AC 2011-2869: PROVIDING AND ENSURING AN EFFECTIVE COMMUNITY COLLEGE TRANSFER PRE-ENGINEERING PROGRAM

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Developing an Effective Community College Transfer Pre-Engineering Program

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 in the first two years. Specifically, Chattanooga State Community College and the University of Tennessee at Chattanooga College of Engineering and Computer Science are teaming to provide students the first two years of the engineering program in parallel.

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 a specific 4-year program's 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 with the promise that they include notes suggesting the student complete other courses prior to entering the 4-year institution.

However, there is another solution. This paper presents 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 College of Engineering and Computer Science are teaming to provide students the first two years of the engineering program in parallel. This paper defines the curricular, instructional, and structural components of the curriculum and partnership. The paper emphasizes the actions taken to ensure (1) desired learning outcomes are coordinated between the two institutions and (2) means are developed to consistently and accurately test the outcomes to support accreditation needs for both programs.

Engineering at The University of Tennessee at Chattanooga

The mission of the College of Engineering and Computer Science (CECS) at the University of Tennessee at Chattanooga (UTC) is to serve the people, businesses, and industries of the Tennessee 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 program 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 program 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 nine disciplines – chemical, civil, computer, electrical, environmental, industrial, mechanical and UTeach (education).

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, 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 (ENGR) program that focuses on providing depth in engineering applications that tend to cross disciplines. This program is accredited by the EAC of ABET as an Engineering program.

Each of the five distinct engineering programs offer 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 are 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 discipline program and may be obtained from the

faculty advisor. Many of the faculty who support the various engineering discipline programs also teach the engineering fundamentals courses.

Pre-Engineering at Chattanooga State Community College

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 major during their first two years. (See Table 1.0).

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

Student: _____ ID# _____

Pre-Engineering Advising Worksheet

Course	Hrs	Grade	Term	UTC Equiv	Comments
Rhetoric and Composition					
ENGL 1010	3			ENGL 121	
ENGL 1020	3			ENGL 122	
Cultures and Civilizations					
RELS 2030	3			non-western	
Humanities/Fine Arts (Take one humanities and one fine arts)					
	3				ART 1030, ART 2030, MUS 1030,THEA 1030
	3				HUM 1010, HUM 1020
Behavioral/Social Science (Take two courses total; in different areas)					
	3				EC 211, EC 212, PO 110, PY 101, PY 241, SO 110, SO 120, SO 215
	3				
Electives (For all Pre-Engineering majors unless otherwise noted.)					
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:

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 as underlined). This leaves 24 hours of engineering related hours that do not meet general education requirements. This is equivalent to 8 courses. At least 13 additional 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. Therefore, students seriously considering transferring to UTC to complete their 4-year engineering degree are strongly advised to not complete the A.S. degree but to take the necessary engineering courses instead (because it is better for the students).

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	

Applied Science in Engineering

Since pre-engineering students are being advised to not complete an A.S. degree Chattanooga State Community College was concerned that it is not being credited for "graduating" these students from their program and institution. Thus, Chattanooga State proposed an Associate of Applied Science (A.A.S.) degree with an option in Engineering Science that will better prepare students to complete a 4-year degree in 2 years once completing a degree program at UTC. 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 1.0 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.

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 61. This provides opportunity for another 3 hour course and laboratory.

UT-Chattanooga/Chattanooga State Community College
Articulation/Transfer Agreement
B.S. Civil Engineering

Chattanooga State Community College, Pre-Engineering

FRESHMAN	Fall	Spring	SOPHOMORE	Fall	Spring	
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)

JUNIOR	Hours	SENIOR	Hours	
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 1.0: UTC – Chattanooga State Articulation Agreement Civil Engineering[3]

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, 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).

Interestingly, the parallel program is opening opportunities for the Chattanooga State pre-engineering faculty to support UTC as adjuncts for the first two year courses and reciprocally for the UTC faculty to adjunct at Chattanooga State. This benefits both institutions. For example the Chattanooga State faculty gets firsthand experience to requirements and objectives of the course and how the UTC faculty addresses them. This is possible because the first time the Chattanooga State faculty member teachers the course one of the UTC faculty works closely with the individual to communicate the course expectations and current practices. Doing this not only helps the Chattanooga State faculty present the course but also allows the UTC faculty to learn what another faculty, and in this situation, institution, may bring to the course.

The parallel program is also opening the door to a dual admission process between the two programs and institutions. This conversation is in its infancy but it is expected to be complete within a year.

Conversation is also active between the two programs to get the A.A.S degree with the Engineering Science option accredited by ABET. UTC and Chattanooga State will work together to obtain accreditation so that the assessment 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. This is important since most pre-engineering students at Chattanooga State move on to UTC for their 4-year degree.

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. 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 UT 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 and Chattanooga State faculty are teaching as adjuncts at UTC.

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. The possibilities are numerous if the institutions continue the open partnership and remember to emphasize the benefit the partnership has for student education.

References

1. "Welcome to Pre-Engineering at Chattanooga State" Chattanooga State**.edu/engineering/preengineering/index.html**, revised 11/24/10, accessed 12/03/10.
2. "Pre-Engineering A.S Area of Emphasis" **http://catalog. Chattanooga State.edu/preview_program.php?catoid=9&poid=790&returnto=603**, accessed 12/03/10.
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