.

Marilyn Barger

Dr. Marilyn Barger is the Principal Investigator and Executive Director of FLATE, the Florida Regional Center of Excellence for Advanced Technological Education, funded by the National Science Foundation and housed at Hillsborough Community College in Tampa, Florida since 2004. FLATE serves the state of Florida as its region and is involved in outreach and recruitment of students into technical career pathways; has produced award winning curriculum design and reform for secondary and post-secondary Career and Technical Education programs; and provides a variety of professional development for SETM and technology secondary and post-secondary educators 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 over 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. Dr. 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 Fellow of the American

Society of Engineering Education, a member of Tau Beta Pi and Epsilon Pi Tau honor societies. She is a charter member of both the National Academy and the University of South Florida's Academy of Inventors. Dr. Barger holds a licensed patent and is a licensed Professional Engineer in Florida.

Richard Gilbert

Dr. Richard Gilbert is a professor of Chemical and Biomedical Engineering at the University of South Florida's College of Engineering. Research interests include the application of STEM principles for the development of applicators and protocols for human applications of electric field mediated drug and gene delivery. Dr. Gilbert is also a Co-PI for the National Science Foundation supported Advanced Technological Education Center for Florida (FLATE). This NSF long term funded center of excellence has developed a working partnership between Florida's Department of Education, the various technical degree programs within the Florida State College System, The Florida Energy Systems Consortium, and Florida's manufacturing sector to implement A.S. degree programs to meet the needs of 21'st century manufacturing in Florida.

Marie Boyette

Dr. Marie Boyette is the Associate Director for the FLATE Center, a NSF Center of Excellence located at Hillsborough Community College. Dr. Boyette's research centers around data structure and analysis which deliver meaningful impact for projects and programs. She earned a Ph.D. in Curriculum and Instruction from the University of South Florida with a triple emphasis in Measurement and Research, Adult Education, and Communication. Her practice includes development of experiential learning strategies providing measurable instructional outcomes for educators, traditional, and non-traditional students. "Summer Camp Style" professional development workshops for teachers and exploration of diversity through standard coursework are current interests.