



A.S. degree Career Pathway within the Florida State College System that includes a Professional Engineering License

Marilyn Barger (Dr.)

Marilyn Barger is the Senior Educational Advisor for FLATE and FloridaMakes, Inc. She has a Ph.D. in Environmental Engineering, a licensed Professional Engineer in Florida, and holds a licensed patent. Dr. Barger is a Fellow of ASEE, with over 25 years of experience developing engineering technology and engineering curriculum for K-12 through Graduate engineering programs.

Richard Gilbert (Professor)

Sam Ajlani

A.S. degree Career Pathway within the Florida State College System that includes a Professional Engineering License

A goal of the Florida Department of Education (FDOE) Division of Adult and Career Education, under the leadership of Senior Chancellor Henry Mack is to create and maintain a Career and Technical Education (CTE) pathway that supports the nation's best workforce education system. The A.S. Engineering Technology (ET) degree, designed and implemented by the National Science Foundation supported FLATE (Florida Advanced Technological Education Center), is a statewide program of study that prepares technicians for Florida's technical workforce. This two-year degree program is offered at 23 of the colleges in the Florida College System. This program of study is also part of a unified technical education approach, the Florida Plan, that includes high school technology and manufacturing, career academy, incumbent worker training, post-secondary technical training, and bachelor's degree programs. The ET degree has developed articulation pathways to Bachelor of Applied Science degrees offered within the Florida College System. An extension step is to create a seamless pathway from the two-year 60 semester credit hour A.S. ET degree into an ABET (Accreditation Board of Engineering and Technology) accredited B.S. Engineering Technology (B.S. ET) degree as a viable pathway to Professional Engineer (P.E.) Licensure. In addition to the ABET accreditation process, there are other challenges centered on the optimal design of the second two years (typically the junior and senior years) to include a tremendous amount of flexibility.

Daytona State College has designed a 4-year program that also articulates from 2-year Associate of Science (A.S.) programs, as well as Associate of Arts (A.A.) programs, to allow students from both to continue forward in that college's ABET accredited B.S. Engineering Technology degree program. The approach includes different course pathways based on the needs, individual backgrounds, and objectives of the students. After graduation with their bachelor's degree, students' options include immediate employment, enroll in a graduate degree program, and/or seek professional engineering (P.E.) registration. Florida is one of several states that provide a pathway to professional engineering licensure to those who earn B.S. in Engineering Technology (not Engineering) degrees. According to the Florida Board of Professional Engineers (FBPE) there are 3 requirements, education, examination, and experience to sit for any of the professional engineer exams and several ways, Table 1, to meet each requirement. **The A.S. degree Career Pathway within the Florida State College System that includes a Professional Engineering License** program with its options and its strong focus on the flexibility required to handle students with various A.S. Engineering Technology degree backgrounds is described here.

Introduction

Student enrollment in and completion of an A.S. degree in Engineering Technology is usually driven by three motivating forces, (i) obtain technical employment, (ii) advancement in their current employment, or (iii) acquire an engineering or engineering technology bachelor's degree. For students that wish to continue with an engineering related degree course of study, usually several factors must be brought to their attention. First, these students may only be aware of the different general types of engineers but will not know what those engineers actually “do for a living”. Second, it is most likely that they have not considered graduate school as an option, nor do they know what it means to be a licensed Professional Engineer (P.E.). Thus, the initial action for continuing students is an informative mentoring stage with the intent to focus their attentions on the career options without overwhelming them with what they might think are impossible hurdles like the Graduate Record Examine (GRE) or the P.E. Fundamentals in Engineering (FE) exam.

The Daytona State College's B.S. engineering technology degree program has structured its junior and senior years to minimize A.S. graduates' issues. An early consideration for students and an element in the program design is the FE exam. A curriculum to meet the needs of Florida industry and to prepare students for the Fundamentals of Engineering (FE) exam in an efficient period, are primary considerations of the requirements of the program.

Most A.S. degree seeking students have not had an examination experience that was not directly connected to success in a single course they are currently taking. They are not aware that there will be an exam after most of their engineering courses are completed but before they graduate nor that this exam is discipline specific for any of the following areas: Chemical, Civil, Electrical and Computer, Environmental, Industrial and Systems, Mechanical, and Other Disciplines. The “Other Disciplines” exam is the target for students with the A.S. Engineering Technology degree. This exam covers mathematics through differential equations, statistics, chemistry, instrumentation and controls, engineering ethics, safety, engineering economics, statics, dynamics, materials, fluids, electrical engineering, and thermodynamics.

Program Design and Options

The technical education pathway to the B.S. Engineering Technology Degree (B.S. ET) which in turn leads to a Professional Engineer's license (Table 1) in Florida is designed to meet that B.S. degree requirement but structured to facilitate two-year A.S. degree graduates. The design of the 128-semester credit hour BSET degree includes 3 course categories: general education courses (36 hours), technical electives (44 hours), and upper-level engineering courses (48 hours). Table 2 presents the 31 semester credit hours (all but one course is 3 hr.) of the required courses for the B.S. Engineering Technology Degree at Daytona State College. The table indicates the one math course requirement. This allows student selection of the Mathematics Department delivered

Calculus I or the B.S. ET program Engineering Technology Calculus I as a prerequisite general education option. Daytona State College general education requirements include 6 hours of mathematics and 6 hours of natural sciences. The degree's 36 hours of general education, program pre-requisites, and program requirements include all lower and upper-level classes (including technical electives) with some of the courses also filling degree pre-requisites in Science, Applied Mechanics, and Physics (ETG 3541), or mathematics, Engineering Technology Calculus I (EGN 2045).

Table 1: General Requirements for Florida P.E. License	
Education	
	Bachelor of Science degree in engineering from an EAC/ABET-accredited program.
	Bachelor of Science degree in engineering technology from an ETAC/ABET-accredited program
	Foreign degree or degree from non-EAC/ABET- or non-ETAC/ABET-accredited program that has been evaluated for equivalency
Examinations	
	Pass the Fundamentals of Engineering (FE) exam
	Pass the Principles & Practice of Engineering (PE) exam
Experience	
	Verified, progressive engineering experience working under a licensed PE: <ul style="list-style-type: none"> • Four years if you have a B.S. in engineering; or • Six years if you have a B.S. in engineering technology

Table 2: B.S. ET Core Courses	
Course	number
Business Writing	GEB 3213
Dynamics	EGN 3321
Electricity& Electronics and Lab*	EET 3085
Engineering Economics Analysis	EGN 3612
Engineering Tech. Calculus II	ENG 3046
Metrology & Instrumentation	ETS4502C
Programmable Logic Applications	ETS 3543C
Project Management/senior design	ETI4448
Project Manage/senior design II	ETG4950C
Statics	EGN 3311
*4 credit hour	

The facilitating structure of the B.S. Engineering Technology (ET) degree is anchored in the degree's required elective 15 credit hours from the options presented in Table 3. These courses emphasize FE test competences including safety, ethics, and engineering economics. These options reflect the flexibility embedded in the A.S. Engineering Technology degree available in 23 state colleges in Florida. This 60-credit hour course of study includes a first-year 18-credit hour Core followed by a 30-credit hour specialization. Specialization choices include

Advanced Manufacturing; Advanced Technology; Alternative Energy; Biomedical Devices; Digital Design and Modeling; Digital Manufacturing; Electronics; Mechanical Design and

Fabrication; Protection and Control Technology; Quality; Supply Chain Automation. Thus, students entering the B.S. ET degree from any one of 23 colleges with any one of 11 specializations will be able to select the degree's required electives plus an additional 29 hours of technical electives to fortify their A.S. degree specialization (or interest) without adding extra courses or extra time to their bachelor's degree program.

Table 3: B.S. ET Options			
Industrial Fundamentals (^{IF}) (Select two from ETI 4205, ETI 4186, ETI 3116, ETI 4640 and ETI 4704)	Energy (^E) (Select one from list) ETM 4220, ETM 4331, EGN 3334	Materials (^M) (Select one from list) ETI 3421, ETG 3533/L, ETG 4241/L	Programming (^P) (Select one from list) COP 2360, COP 2800 EGN 3214
Applied Logistics	Energy Systems	Materials and Processes	C# Programming
Applied Reliability	Fluid Mechanics	Strength of Materials	Java Programming
Engineer Quality Assurance	Thermodynamics	-	-
Operational Management	-	-	-
Operational Safety	-	Construction Materials & Lab	Programming for Engineering

The B.S. Engineering Technology degree at DSC also provides flexibility for students that elect entrance to an engineering graduate program. These engineering graduate degree programs universally require a set of mathematics prerequisite. The college's mathematics department offers this course sequence (Calculus I, Calculus II, Calculus III, and Differential Equations) and these courses can substitute or complement the ET degree math requirements. This four-course sequence is absorbed into a student's 128 total hours as required math credit substitutes (the Engineering Technology math courses, EGN 2045 and EGN 3046) and technical elective hours.

Table 4 presents a student profile DSC of a student that entered the program with an A.S. Engineering Technology degree. Since no specific information about this student is provided the table allows for speculation about the student's motivation. The table indicates the student opted to attend the summer semester between the junior and senior year. Although this may not be the usual practice of a traditional student, it is a common option for A.S. degree students. The math selection, MAC 2311 instead of EGN 2045, suggests that a graduate engineering degree might have been in the career path, however, taking EGN 3046 the next semester would indicate an alteration of career intent or simply selecting the math course based on its availability. The elective focus beyond the two required Industry Fundamentals (IF) suggests an initial career in operational level industry management. For this student, those electives included ETI 4205 and ETI 4640. Collectively, this student completed four courses (12 semester hours) in Industry Fundamentals which is a concentration option that would not usually fit into a B.S. engineering degree portfolio. However, it does represent a great starting platform for a career in plant management.

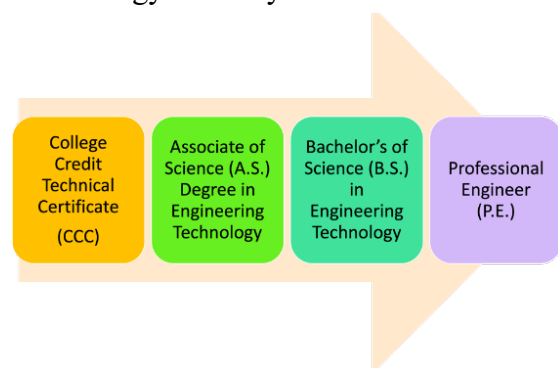
Conclusion

The B.S. Engineering Technology (ET) degree at Daytona State College provides the missing link in the Career and Technical Education pathway portfolio supported by the Florida

Table 4: Case study- ET degree holding Student's pathway (*required)	
First Year 1st Semester (Fall)	First Year 2nd Semester (Spring)
Calculus 1 MAC 2311 (EGN 2045 substitute)	Engineering and Technology Calculus II (EGN 3046)
Electricity and Electronics* (EET 3085 -3hr)	Engineering Economics Analysis* (EGN 3613 -3hr)
Electricity/Electronics Lab* (ETT 3085L-1hr)	Metrology and Instrumentation* (ETS 4052 -3hr)
Programmable Logic Applications* ETS 3543	Engineering Quality Assurance ^{IF-2} (ETI 3116 -3hr)
Business Writing* (GEB 2313 - 3hr)	
Operational Safety ^{IF-1} (ETI 4704-3hr)	
First Year Summer Semester: Programming for Engineering ^P	
Second Year 1st Semester (Fall)	Second Year 2nd Semester (Spring)
Statics* (ETG 3311 -3hr)	Project Management & Senior Design II*(ETG4950)
Materials and Processes ^M (ETI 3421 -3hr)	Dynamics* (ETN 3321 -3hr)
Project Management & Senior Design I*	Applied Logistics (ETI 4205 -3hr)
Energy Systems ^E (ETM 4220 -3hr)	Operations Management (ETI 4640 -3hr)

Department of Education. With its implementation, students in CTE programs in any high school in Florida have an articulation route to a Florida Professional Engineer license with increasingly challenging but rewarding career exit options upon completion of College Credit Credentials (CCC), A.S. ET degree, and B.S ET degrees. The degree offered at Daytona State

Figure 1. Florida Engineering Technology Pathway to P.E.



College is designed and structured to provide the flexibility to address the constraints A.S. degree students put into play. These constraints include: (i) articulation agreements that can absorb the nuances of the 23 state colleges that offer the A.S. ET Degree; (ii) meet competency requirements embedded within an ABET accreditation engineering degree program; maintain the 128-semester credit hour cap for that program; and (iii) meet the knowledge and skill expectation for the technical workforce in Florida based industry. The

fact that the last two years can be completed completely online makes this B.S. Engineering Technology pathway extremely attractive to many graduates of the 23 A.S. ET degrees in Florida. A.S. graduates can enroll in the B.S. ET program part time while enjoying full time employment in one of the many Florida industry sectors supported by this degree. With over

2,000 students enrolled in the A.S. ET degree statewide and this Florida College System pathway provides a very accessible opportunity for all A.S. program graduates to complete a bachelors' degree and possibly professional license and/or graduate degrees.

To build an articulation link from a two-year A.S. program to an engineering program in your college there are several lessons learned that will make that task easier. First, the current requirements of the Daytona State College B.S. ET degree evolved as the department and faculty learned of and discussed the different requirements and demands of the A.S. students to be served. Second, changes made to the program requirements over time were always driven by the intent to reduce rigidity and increase the long-term flexibility of the program. Third, the B.S. ET core and electives focused on ABET expectations for the degree however, the content of elective options also amplifies the A.S. student high level of hands-on experience to the point that a "traditional" engineering student taking these electives will find integrating that skill and knowledge base into their classroom activities (virtual and real) new and perhaps challenging. Fourth, develop faculty communication and cooperative links with the target A.S. programs. Finally, A.S. graduates will need guidance and assistance with the entire FE exam process with the minimum intervention being constant reminders of its importance and a bit of pressure to make sure they sit for the exam.