122nd ASEE Annual
Conference & Exposition
June 14 - 17, 2015
Seattle, WA
Making Value for Society

Paper ID #13548

Converting a Traditional Engineering Technology Program to a Competency-Based, Self-Paced, Open-Entry/Open-Exit Format

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Dr. Eric A. Roe has extensive experience in creating high-performance, high profile programs, and collaborative partnerships to make workforce education and training relevant for employers and the economy through systemic reforms which align competencies with talent development pathways.

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At CLEE, Dr. Roe is responsible for the college's professional engineering master's degree programs, engineering professional development, conferences, and customized corporate training. At Polk State Dr. Roe was the Director of Applied Technology and founder of the Manufacturing Talent Development Institute. In these roles he oversaw the shift from a traditional program to a competency-based Open-Entry / Open-Exit Engineering Technology AS degree, served the state through the ManufacturingTDI statewide resource center bridging industry and talent development systems, and served as Co-Principal Investigator and director of three TAACCCT grants to strengthen Engineering Technology and Advanced Manufacturing training and education programs.

All of these initiatives have created a unified educational system in Florida that provides the curriculum, educational articulation pathways, and certifications needed to deliver required workplace competencies for modern manufacturing.

Dr. Roe held various positions in manufacturing research, technical services, and engineering before joining the education sector to become a founding director of FLATE, the Florida Advanced technological Education Center and shifted his focus to creating a skilled and educated STEM workforce.

Dr. Roe earned his Ph.D. in Chemical Engineering from the University of South Florida, where he developed an alternative feedmill process for citrus processing. In his professional career, he has worked in 3 areas of vital importance to Florida – Manufacturing, Citrus, and Education. He has served as keynote speaker and technical lecturer at regional, national, and international conferences in economic and workforce development, education, and engineering.

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Abstract

Higher education is generating new pedagogical models as a result of a number of disruptive innovative agents that are acting as a catalyst to transform program and content delivery, enrollment and registration practices, financial aid, instructor roles and the technology systems required to support these models. To respond to industry needs, empower students through the educational process, and align to the needs of non-traditional students in an affordable, accessible, and targeted manner, Polk State College is in the process of utilizing NSF-ATE funding for the "Open Entry/Open Exit Advanced Manufacturing Engineering Technology Project" (OEOE) to transition a traditional Engineering Technology Associate of Science degree program to a hybrid competency-based, modular, OEOE, non-term, self-paced, learner-centered, faculty-mentored format. The program serves to educate two-year college students, and provide a common pathway to engineering technology related programs for high school students, creating career pathways into the high-performance field of advanced manufacturing. Polk State's OEOE Engineering Technology program is developing, adapting, and implementing:

- educational reform - transitioning a traditional AS degree in Engineering Technology to an open entry / open exit competency-based, modular, open-lab, degree program;
- professional development – technical skills professional development for the college and secondary program faculty and pedagogical professional development for the college staff and faculty on competency-based program development and delivery; and
- outreach programs – increased collaboration with secondary feeder programs in the college's service area, disruptive innovation applied to advisory council collaboration, and greater engagement with industry.

The project is a direct response to industry needs and represents a strong partnership between the college, employers, secondary and four-year academic institutions, and regional and state workforce investment entities in Mid-Florida. The flexible modular format is loosely based on the Fox Valley Technical College term-based model but adapted and enhanced to include best practices from competency-based programs (ie. Western Governors University), to implement a true OEOE registration process, and work within the Florida College System. This impacts technological education by implementing a hybrid competency-based, self-paced, open-lab OEOE program where the content is structured into modules organized within 1-credit courses that are faculty-mentored and offered in a non-term schedule that is accessible to working learners and is learner-centered rather than faculty-centered**.** This project also focuses on building a collaborative relationship between the secondary system and the college that embeds certification-based articulation resources and pathways into the program; and providing pathways to baccalaureate degrees.

This paper will present a progress update on this project with lessons learned and a discussion of the enablers and barriers experienced during implementation.

Need for an Improved Educational Model

Polk State College adopted the Engineering Technology (ET) AS degree[1] in 2008 with a specialization in Advanced Manufacturing and soon thereafter added a registered apprenticeship program with the Mosaic Company[2] that shifted from the traditional clock-hour model to a competency blueprint with strong articulation pathways to the degree. The ET degree program at Polk State provides the fundamentals of production processes, the maintenance of those processes, quality assurance, and safety; followed by more in-depth study of automation and instrumentation, metrology, process improvements, total predictive maintenance, technical management competencies, as well as quality work practices utilizing Lean and Six Sigma principles. Students develop both technical skills and the management competencies needed to advance efficient and effective performance within advanced manufacturing entities. The program is structured such that a student typically takes general education courses and a technical core in their first year of study. This is followed in the second year by taking technical courses in an area of specialization that meets local needs.

The Maintenance Combination Craft Apprenticeship program includes training for both Electrical Instrumentation & Automation Technicians and Mechanical/Millwright Craft. The program was created to align with the Department of Education's Journeyman requirements and consists of 1232 hours of classroom instruction combined with on the job training at the Mosaic Company facilities in Polk County. Specifically the program consists of the following instruction: curriculum from ManufacturingTDI that is aligned with the Manufacturing Skill Standards Council (MSSC) Certified Production Technician (CPT) national certification – 5 Weeks; Industrial skills fundamentals curriculum – 18 Weeks; Trade-specific skills curriculum – 12 to 18 Months; Advanced standing for current incumbents to meet program requirements; Employer provided hands-on OJT. Upon completion of the apprenticeship program, the participants are elevated to full journeyman status at the Mosaic Company and obtain a pathway into Polk State's Engineering Technology degree program. Students completing the apprenticeship program and obtaining the MSSC CPT earn up to 31 credits towards an ET degree, a strong career and educational pathway into advanced manufacturing.

Even with these two innovative programs in place, by 2011, during persistently double-digit unemployment[3] in Florida, manufacturers were scrambling for employees with the advanced skill sets needed for more sophisticated manufacturing processes.[4] In a series of regional focus groups and one statewide focus group of industry employers conducted in 2011 by the Florida Banner Center for Advanced Manufacturing (ManufacturingTDI), 82% of respondents reported having problems finding qualified candidates.[5] It was projected that the long term demand for advanced manufacturing talent would continue to grow as baby boomers retire and the number of high-skill manufacturing jobs increases. By 2018, Florida companies will add 133,774 production and installation / maintenance / repair jobs to the economy.[6] Many of these jobs will be in advanced manufacturing niches such as high-tech electronics and instruments to serve a number of industries including marine/environmental, medical devices and instruments, and defense/aerospace. These industry sectors are specifically targeted by Florida economic development initiatives such as the Tampa Bay Region's Blueprint for Economic Development, of which Polk County is a partner.

Three significant barriers to program enrollment and completion were identified:

1) Currently, roughly 85 percent of U.S. higher education students are post-traditional[7]; that is, they are not 18–22 year olds attending full-time, living on campus, supported by their parents. The traditional ET degree program does not address the needs of nontraditional

students such as apprentices in the program, working Journeymen who have completed the apprenticeship program, incumbent manufacturing employees doing shift work, or returning veterans with past experience in production and maintenance work or military training related to Engineering Technology.

2) The majority of students identifying ET as their first or second educational objective don't enroll in the ET program courses, in part because there are few opportunities for students to interact and bond with ET faculty while they complete prerequisites or developmental general education courses. The faculty/student relationship is critical when students are confronted with challenging gateway courses that may dissuade them from pursuing an ET degree.

3) The curricula used in six related secondary level career academies in Polk County do not directly align with the industry certification embedded in the ET Core, the Manufacturing Skill Standards Council (MSSC) Certified Production Technician credential (CPT), although the program benchmarks and core skill sets (safety, quality, processes, and maintenance) are the same or overlap. This eliminates the 15 credit hour articulation pathway into the ET degree for graduating high school students, reducing student's incentive to major in this STEM discipline at the college level.

The overarching OEOE project goal is to increase the number of advanced manufacturing technicians in the workforce with a strong practical and theoretical knowledge base in engineering technology that prepares them to successfully work within and adapt to technological advances in advanced manufacturing, and enables them to transfer to 4-year universities if they want to pursue an advanced degree in manufacturing or engineering technology.

Competency based education strategies include online and blended learning, dual enrollment and early college high schools, project-based and community-based learning, and credit for prior learning, among others. Competency based education strategies strive for better student engagement through personalization – learning materials and pathways that are relevant to each student and tailored to their unique needs. It also strives for better student outcomes because the pace of learning is customized to each student.[8] Investments in competency-based education (CBE) programs make sense as our nation strives to educate an increasingly diverse population.

Utilizing CBE strategies in the development of an OEOE degree model should enable Polk State to address the three points above:

1. Post-traditional students need the flexibility and acceleration options offered by an OEOE program to build skills and work toward credentials at any time and any age. Industry representatives have repeatedly voiced the need for programs that enable students to earn credentials by demonstrating their "competencies" (defined as a balanced blend of knowledge, skills, and abilities) without the traditional confines of credit hours (and required seat time).
2. The flexibility afforded by OEOE competency based education strategy format will allow earlier faculty/student interaction.

3. Partnering with the school district to enhance secondary programming and dual-enrollment in the OEOE program will support increased articulation opportunities for secondary students by aligning MSSC CPT Certification with the curriculum of six career academies and programs of study.

Resulting in an OEOE model that drives an increase in the number of students enrolled in the ET degree at Polk State College that have the skills and knowledge demanded by our employer partners. Furthermore, by developing a replicable OEOE option for the Engineering Technology AS degree that offers flexibility and acceleration options often important to post-traditional students, such as incumbent workers and returning veterans, Polk State can support regional model replication and dissemination to other technological two-year programs.

Implementation

The NSF-ATE funded Open Entry/Open Exit Advanced Manufacturing Engineering Technology Project (OEOE) seeks to educate two-year college and secondary students in engineering technology related programs, creating career pathways into the high-performance field of advanced manufacturing. OEOE is developing, adapting, and implementing:

- educational reform - transitioning a traditional AS degree in Engineering Technology to an open entry / open exit competency-based, modular, open-lab, degree program;
- professional development – technical skills professional development for the college and secondary program faculty and pedagogical professional development for the college staff and faculty on competency-based program development and delivery; and
- outreach programs – increased collaboration with secondary feeder programs in the college’s service area, disruptive innovation applied to advisory council collaboration, and greater engagement with industry.

The project is a direct response to industry needs and represents a strong partnership between the two-year Engineering Technology Associate of Science degree program, employers, secondary and four-year academic institutions, and regional and state workforce investment entities in central Florida.

Starting with an ongoing traditional (semester-based, lecture/lab format, scheduled weekly courses) provided Polk State with core course materials that could be competency mapped and updated to employ CBE strategies. Course development proceeded with the following principles in mind:

- All Courses would be transitioned to 1 credit hour modular courses to facilitate manageable block of competencies
- Courses would be hybrid
    - Theory is Online
    - Interactive Online Learning
    - Faculty Mentored On-Site Labs
- On-Site Competency Assessments
- Modular units within each 1-credit course based on a replicable template
- Course numbers would be retained to support transfer to other Florida College System institutions and retain statewide common course numbering formatting. For example, the 3 credit hour ETD1320C course would become three separate 1 credit hour courses ETD1320C-1, ETD1320C-2, ETD1320C-3

Modular Course Development

The OEOE team then looked at the ET degree framework (competency blueprint of benchmarks and standards) and the current traditional courses to create a matrix of 1 credit hour courses that aligned with the traditional course numbers and content. This enabled Polk State to then map current course materials from the program, external grants, and new content into a matrix to guide content development (see Table 1).

Table 1 – ET Course Development Matrix

#	Traditional Course Number	Course Title	Cr. Hrs.	Course Category	Prereq(s) #	Certification(s) Alignment	Proposed OEOE 1 Cr. Hr. Course1	Proposed OEOE 1 Cr. Hr. Course2	Proposed OEOE 1 Cr. Hr. Course3	Proposed OEOE 1 Cr. Hr. Course4
1	EET 1084C	Intro to Electronics	3	* ET Core	None	ISCET - CET Assoc.	Basic Fundamentals	Series/Parallel Circuits	AC Circuits	-
2	ETD 1320C	CAD	3	* ET Core	None	Autodesk Certified Professional	Sketching and Print Reading	Advanced Editing	Dimensioning	-
3	ETI 1110	Intro to Quality	3	* ET Core	None	MSSC - Quality	Quality Theory	The Voice of Quality	The Tools Of Quality	-
4	ETI 1420	Mfg. Processes & Materials	3	* ET Core	None	MSSC - Processes	Mfg. Proc. & Materials - 1	Mfg. Proc. & Materials - 2	Maint. Awareness - 1	-
5	ETI 1701	Industrial Safety	3	* ET Core	None	MSSC - Safety / OSHA-10hr	Safety Standards	Hazards	Ethics and Culture	-
6	ETM 1010C	Mech, Measurement & Instrumentation	3	* ET Core	None		Mech, Measurement & Inst - 1	Mech, Measurement & Inst - 2	Mech, Measurement & Inst - 3	-
7	ETI 1622	Lean Mfg & Six Sigma	3	Adv.Mfg. Req'd	3	SME/ASQ/Shingo - Lean Bronze	Lean Culture	Continuous Improvement	Lean Measures	-
8	ETM 2315C	Hydraulics & Pneumatics	4	Adv.Mfg. Req'd	4,5	MSSC - Maint.	Fluid Power	Actuators and Accumulators	Hydraulic Systems	Pneumatic Systems
9	ETS 1511	Motors and Controls	3	Adv.Mfg. Req'd	2,4		DC Motors	AC Motors	Motor Control Systems	-
10	ETS 1542	Intro to PLC's	3	Adv.Mfg. Req'd	2,4	PMMI - PLC Certificate	Ladder Logic Circuits	Fund's of PLC's - 1	Fund's of PLC's - 2	-

11	ETI 1181	Quality Systems and Workplace Dynamics	2	Tech. Elective	3	ASQ - CQIA	CQIA - 1	CQIA -2	-	-
12	ETI 1403	Intro to Adv. Mfg.	1	Tech. Elective	None	n/a	Intro to Adv. Mfg.	-	-	-
13	ETI 1931	Special Topics in Mfg.	3	Tech. Elective	*	t.b.d.	t.b.d.	t.b.d.	t.b.d.	-
14	ETI 1949	Mfg. Internship	2	Tech. Elective	*	n/a	N/A - Polk State	N/A - Polk State	-	-
15	ETS 1535	Automated Process Control	3	Tech. Elective	*, 10	ISA - CCST	Fund's of Ind. Process Control - 1	Fund's of Ind. Process Control - 2	Intro to Proc Inst - 1 / Process Variables & Meas -1	-
16	ETS 1539	Instrumentation Systems Safety	3	Tech. Elective	*, 10	ISA-84 Fundamentals Specilaist	Intro to Proc Inst - 2 / Process Variables & Meas -2	SIS - 1	SIS - 2	-
17	ETS 1540	Ind. Application of PLC's & Robotics	3	Tech. Elective	*, 10		Servomechanisms	Robotic Applic - 1	Robotics Applic - 2 / Industrial Sensors	-

Key:

Source Curriculum	Shading
Polk State ET faculty/staff	
OEOE Staff / Co-PI	
US DOL ETAM Project	
ManufacturingTDI	

As the content was either adapted or created the developers followed a standard template that could replicated in the college's Learning Management System. Online, theory is presented via learning objects and reading assignments and videos. In the open-lab, there are two types of assessments, on laboratory experiments and written/demonstration examinations. To enable students to be self-directed, the documentation must be thoroughly organized. Each of the one-credit courses is broken down into several modules, called *units*. Each unit represents a major topic area. The unit consists of a study guide, worksheets, laboratory experiments, handouts on theory not covered in the book, etc. The study guide is an assignment sheet that is a list of learning activities to be performed in sequential order. These activities include:

- Read particular pages in the textbook.
- View videos (that take the place of live lectures)
- Ask the instructor for a demonstration or an introduction to the laboratory equipment.
- Fill out worksheets and practice problems.
- Perform laboratory experiments.
- View multimedia materials.
- View online supplements

For each module, several laboratory experiments are assigned. At the completion of each one, the student must show the results of the exercise by filling in tables or writing answers on the lab activity handout. If the instructor determines that the student successfully completed the activity, by asking standardized key questions and comparing the written lab results to a key, the student experiment log sheet is assessed as complete and a grade is recorded.

The final activity listed on the study guide for each module is to take the unit exam. Students are allowed to advance to the next module after the successful completion of the assessment and after demonstrating he/she has acquired the competencies to properly construct and operate the circuitry or equipment, and the instruments used in the laboratory exercises. The questions are based on concepts and skill standards that pertain to the learning materials in that particular unit. Before an instructor issues the exam, the student must fulfill two requirements: (1) Show module completion in the LMS to verify assignments have been successfully completed, and (2) Register online for the appropriate exam. At the designated exam time, the instructor prints the exam requested by the student by going to a secured hard drive only accessible to the staff members in the program. The student takes the exam in a test room that is quiet and has windows that enable the instructor to monitor the testing process while working with other individuals. A standard calculator is provided at each station, and no cell phones are allowed in the room to prevent outside information sources and to ensure the exam is not photographed. When the student completes the exam, it is returned to the instructor on duty to be graded and reviewed later. If the instructor is not working with another student at that moment, the student can request that the exam be graded and reviewed.

This entire process ensures that the exams are always secure and only accessible to students while they are taking exams or reviewing them with the instructor. If the instructor discovers an exam is missing while recording the scores, the Student Exam log sheet that was filled out when the exam was issued can be referenced. If it shows a student was issued this exam, further inquiries will be made to determine the whereabouts of the missing document.

Polk State is not currently using student assistants in the OEOE ET program. If at some time in the future they are used, student assistants will not have access to the exams or answer keys, and they will not have the authority to sign the log sheet. Instead, they are responsible to assist other students who are having difficulty with the lab experiments, and to answer theoretical questions if they are able to do so. Assistants are also responsible for maintaining the equipment in the lab by making repairs, ordering replacement parts, or sending it out to vendors when there is a serious problem.

Separate from the assessments, course module quality will be monitored via a systematized process. There is be a quality control box in the instructional area for instructors to use. Whenever an issue surfaces, even as minor as a misspelled word on a test, a form is completed and placed in the box. Forms are then removed on a periodic time schedule to address and resolve the defect.

OEOE Open Lab & Shared Instruction

The Engineering Technology program at Polk State College has converted their method of instruction from traditional lecture/lab based classes to an open-entry, open-exit format. Rather than being scheduled at specific times on specific days, the courses are offered in a flexible format where the students can attend at times which are convenient for them. All program courses are 1-credit offerings that can be started on any given day, and must be completed within five weeks after they are started. Students enroll in the number of 1 credit hour courses they are capable of completing during the 5-week period.

Several different terms have been used to describe this learning method**.** They include *CBE, self-paced*, *self-directed*, *individualized instruction*, *student directed*, and *open lab*. The reason for using these terms is that none of the courses are offered in the traditional lecture-based mode, where classes and labs are scheduled at a particular time and days of the week. Instead, all of the 42 one-credit courses are scheduled every day and at all times during open-classroom/lab hours. The open classroom/lab is held 5 days each week. There are no lectures, but there is always at least one instructor or lab assistant present to work with the students and to ensure a safe operation. The weekly schedule for the Engineering Technology program are as follows:

Monday – Thursday: 8:00am – 8:00pm

Friday: 8:00am – 6:00pm

Students are allowed to attend at any time and can work with any instructor. However, they are encouraged to select an instructor who is scheduled at the same time the student is likely to be in the lab. This instructor will grade the exams, monitor the progress of the assigned student, and issue their grades. During their assigned lab/classroom hours, instructors perform the following tasks:

1. Answer questions on theory materials and assigned laboratory activities.
2. Hand out various materials as required, such as module packets and exams.
3. Verify the successful completion of each laboratory experiment.
4. Grade exams and review them individually with students who are assigned to them.
5. Demonstrate and/or introduce students to the laboratory equipment trainers.
6. Give mini-lectures to small groups.
7. Help students find components and learning materials.
8. Demonstrate how to navigate through LMS packages such as Desire-2-Learn.
9. Student advising.

With the OEOE model, faculty support student learning through facilitation in the Engineering Technology lab, mini-lectures, and validation of competencies through lab assignments and assessments.

The proposed faculty loading formula is:

- 26 hrs/wk in the Engineering Technology labs at the ATC
- 7 hrs/wk of office hours in a dedicated office/cubicle at the ATC
- 7 hrs/wk of flexible planning time

This staffing model required two enabling technologies, 1) A LMS that permitted shared instructor access to all ET courses so that the instructor on duty can answer online inquiries or assist students arriving in the open-lab with their assignments and assessments. 2) An online scheduling software solution that students use to reserve lab equipment, request instructor assistance, see instructor schedules, and request end of course evaluations.

Student Enrollment

Due to the complexity of the non-term, self-paced program that started in the Fall 2014 and the ongoing OEOE model a faculty mentoring student support model using “faculty mentors” in concert with the college’s academic advising was proposed and implemented. Faculty mentors provide students with the guidance they need to develop and complete their ET academic goals. Faculty mentors help students with academic requirements, course selection degree or certificate completion, and career planning. Faculty advising is a shared responsibility between the student, student services, and the faculty mentor. All ET students develop a learning contract with their faculty mentor that lays out the program and the requirements to successfully complete their academic goals in the new OEOE format. The ET program created a guidance sheet to share with all student services advisors so that they can discuss the ET degree with students seeking program and career guidance. Students interested in ET complete online college orientation and are then directed to the Engineering Technology department to develop their learning contract, complete program orientation, and the registration process for the proper course track. Students in the program range from part-timers who take one-credit per 5-week grading period, to full-timers who take 5 program credits per 5-week session. Students sign up for the number of credits they can manage during the grading period. Students are encouraged to enroll in the number of credits they feel they can complete during a given grading period. For example, a student who works full-time, does some traveling for an employer, and has a family may only have time for a single 1-credit course per five weeks. For students accessing either financial aid or Veterans benefits specific counseling by those respective college departments is provided to ensure eligibility and compliance. To work around their many personal and employment obligations, students attend whenever it is convenient for them. The amount of time spent by students on the course, including being present in the lab, is dependent on the amount of time required to complete the courses in which they are enrolled during the 5-week block. If the student finishes early, he/she is allowed to work ahead. A student who does not complete a course by the end of the block is penalized by receiving a failing grade, or an incomplete if circumstances merit, and must re-enroll and pay tuition a second time.

Enrollment trending:
Figure 1 represents student enrollment since the start of the engineering technology AS degree program. The corresponding time periods are annotated on the left side of the graph. “Program Start” represents early program enrollment with courses taught primarily by the program director. Next, the two year plus a summer semester period identified as “Traditional Semester-based Lecture/Lab ET Program” represents the period of program steady-state in a traditional semester based, instructor (faculty & adjuncts) led program of lecture and lab courses. Immediately following that period, during the “Traditional Semester-based Piloting Content” the program began to modify course content in preparation of the shift to OEOE. The course development matrix was established (Table 1) and as courses were modified to become more self-directed they were used in the semester-based classroom. The instructor still facilitated discussions and held regularly scheduled classes, but more of the theoretical learning was shifted to the student outside of class time. This delivery model most closely resembled the “flipped classroom” often structured where students first study the topic by themselves using prepared lessons. In class students applied the knowledge by solving problems and laboratory exercises while the instructor offered guidance and offered questions rather than in person lectures. The

final phase in Figure 1 is “OEOE ET”, representing enrollment in the Fall 2015 semester. This semester the program switched to non-term (the student could start any day and have 5 weeks to complete the 1 credit hour modular courses in which they enrolled) and compete at their pace. All theory was online in the program LMS, hands-on lab exercises and competency validation was done on site in the open-lab. Data for the OEOE Spring semester is still being collected at the time authoring this paper.

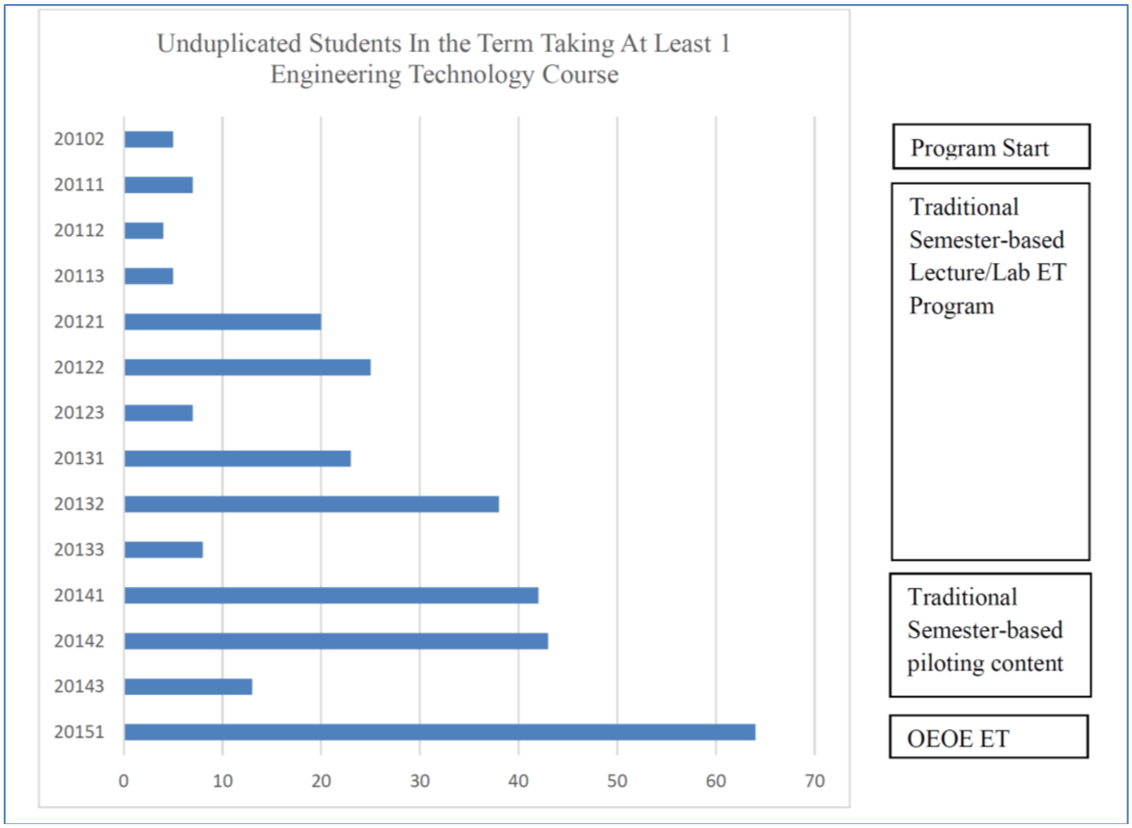

Figure 1 – Semester Based Student Enrollment in Engineering Technology

Secondary Outreach

Geographically, Polk is larger than the state of Rhode Island and equal in size to Delaware. The total area of the county is approximately 2,010 square miles which makes it the fourth largest county in Florida. Within this ecosystem, there are eight public high school career academies, one charter high school career academy, two technical centers, and one state college offering STEM programs aligned with advanced manufacturing, applied engineering, and/or engineering. To facilitate collaboration, articulation and curriculum improvement Polk State created the Polk Engineering Technologies Education Council [PETEC]: A county-wide shared industry advisory council for secondary, post-secondary certificate, & college programs to foster collaboration, reduce redundancy, and provide for a comprehensive approach to talent development for advanced manufacturing, engineering, and engineering technology.

Prior to the creation of PETEC (Polk Engineering Technologies Education Council) each of these institution had their own advisory councils, with varying degrees of industry participation, and very little inter-institutional collaboration. Through a partnership between Polk State College and Polk County Schools, the design, development and implementation of a county-wide sector-specific advisory council that connects industry and serves secondary career academies and post-secondary institutions with knowledge and insights regarding industry needs has eliminated redundancy, fostered collaboration and re-energized industry engagement.

PETEC is a countywide engineering technology / advanced manufacturing / engineering advisory and oversight council comprised mainly of industry representatives with strategic academic, training, and economic and workforce development partners. The advisory council is specifically chartered to provide guidance and input for Science, Technology, Engineering, and Mathematics (STEM) related secondary career academies, technical center certificate programs, college degree programs and corporate college training initiatives serving the sector to ensure relevancy to the engineering technology / advanced manufacturing / engineering employers.

The Council is structured so that each career academy, technical center, and college has an industry partner that represents the program quarterly at the PETEC meetings. Additionally, the council has representatives from industry at-large, economic development (CFDC & the Chamber of Commerce), the regional workforce board (CareerSource Polk), the Florida Engineering Association, and the regional manufacturing association (Mid-Florida MSCA).

The Council members provide active involvement through participation in quarterly meetings by providing subject matter expertise and advocating for a latticed and credentialed STEM workforce preparation system aligned with unified educational pathways. The Council works to effectively engage the Mid-Florida community in:

- Strengthening talent development for Florida's engineering technology, advanced manufacturing, production, and engineering workforce and student populations;
- Champion the Council's cause for planning, development, and implementation of programs, initiatives, and services to align educational and training programs with employer needs;
- Identification of current industry needs/training capabilities and future growth potential;
- Assist with the identification and recruitment of additional board members;
- Initiatives that include curricula development, identification of relevant industry certifications, educational research, business and infrastructure development, public relations, and workforce requirements and availability;
- Participation and promotion of focus groups from which training will be guided;
- Establishing Polk County as a leader in STEM workforce training/education in Florida by fostering partnerships with industry, training providers, and the county's network of career academies, technical centers, and colleges;
- Dissemination of marketing campaigns to raise awareness of careers and educational pathways;
- Program advising via PETEC where the 7 high school career academies, 2 technical career centers, and Polk State College share a joint advisory council
- Providing field experience for students (tours for secondary, increased internship opportunities for college)
- Increase college tours and collaboration with high school career academies
- Increase articulation agreements with high school career academies

- Strengthening partnerships with industry
    - Increase advisory engagement (via PETEC)
    - Validate the competencies defined in the modular courses
    - Promoting certifications that apply to a Polk degree
    - Promote the inclusion of certifications and degree credentials in hiring and promotion practices
    - Emphasizing the flexible schedules available to their workers under the OEOE format
- Shared curriculum and equipment with high school career academies
- Professional development (faculty connections with high schools) contributes to outreach
- Manufacturing Day – speakers / industry tours

Advantages

There are numerous advantages to offering the courses in the open-lab format, both to students, and for the program.

Student Advantages

- Serves full-time students.
- Serves part-time students, offering courses over extended hours each day, and allowing them to attend whenever convenient. Many of these part-time students are individuals who either work part time or full time, or are single parents.
- Students who learn at a slower pace sign up for a reduced number of 1-credit courses. Students who learn at a faster pace complete courses at an accelerated pace.
- If an incumbent worker travels for 2 or 3 weeks for an employer, lectures won't be missed. The students can catch up by attending extra hours as needed.
- If a student misses class because of a child being sick, or being sick themselves, they can catch up by attending extra hours.
- Classes are always offered. They are never cancelled due to low enrollment.
- Students do not have to wait to sign up for courses, such as advanced courses that are only scheduled once each year. All courses in the program are always offered.
- Students can begin the program at any time instead of waiting for the beginning of the fall or the spring semester.
- If a student has to repay the tuition for a one-credit class, it will not be as expensive as it is for a three-credit course.
- Students are able to finish a program at the middle of a semester rather than at the end. One advantage is that they can apply for jobs before other students in a traditional program who are waiting to graduate at the end of the semester.
- Part-time students who are swing shift workers, can attend days on the weeks they work in the evening, and then attend evenings the weeks when they work during the day.

Program Advantages

- There is no concern about not having enough students enrolled to run a class (usually 12 are required).

- The flexible schedule offers the ability to offer courses to a larger customer base than programs who offer courses on a rigid schedule. Therefore, low enrollment concerns are minimized.
- The one-credit courses attract course takers who are not interested in earning a degree. They include hobbyists, technicians who take a course for upgrading, students from other programs who need one more credit to receive financial aid and take a course to fulfill an elective requirement.
- The one-credit courses aggregated together create certificates for students not interested in obtaining an associate degree. However, if the certificate students decide to eventually pursue a degree, all of the certificate credit can be applied.
- The one-credit courses can customize the training needs of a local employer who wants an economic development contract.
- The operation of this program is less expensive than traditional technology-based college programs with training equipment used for performing laboratory experiments. For example, a traditional lab facility that has 15 students scheduled at particular times for a programmable controller course requires 15 lab trainers. Also, these labs are empty for the majority of the time. The Engineering Technology program at Polk State College requires only 3 lab trainers because PLC students are spread throughout the program, and attend at different times throughout the day and evening.
- It is less expensive for employers to upgrade the skills of their staff by attending these technical courses rather than sending them to an industrial training workshop.

Institutional change:

The following graphic (Figure 2) represents stakeholders that either influence or will be influenced by the success of the Engineering Technology OEOE project. Vectors leading away from the OEOE core indicate that there is expected to be an impact on the organization. Vectors pointing to the OEOE core indicate that the organization has a critical impact on the success of the OEOE project (and must be considered in the planning and implementation process).

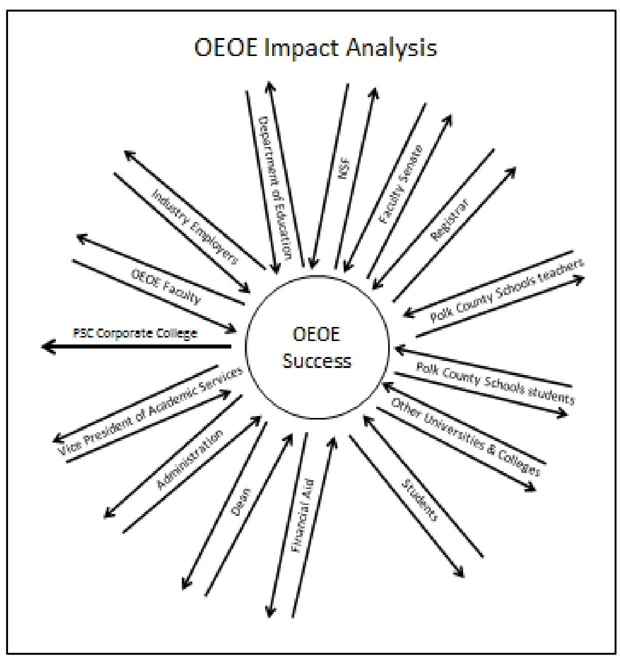

Figure 2 – Impact Diagram

At the college the ET OEOE program has resulted in:

- Culture Change
- Structural Change
- Change in Policy to accommodate rolling OEOE, related to
    - Registration, Financial Aid, Scheduling
    - Faculty employment models (still in development)

    - Need to shift the expectation that faculty will support the OEOE format with a 40 hour a week schedule vs. points / class loading formula (usually equivalent to 5x3 credit hour courses and approximately 2 hours out of class for each of those = 25 hrs).
    - Faculty Load
- Change in location of the program –Advanced Technology Center (ATC) at the new Bartow Campus
  - Design of the building to support student centered learning
  - Design of the Engineering Technology lab/classroom space to support the new OEOE format in concert with current apprenticeship programs and corporate college training

Lessons Learned

Through the design, piloting, implementation, and ongoing program delivery of the OEOE Engineering Technology degree the Polk State College team has encountered overwhelming support from the college administration and industry partners. The transition has not been easy due to the magnitude of systems and structures that needed modified. In addition to the foundational issues discussed above, the following key lessons learned should considered by any program considering shifting from traditional semester-based programing to competency-based OEOE:

1. To successfully make a conversion from traditional courses to a non-traditional format, it is necessary to provide information that is clear enough to understand for everyone at the college who is involved in making this change (Registrar, Financial Services, Student Services, Institutional Effectiveness …). Engagement of these divisions early in planning and then integration of their staff into the process at the right point of the project plan has been a major challenge in this project. Clear communication early on is necessary to explain the beneficial value of this program modification creating buy-in at all levels of the college, resulting in adequate support throughout the process.
2. At the state system level, constraints around reporting systems must be considered. In our case, the proposed OEOE course numbers do not align with the number of characters used by the Florida college system. As a result, workarounds for reporting had to be implemented and eventually new numbers may need to be assigned for each 1-credit course.
3. In a non-term environment the start and end dates for each course for the OEOE program do not align with the semester schedule at the college. They are instead created based upon the date of course registration for each individual. This presents a challenge for the Student Services department that coordinates funding for financial aid students and veterans. Therefore, much of the information entered into the college system computer and documentation must be customized and done manually, which is often a time consuming process. As a solution to this challenge, the college is considering hiring a software programmer to develop a program that will manage this process automatically. In addition the college is participating as an experimental site with the U.S. D.O.E. on competency-based programming to help shift federal barriers to implementation.
4. In addition to monitoring, mentoring and managing students taking courses simultaneously throughout the program on different schedules, performing laboratory functions, and developing and updating course materials, the instructors manually

calculate dates for students, register them and enter grades on a daily basis. In response to this challenge the project funded a programmer who will develop a software patch to automate the calculation of critical program dates, monitoring the progress of students, migration of grades into the college system when a student completes a course, and to eliminate any other tasks that must be done manually.

Conclusion

Through funding provided by the National Science Foundation, Polk State College is in the final stages of converting the method of instruction of their Engineering Technology program from a traditional lecture-based format to a self-paced, instructor mentored open-lab alternative. The purpose of this change is to provide an open-entry/open-exit option for students who can begin taking courses on any given day rather than having to wait for a start date at the beginning of a semester or summer session. To make this change, all of the courses are being restructured into modules, which are then organized into 1-credit courses. Every course in the program is offered at all times simultaneously, and students can attend whenever they want to during an extended 12-hour daily schedule. The flexibility that the open-lab format provides serves traditional students, and also enables non-traditional students to attend at convenient times, often around their hours of employment and family obligations. Serving a larger student base will also increase the enrollment in the program.

The courses offered by the Engineering Technology program align with the MSSC CPT certificate, and the Maintenance Combination Craft Apprenticeship program, allowing for the transferability of credits and a career pathway for high school students. The credits earned in the program are also transferable to some 4-year universities.

Upon completion of the OEOE project, the Engineering Technology program at Polk State College can serve as a model for other colleges in Florida and the United States who want to make a similar conversion.

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