

Developing an Effective Community College Transfer Pre-Engineering Program

Cecelia M. Wigal, Ph.D., P.E.¹ Tim McGhee, M.S.²

Abstract – Many states are actively addressing strengthening the ties between the states' 2-year and 4-year degree granting institutions. The stated purpose for this activity is to define articulation agreements for A. S. degrees that aid students in completing 4-year degrees in 4 years whether the students begin their academic careers at the 4-year institution or at the 2-year institution. This paper presents another means to address the 2-year program – an A.A.S degree that embeds less general education and more engineering relevant content courses in the curriculum. Specifically, Chattanooga State Community College and the University of Tennessee at Chattanooga (UTC) College of Engineering and Computer Science are teaming to provide students the first two years of the engineering program in parallel. The structure of this degree program, its benefits, concerns, and possibilities are addressed.

Keywords: Pre-Engineering, Community College Partnership, 2-year degree

INTRODUCTION

Many states, including Tennessee, are actively addressing strengthening the ties between the states' 2-year and 4-year degree granting institutions. The stated purpose for this activity is to define articulation agreements that aid students in completing 4-year degrees in 4 years whether the students begin their academic careers at the 4-year institution or at the 2-year institution. For most BS and BA degree programs this activity does not create much anxiety. However, for professional programs, such as Nursing and Engineering, this task creates much apprehension. The major concern is how can generically defined engineering courses meet our programs' needs?

The State of Tennessee's solution for engineering is to define an A.S. degree of 66 hours that includes meeting the state's general education requirements (42 hours) as well as 24 hours in the major. For most engineering programs this means meeting mathematics, chemistry, and physics requirements and a few major specific courses (Circuits I, Statics, Dynamics for example) that are necessary for the student to progress at the Junior level once the A.S. degree is obtained. However, due to the general education requirements of the A.S. degree, it is not possible to include all required sophomore level engineering courses in the agreement. Thus these agreements have only been accepted by the 4-year programs if they include notes strongly suggesting the student complete other courses prior to entering the 4-year institution.

This paper presents another means to address the 2-year program pre-engineering curriculum – an A.A.S degree that does not have the same general education completion requirements. Chattanooga State Community College and the University of Tennessee at Chattanooga (UTC) College of Engineering and Computer Science are teaming to provide students the first two years of the engineering program in parallel. This paper addresses the curricular, instructional, and structural components of the partnership. In addition, actions for ensuring desired learning outcomes are identified.

¹ University of Tennessee at Chattanooga, 615 McCallie Ave., Chattanooga TN 37403, Cecelia-wigal@utc.edu.

² Chattanooga State Community College, Amnicola Highway, Chattanooga TN 37406, Tim.McGhee@ChattanoogaState.edu.

ENGINEERING AT UTC

The mission of the College of Engineering and Computer Science at UTC is to serve the people, businesses, and industries of the Chattanooga region and to support its technical needs. The program is grounded in the application of scientific and mathematical principles and is based on a commitment to interdisciplinary study. To this end, the mission of the engineering programs is to provide accessible education in the theory and application of engineering in a supportive, interdisciplinary environment that prepares students for successful careers in industry, government, and academia. UTC Engineering emphasizes project-based learning as one means to respond to this mission.

The strengths of UTC's four-year Engineering programs are the emphases on breadth, interdisciplinary interaction, design, and depth. Every student completes a structured set of courses that form a foundation in written and oral communication, mathematics, chemistry, physics, and engineering fundamentals. Special emphasis is placed on learning the basic tools and techniques of engineering. Interdisciplinary interaction is introduced and emphasized through interdisciplinary design projects, team experiences, and laboratory exercises that begin the freshmen year. Depth is provided through theory and hands on experience (laboratories) in one of eight disciplines – chemical, civil, computer, electrical, environmental, industrial, mechanical, and nuclear – as chosen by the student. A ninth discipline – education – is presently in review by the University Curriculum Committee for initiation in Fall 2011.

Four of the engineering disciplines are structured as discipline specific programs. These are the chemical, civil, electrical, and mechanical engineering programs. These programs are accredited by the Engineering Accreditation Commission (EAC) of ABET Inc., the national accrediting agency for engineering, computing, and technology programs as specific Chemical, Civil, Electrical, and Mechanical engineering programs, respectively.

The remaining disciplines are structured as options within an interdisciplinary engineering (ENCR) program that focuses on providing depth in engineering applications that tend to cross disciplines. This program is accredited by the EAC of ABET Inc., as an Engineering program.

Each of the five distinct engineering programs offers specific upper-level undergraduate courses that provide learning opportunities to support the skill and knowledge needs of graduates of that program. Each program is governed by its own mission and set of program objectives.

In addition, the ENGR program services the other four programs with engineering fundamental courses taken by students during their four year curriculum (most are required during the first two years). The engineering fundamental courses equip the student with an understanding of basic engineering science, engineering economic analysis, statistical analysis tools, and decision making tools. Laboratories develop an understanding of engineering instrumentation, experimentation, and fundamental principles. Written and oral communication is emphasized throughout the curriculum. The engineering design experiences begin with freshmen team design projects, are continued throughout the curriculum, and culminate in a two-semester interdisciplinary design project. The study of the computer and its applications is integrated throughout the curriculum.

The engineering curriculum is highly structured. The typical engineering course has one or more prerequisites which must be completed before enrollment in that engineering course. It is expected that laboratory courses are taken simultaneously with the related lecture course. Typical courses of study have been prepared for each program. Many of the faculty who support the various engineering programs also teach the engineering fundamentals courses.

PRE-ENGINEERING AT CHATTANOOGA STATE

Presently Chattanooga State Community College offers an associate of science (A.S.) degree for students wanting to transfer to a university to complete their engineering degree requirements. This program is titled Pre-Engineering and is housed in the Engineering Technologies Division. The program states that by taking the appropriate courses one can complete up to 64 semester hours of an engineering degree at Chattanooga State prior to transferring to a university (such as UTC). In most cases, credits received by transfer for engineering courses require a minimum grade of C.

Chattanooga State presently offers almost all of the engineering, math, chemistry, physics, and english courses UTC requires of its engineering majors. These courses are shown in the Chattanooga State Pre-Engineering advisement sheet (Figure 1.0) below.

Student: _____		ID# _____			
Pre-Engineering Advising Worksheet					
Course	Hrs	Grade	Term	UTC Equiv	Comments
<i>Rhetoric and Composition</i>					
ENGL 1010	3			ENGL 121	
ENGL 1020	3			ENGL 122	
<i>Cultures and Civilizations</i>					
RELS 2030	3			non-western	
<i>Humanities/Fine Arts (Take one humanities and one fine arts)</i>					
	3				ART 1030, ART 2030, MUS 1030, THEA 1030
	3				HUM 1010, HUM 1020
<i>Behavioral/Social Science (Take two courses total; in different areas)</i>					
	3				EC 211, EC 212, PO 110, PY 101, PY 241, SO 110, SO 120, SO 215
	3				
<i>Electives (For all Pre-Engineering majors unless otherwise noted.)</i>					
CHEM 1110 General Chemistry	4			CHEM 121/123	Prereq: Chem 1010 or equiv., Coreq: Math 1710
EG 104 Vector Statics	3			ENGR 104	Concurrent: Math 1920
EG 185 Intro Engr. Design	3			ENGR 185	Concurrent: Math 1720
EG 222 Engr. Statistics	3			ENGR 222	Prereq: Math 1720
EG 224 Intro Engr. Computations	3			ENGR 224	Chemical, Civil, Environmental, Mech. majors Prereq: Math 1720
EG 225 Engr. Programming	3			ENGR 225	Electrical, Industrial majors Prereq: Math 1720
EG 246 Mech. of Materials	3			ENGR 246	Prereq: EG 104
EG 247 Mech. of Materials Lab	1			ENGR 247	Concurrent: EG 246
EG 248 Dynamics	3			ENGR 248	Civil, Industrial, Mech. majors Prereq: EG 104
EG 270 Electrical Circuits	3			ENGR 270	Concurrent: Math 1920
EG 271 Electrical Circuits Lab	1			ENGR 271	Chemical, Civil, Electrical, Industrial majors Concurrent: EG 270
MATH 1910 Calc I	4			MATH 151/152	Prereq: Math 1720 or equiv.
MATH 1920 Calc II	4			MATH 161/162	Prereq: Math 1910
MATH 2010 Linear Algebra	3			MATH 212	Prereq: Math 1910
MATH 2110 Calc III	4			MATH 255	Prereq: Math 1920
MATH 2120 Differential Eqs.	3			MATH 245	Prereq: Math 1920, Coreq: Math 2010
PHYS 2110 Calculus Physics I	4			ENGR 103/113	Prereq: Math 1910 and Phys 2010 or dept consent, Coreq: Math 1920
PHYS 2120 Calculus Physics II	4			PHYS 231/281	Prereq: Phys 2110

Notes:

Figure 1.0: Chattanooga State Pre-Engineering Advisement Sheet [1]

However, the Pre-Engineering A.S. area of emphasis requires that the students complete only a portion of these courses to complete the A.S. degree (see Table 2.0). This is because the students must complete the general education courses required of an A.S. degree. This is 36 hours of the required 60 hours toward the degree (Courses meeting general education requirements are shown in orange print). This leaves 24 hours of engineering related hours that do not meet general education requirements. This is equivalent to 8 courses. At least 13 hours are needed for the student to complete the course requirements to enter one of UTC's engineering programs at the junior level (based on engineering course preparation). Thus, even though the Pre-Engineering program at Chattanooga State is publicized as a 2+2 program it does not sufficiently prepare students to successfully complete an engineering degree in 2 years following transfer to the 4 year program.

APPLIED SCIENCE IN ENGINEERING

Chattanooga State has proposed a different approach that will better prepare students to complete a 4-year degree in 2 years once completing the program at Chattanooga State and transferring to a 4-year program such as UTC's. They are proposing an Associate of Applied Science (A.A.S.) degree with a concentration in General Engineering. This curriculum mirrors the first two years of engineering course requirements at UTC for each of its engineering programs. An example of the curriculum requirements is shown in Figure 2.0 for civil engineering. The courses offered at Chattanooga State are the same courses offered at UTC for that program. Thus the students starting their

engineering degree at Chattanooga State can have a seamless transfer to UTC and expect to complete their engineering degree in 2 additional years at the same course load as those students who started their degree program at UTC.

Table 2.0: Chattanooga State Pre-Engineering Course Schedule [2]

Chattanooga State Sample Course Schedule: Pre-Engineering	
Fall (Semester 1)	Spring (Semester 2)
CHEM 1110 – Chemistry I	ENGL 1020 – Composition II
ENGL 1010 – Composition I	EG 104 – Vector Statics
MATH 1910 – Calculus I	EG 224 – Intro to ENGR Computations
EG 185 – Intro to Engineering	Or EG 225 – ENGR Programming
EG 222 – Prob/Stats for ENGR	SP 110 – Public Speaking
Fall (Semester 3)	Fall (Semester 4)
EG 246 – Mechanics of Materials	RELS 2030 – Religions of the World
EG 247 – Mechanics of Materials Lab	History Sequence course
EG 270 – Electrical Circuits	Literature Elective
MATH 1920 – Calculus II	Social & Behavioral Gen Ed Elective
PHYS 2110 – Calc based Physics I	Humanities/Fine Arts Gen Ed Elective
Note: It is suggested that additional engineering, math, physics courses be taken, as required for the terminal engineering degree, such as	
EG 271 – Electrical Circuits Lab	MATH 2110 – Calculus III
EG 248 – Dynamics	Phys 2120 – Calc based Physics II
MATH 2010 – Linear Algebra	

What makes this possible is that the A.A.S degree is not considered a transfer degree and thus does not have to meet the same general education requirements as the A.S. degree. Thus the additional hours are available for completion of engineering requirements. This curriculum also recognizes that the engineering degree requires 128 hours. Thus at least 64 of these hours are completed at Chattanooga State, instead of 60 or 61. This provides opportunity for another 3 hour course and laboratory.

IMPLICATIONS

The Opportunities

Having a parallel 2 year program at the local community college provides a number of opportunities to the 4-year degree program other than the ability to graduate transfer students prepared for beginning the 3rd year of their engineering program at UTC. It also provides a means for 4 – year program students to take courses they could otherwise not take due to closed status or scheduling conflicts. Chattanooga State is located 15 minutes from the UTC campus and students can easily commute between the two campuses.

For the parallel program to be successful it is required that the faculties in the 2-year and 4 –year programs have open discussions where curriculum syllabi, teaching strategies and course goals are shared. The engineering courses at Chattanooga State are modeled after the UTC courses. In fact, prior to a recent change in numbering at UTC, the courses were also numbered the same to simplify the transfer process (the new course numbering will be provided to Chattanooga State so that their system can be revised accordingly).

UT-Chattanooga/Chattanooga State Community College Articulation/Transfer Agreement B.S. Civil Engineering					
Chattanooga State Community College, Pre-Engineering					
<u>FRESHMAN</u>	<u>Fall</u>	<u>Spring</u>	<u>SOPHOMORE</u>	<u>Fall</u>	<u>Spring</u>
CHEM 1110	4		EG 222	3	
ENGL 1010, 1020	3	3	EG 224		3
MATH 1910, 1920	4	4	EG 246	3	
EG 104		3	EG 247	1	
EG 185	3		EG 248		3
S/BS Elective		3	EG 270		3
Fine Arts Elective		3	EG 271		1
			PHYS 2110, 2120	4	4
			MATH 2010, 2120	3	3
			MATH 2110	4	
	14	16		18	17
					65

The University of Tennessee at Chattanooga (B.S. Civil Engineering)			
<u>JUNIOR</u>	<u>Hours</u>	<u>SENIOR</u>	<u>Hours</u>
ENGR 3070/3070L	4	ENGR 3850	3
ENCE 3400	3	*ENGR 4850 or ENCE 4500	3
ENGR 3520	3	ENCE 3620	3
ENCE 3610	3	ENCE 4610	3
ENCE 2610	3	ENCE 4620	3
ENCE 3630	3	ENCE 4680	3
ENCE 3680	3	ENEV 4380	3
ENEV 3310	3	GEOL 4450	3
Non-western Culture	3	Approved 300/400Tech Elective	6
Humanities Elective	3		
Behavioral & Social Sciences	3		
	34		30
			64
			129

Figure 2.0: UTC – Chattanooga State Articulation Agreement Civil Engineering [3]

The A.A.S degree with the General Engineering concentration is also an accreditable program. UTC and Chattanooga State will work together to obtain accreditation so that the processes used at Chattanooga State will be similar to those at UTC. Thus the results that Chattanooga State obtains during its assessments can also feed into the UTC assessment activities.

The Concerns

The main concerns of the proposed A.A.S degree is that it is not considered a transfer degree program. A.A.S degrees are used most often for students interested in a 2-year program that prepares them for a position in the work place. However, if a student is looking for a transfer degree program in Engineering they will be directed to the A.S. program previously defined. This is the degree program supported by the Tennessee Board of Regents. Thus Chattanooga State will have to take the initiative to advertise the A.A.S degree program as a more effective program for transfer execution. The students will have to understand they are preparing themselves for a 4-year degree and not a 2-year degree that completes their general education requirements. As a benefit, the proposed A.A.S degree is a strong degree to prepare students to be engineering assistants and technicians.

In addition, the success of the parallel program depends on the open communication between the faculties of the 2- and 4-year programs. The 4-year program must relinquish the thought that they own the 4-year degree. The 2-year

program must be open to serving the needs of the 4-year program. Both sets of faculty must be open to learning from each other especially with respect to how students assimilate material. Both programs can benefit from the teaching strategies practiced at both institutions.

CONCLUSION

Chattanooga State Community College and the UTC College of Engineering and Computer Science have worked on the A.A.S articulation agreement for almost one year. The benefit of the work has been the initiation of a stronger link between the two institutions. More syllabi and laboratory assignments have been shared and faculties from both programs have visited each other's campus for program discussions. The two programs have also teamed to initiate a strategy for securing program accreditation by ABET, Inc for the new A.A.S degree program. The faculties are also proposing a dual admission partnership so students at Chattanooga State will have the benefits of the UTC 4-year degree students (such as facility use and UTC advising) while they complete their first two years at Chattanooga State.

As the partnership grows it is believed that more benefits will arise including the growth of student chapters of engineering societies (from including students from both institutions). There may also be opportunities to create student project teams that consist of students from both institutions and opportunities to share faculty (this was initiated this spring – 2011). The possibilities are numerous if the institutions continue the open partnership and remember to emphasize the benefit the partnership has for student education.

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Cecelia M. Wigal

Cecelia M. Wigal received her Ph.D. in 1998 from Northwestern University and is presently a professor of engineering and Assistant Dean of the College of Engineering and Computer Science at the University of Tennessee at Chattanooga (UTC). Her primary areas of interest and expertise include complex process and system analysis and quality process analysis in industry and service systems. Dr. Wigal is also interested in engineering education reform to address present and future student and national and international needs.

Tim McGhee

Tim McGhee received his M.S. in 2007 from the University of Tennessee at Chattanooga and currently serves as the Dean of the Engineering Technology Division at Chattanooga State Community College. He has over 21 years of project engineering/management and construction experience with the U.S. Army Corps of Engineers with responsibilities in site drainage design and erosion control. His primary areas of expertise now include capacity building in relation to aligning engineering technology curricula with industrial workforce development needs. Mr. McGhee is deeply involved with redesigning engineering technology education with an appropriate body of knowledge that will provide highly-skilled and prepared engineering technicians for the current and future workforce needs of the greater Chattanooga economic region.