AC 2012-4601: ASSOCIATE OF SCIENCE DEGREE PROGRAM TO FACILITATE TRANSFER OF STUDENTS FROM TWO-YEAR TO FOUR-YEAR ENGINEERING PROGRAMS

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James K. Nelson received a bachelor's of civil engineering degree from the University of Dayton in 1974. He received the master's of science and doctorate of philosophy degrees in civil engineering from the University of Houston. During his graduate study, Nelson specialized in structural engineering. He is a registered Professional Engineer in four states, a Chartered Engineer in the United Kingdom, and a Fellow of the American Society of Civil Engineers. He is also a member of the American Society for Engineering Education and the SAFE Association. Prior to receiving his Ph.D. in 1983, Nelson worked as a Design Engineer in industry and taught as an Adjunct Professor at the University of Houston and Texas A&M University, Galveston. In industry, he was primarily involved in design of floating and fixed structures for the offshore petroleum industry. After receiving his Ph.D., Nelson joined the civil engineering faculty at Texas A&M University. He joined the civil engineering faculty at Clemson University in 1989 as Program Director and Founder of the Clemson University Graduate Engineering programs at the Citadel and became Chair of Civil Engineering in 1998. In July 2002, Nelson joined the faculty at Western Michigan University as Chair of Civil and Construction Engineering. At Western Michigan, he started the civil engineering undergraduate and graduate degree programs and also chaired the Departments of Materials Science and Engineering and Industrial Design. In summer 2005, he joined the faculty at the University of Texas, Tyler. At UT, Tyler, he was the Founding Chair of the Department of Civil Engineering and instituted the bachelor's and master's degree programs. In 2006, he became the Dean of Engineering and Computer Science. Nelson's primary technical research interest is the behavior of structural systems. For almost 25 years, he has been actively involved in evaluating the behavior of free-fall lifeboats and the development of analytical tools to predict that behavior. His research has formed the basis for many of the regulations of the International Maritime Organization for free-fall lifeboat performance. Since 1998, Nelson has served as a Technical Advisor to the U.S. delegation to the International Maritime Organization, which is a United Nations Treaty Organization. In that capacity, he is a primary author of the international recommendation for testing free-fall lifeboats and many of the international regulations regarding the launch of free-fall lifeboats. He has authored many technical papers that have been presented in national and international forums and co-authored three textbooks. Nelson chaired a national committee of the American Society of Civil Engineers for curriculum redesign supporting the civil engineering body of knowledge. He is actively engaged in developing strategies for enhancing the STEM education pipeline in Texas and nationally and has testified before the Texas Senate Higher Education Committee in that regard. He served on a committee of the Texas Higher Education Coordinating Board to develop a statewide articulation compact for mechanical engineering and currently chairs the council for developing articulation compacts in other engineering disciplines. He also served on the Texas State Board of Education committee preparing the standards for career and technical education.

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Mary Smith has been employed with the Texas Higher Education Coordinating Board since 1987 and now serves as Assistant Deputy Commissioner for Academic Planning and Policy. She is responsible for the administration and management of matters related to the board's higher education academic planning and policy functions, and she provides leadership on key projects, reports, and studies that cut across divisions of the agency. She has taught at the University of Texas, Austin,, and she currently is an Adjunct Assistant Professor of communication at St. Edward's University in Austin. Smith serves as the Project Coordinator for the $1.8 million productivity grant awarded to Texas from Lumina Foundation for Education to plan methods of making the opportunity of going to college more affordable for students and the state. Smith has organized numerous meetings and conferences on behalf of the Coordinating Board, and she has made a number of presentations at various academic and professional conventions and conferences. Smith served for five years as a Program Director in the former Division of Universities and Health-related Institutions, where her primary responsibilities included the review of new degree program proposals and the administration of the Minority Health Research and Education Grant program. Smith spent her first 12 years of employment with the Coordinating Board in the Department of Personnel Services, where from 1996 to 1999 she served as the department's Assistant Director. Prior to her employment with the Coordinating Board, Smith spent 13 years in the health care field. Smith holds a Ph.D. in communication studies, a certificate in dispute resolution, a master's of arts degree in speech communication, and a bachelor's of arts degree in psychology, all from The University of Texas, Austin.

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Associate of Science Degree Program to Facilitate Transfer of Students from 2-Year to 4-Year Engineering Programs

Abstract

Although enrollments in engineering programs have increased slightly in recent years, there continues to be concern about preparing the number of engineers necessary to meet the work force needs of the United States to maintain technological competitiveness. Community colleges continue to represent a source of students who could potentially enroll in baccalaureate engineering programs after completing their studies at the community college, if a coherent curriculum were available that would ensure seamless migration to a bachelor's degree and graduation in a timely manner. Presented in this paper is the basis for a highly structured statewide Associate of Science in Engineering Science (ASES) degree program, and the manner in which baccalaureate programs build upon this degree to complete the expectations for a baccalaureate engineering degree. The degree, which has been implemented in Texas, represents the culmination of several years of effort to align coursework among multiple institutions. Further, the degree represents a significantly new approach to curricula development. The paradigm is changed from viewing curricula as a number of courses to viewing curricula as the development of a necessary body of knowledge for a discipline. As of this writing, the ASES degree has been adopted by several institutions. Significant benefits of the degree for the student are that it provides significantly more flexibility compared to articulated programs and it provides a degree completion time that is nearly the same as a student directly entering a baccalaureate engineering program as a freshman. Benefits of the ASES degree for the educational institutions include elimination of the need for multiple articulation agreements and the need to reverse articulate coursework to provide reliable retention and graduation data for accountability.

Introduction

A statewide model Associate of Science in Engineering Science (ASES) degree program was implemented in Texas and made available at all community colleges choosing to participate and supported by participating universities. Typically, this degree is the first formal engineering degree to be offered at the community college and is intended to serve as a stepping stone to a baccalaureate engineering degree at a participating university. As ABET accreditation is a critical component of this degree, participating community colleges will seek accreditation at the earliest opportunity, normally after the first student receives the degree at that institution.

Students who successfully complete this ABET-accredited degree will be accepted into selected baccalaureate engineering degree programs on the basis of this degree at partner universities, provided they satisfy all other admission requirements of the institution and program. After being admitted, the student will follow a specified "completion curriculum" for the baccalaureate degree that is founded on the body of knowledge obtained in the associate's degree. To be entitled to pursue the degree completion curriculum after being admitted, the student must complete the prescribed courses with an overall GPA of at least 2.5, and with no grade lower than "C." No further testing or evaluation will be required.

The model Associate of Science in Engineering Science curriculum was developed to provide students with the foundational knowledge, skills, and attitudes necessary for successful pursuit of a baccalaureate engineering degree, or for employment in an engineering firm if they do not pursue a baccalaureate engineering degree. The curriculum mostly embodies courses that are already offered at participating community colleges. In general, only three additional courses may need to be offered to complete the curriculum, and these may be available through on-line instruction from other institutions. The administrative and technical staff required at a community college is not expected to increase solely as a result of offering this degree to students.

During development of the ASES curriculum, consideration was given to the necessary attributes of engineers indicated by the National Academy of Engineering in the report *The Engineer of 2020, Visions of Engineering in the New Century*[1]. Further, consideration was given to the criteria of the Applied Science Accreditation Commission of ABET, Inc. for Engineering Science programs, the curricular requirements of the State and partner universities, the requirements of the Texas Higher Education Coordinating Board (THECB), and the Engineering Deans Council and Corporate Roundtable recommendations in the report *Engineering Education for a Changing World*[2].

Background on Texas Initiatives

Despite well-established financial benefits to students and institutions, educational systems are not meeting either the regional or the national demand for an engineering workforce with the necessary knowledge, skills, and attitudes. Community colleges are perhaps the largest, mostly untapped, resource for additional very talented students to enter the engineering workforce. Nationally, one in five PhD graduates attended a community college[3]. Within Texas in fall 2010, the community colleges in the state enrolled 721,962 students while the universities in the state enrolled 557,550 students[4]. Annually, approximately 73% of all freshmen and sophomores in Texas are enrolled in community colleges. Eighty percent of all bachelor's degree completers in Texas attended more than one college or university[5]. Further, the community college student population continues to be diverse, with an average of 48% minority and 42% first-generation college students[6].

The THECB recently conducted a cohort study of students entering higher education in fall 2002[7]. The study found that of the 169,630 students who first enrolled in higher education in fall 2002, 66% of the students enrolled in community colleges. Further, the study found that only 4.5% of the entering students declared a major in engineering or graduated with a degree in engineering during the next six years. Interestingly, 74% of these students started at a 4-year institution.

These statistics indicate that community colleges are potentially the single largest untapped regional source of future engineering professionals. Yet across Texas and the nation, students in community college systems with the talent and motivation to become engineers are not entering and migrating from pre-engineering programs at 2-year institutions to baccalaureate engineering programs at 4-year institutions, despite the economic and educational benefits of this pathway for the students. The question is "Why?"

The students, in a series of focus group meeting[10], provided some of the answers to this question. Comments from the group regarding community college to university transfer included:

- Improve advising, and expand university transfer advisors housed on community college campuses;
- Expand joint programs; and
- Multitudes of articulation agreements are confusing and not enough[10].

Community college students interested in engineering may choose an engineering technology associate of applied science (AAS) degree or a pre-engineering associate of science (AS) degree. Many students choose the AAS degree program because it is a clear pathway to a marketable degree, and the pathway to a baccalaureate engineering degree is too confusing, uncertain, and long. Those community college students who do want a 4-year engineering degree generally follow one of two pathways. These pathways are:

1. Through an approved articulation agreement between the 2-year and 4-year institutions; or
2. By taking courses, which may or may not be the best selection of courses for the student's proposed major, that are later transferred to the 4-year institution.

This method of "course" migration has several disadvantages for the students and for the institutions involved. These disadvantages include:

1. A clear path to an engineering baccalaureate degree is often not visible, so qualified students entering 2-year institutions do not consider engineering careers;
2. An articulation agreement must be developed between each 2-year and each 4-year institution, which results in a multitude of duplicative articulation agreements between a 4-year institution and the several 2-year institutions from which students transfer;
3. Where no articulation agreement is in place, determination of course transferability is a time-consuming, labor intensive, and subjective process;

4. A defined pathway for transfer to universities is not available to community college advisors and students, leading to inaccurate information and loss of semester credit hours; students choosing one articulation agreement and then deciding to attend a different university lose semester credit hours;
5. Upon completion of the pre-engineering program at the 2-year institution, the students may only have an amalgamation of courses and transcripts to show for their efforts; and
6. Community colleges vary on the nature and quality of pre-engineering programs and advising offered, and, given this, students may have to complete as much as seven additional semesters or attend school full time about six years before obtaining an engineering degree.

The THECB has taken considerable steps to ameliorate these issues through its Texas higher education plan, *Closing the Gaps by 2015,* and through development of statewide voluntary articulation compacts, which are discussed in the next section of this paper. Nevertheless, issues still exist that cannot be addressed solely through statewide articulation compacts, because the compacts do not address issues of quality and levels of assessment as those for baccalaureate engineering programs at the 4-year institutions in the state.

"Tuning" in Texas

The THECB's goal of supporting the development of 2+2 programs to more fully and efficiently use the community college pathway to baccalaureate degrees began with the Voluntary Mechanical Engineering Transfer Compact (ME Compact). The ME Compact was developed in 2009 as a pilot project by the THECB, with grant support from Lumina Foundation for Education (Lumina) and the work of a voluntary advisory committee made up of engineering deans and their designees from across Texas. The more specific goal of the project was to identify a set of lower-division courses, up to the level of an associate's degree, that would provide the necessary academic background to integrate a mechanical engineering student seamlessly into participating mechanical engineering programs at 4-year institutions. The broader goal of the project was to develop a collaborative process that could be utilized to develop voluntary statewide compacts for additional disciplines. To date, the chancellors or presidents of 14 universities and 34 community and technical colleges or systems have agreed to participate in the ME Compact, eliminating the need for potentially over 475 institution-to-institution articulation agreements among these signatory institutions.

Due in part to the success of the pilot project, Texas became eligible and successfully competed for a four-year "Productivity Grant" from Lumina to implement plans to improve college completion rates and reduce the cost and time to degree. In 2010 and as part of this grant-supported project, Texas began integrating the "Tuning" process into the course alignment work that was piloted in 2009 through the efforts of the Voluntary Mechanical Engineering Transfer Compact Committee. Tuning is a faculty-led process that is designed to define what students must know, understand, and be able to demonstrate after completing a degree in a specific field, and to provide an indication of the knowledge, skills, and abilities students should achieve prior to graduation at different degree levels (i.e., associate's degree, bachelor's degree, etc.) – in other words, a body of knowledge and skills for an academic discipline in terms of outcomes and levels of achievement of its graduates. It involves creating a framework that establishes clear learning expectations for students in each subject area while balancing the need among programs to retain their academic autonomy and flexibility. The objective is not to standardize programs offered by different institutions but to better establish the quality and relevance of degrees in various academic disciplines.

With the help of faculty who comprised the 2010 Tuning Oversight Council for Engineering, Texas now has final Tuning packages and voluntary transfer compacts for Civil, Electrical, Industrial, and Mechanical Engineering. "Year Two" of Tuning Texas is well underway, including Tuning work on two additional engineering disciplines (Biomedical and Chemical Engineering) and two areas of science (Biology and Chemistry). "Year Three" of Tuning Texas will begin in February 2012 with the 2012 Tuning Oversight Council for Mathematics, Business, and Computer/Management Information Systems. "Year Four" of Tuning Texas will begin in February 2013 with Tuning work on additional high-need and high-demand disciplines.

A model community college associate's degree program that provides a statewide standard of achievement for students in pre-engineering programs, and that is recognized as an achieved body of knowledge for admission by engineering programs at 4-year institutions, is the next natural step to make the migration of community college engineering students into Texas universities for bachelor's degree completion more efficient and more seamless. The curricular content of the Associate of Science Degree in Engineering Science provides students with increased flexibility in selecting an appropriate engineering program at a participating 4-year institution, and minimizes the time to completion of the baccalaureate degree for students who choose this pathway. A critical component of the model program is that the degree will be accredited by the Applied Science Accreditation Commission of ABET (ASAC/ABET) at each participating community college to ensure the same standards of achievement as those that exist at ABET-accredited engineering degree programs at 4-year institutions. Students completing the program of study and graduating with the associate's degree from a community college will be immediately accepted into a participating 4-year institution of their choice (space permitting, meeting GPA requirements, etc.) to complete a baccalaureate engineering degree. The degree program pathway demonstrates the true spirit of both the *Closing the Gaps* and the Texas Tuning initiatives.

As stated previously, the voluntary statewide articulation compacts and the Associate of Science in Engineering Science degree program represent parallel pathways to the engineering degree. These pathways are parallel to a third pathway, which is matriculation into a baccalaureate engineering program as a freshman. These pathways are shown in Figure 1. Of the pathways through the community college system, the Associate of Science in Engineering Science provides the student with the greatest flexibility and with the least opportunity for "misadvising" and lost coursework. That degree program, and its development and implementation, is discussed herein. The program was made feasible because of the horizontal course alignment, alignment in regard to content and learning outcomes to be achieved, conducted through the "tuning" process discussed.

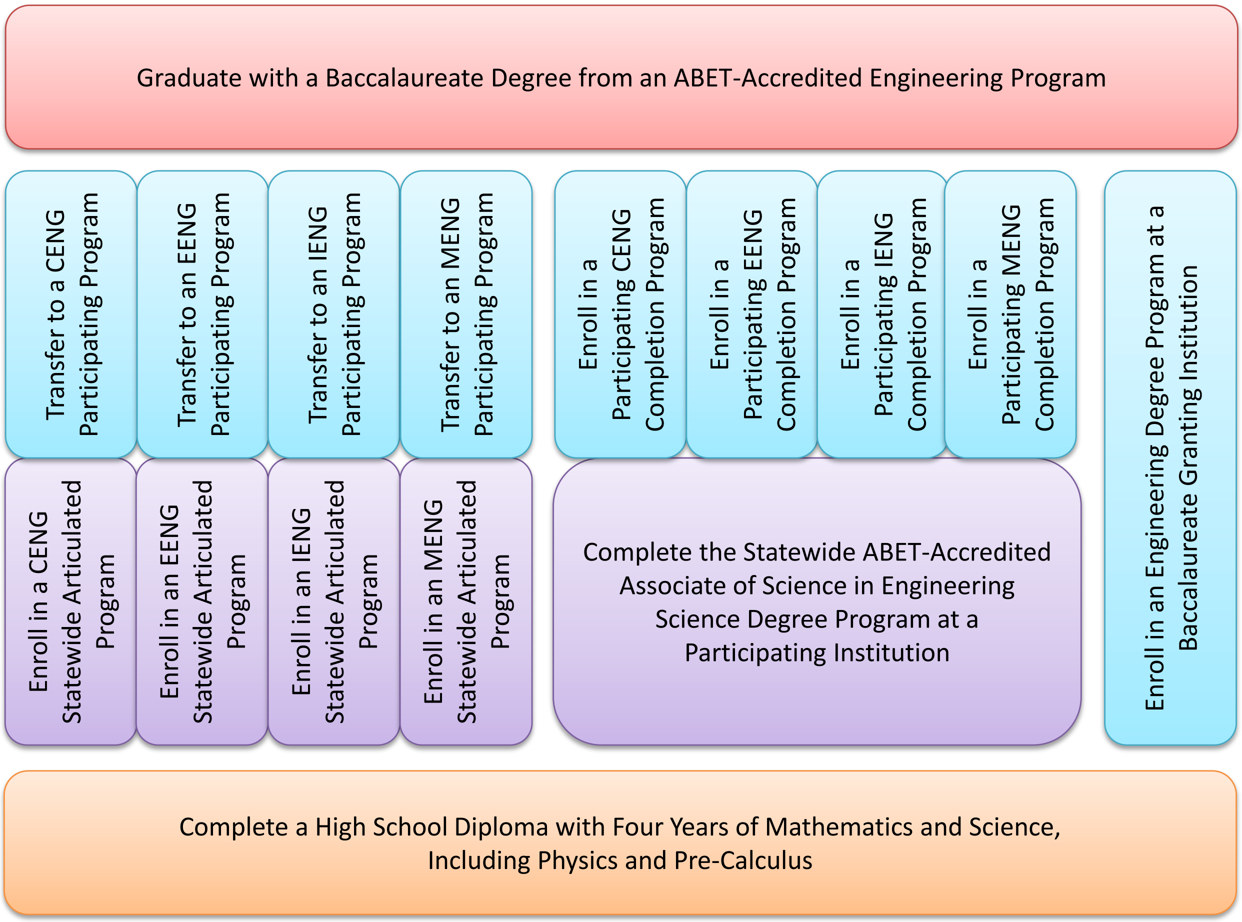


Figure 1: Pathways to a baccalaureate engineering degree

Development of the Degree Program

Certain objectives were intended to be achieved with the Associate of Science in Engineering Science degree program. These objectives included:

- The degree program should be highly structured so that minimal advising as to what courses to take is necessary, as extensive engineering advising is likely not available at the community colleges.
- There should be a single curriculum for the degree program, which leads to multiple completion programs, so that a student does not have to choose an engineering field until

he or she is getting ready to migrate to a participating university where more extensive engineering advising is available.

- The degree program must be structured so that is can be accredited by ASAC/ABET, as such accreditation provides a "level of comfort" as to the content and rigor of the program.
- The single degree program must enable the student to pursue a variety of engineering programs upon migration to a 4-year institution, while providing for reasonable total credit hours earned at the time of graduation.
- If the student does not complete a baccalaureate degree, the associate's degree should enable the student to seek technical employment.

These objectives were achieved with the degree program as implemented.

A Change in Paradigm

For the Associate of Science in Engineering Science and completion degree programs to be developed, the paradigm for the manner in which an education is viewed needed to change. Traditionally, the subject areas in which a student needed to study were determined and courses in those subject areas were included in the curriculum. This approach to curriculum development naturally leads to the course by course transfer of courses from one curriculum to another when a student changes degree programs within an institution or migrates to another institution for study. This approach for curriculum has been effective when a student has remained within an institution, but has been less than effective when a student transfers to another institution, as must occur when beginning engineering study at a community college. The result of this view of a curriculum has resulted in much loss of credit and extended time to graduation when students begin study at a community college and then migrate to a university to complete an engineering degree, as has been discussed previously.

For this degree to be developed, the paradigm was changed from what subject areas are necessary for a degree to what are the knowledge, skills, and attitudes necessary for a baccalaureate degree in a particular field, and resulting employability. The change of paradigm began with the work of the American Society of Civil Engineers (ASCE) when it defined the Civil Engineering Body of Knowledge[8]. Within that work, courses were not listed. Rather, the body of knowledge was cast in terms of learning outcomes, and the level to which those outcomes were achieved was coupled with Bloom's taxonomy for learning. This work continued in Texas through the "Tuning" initiative and associated activities funded by Lumina Foundation for Education in Texas through the THECB. A significant piece of the work coordinated by the THECB was determining expectations of achievement of portions of that body of knowledge at different milestones in the educational process, for example when a student graduates from high school and enters a university or community college, or when a student completes study at a community college and enters a university.

A graphic example of the body of knowledge for Civil Engineering, as developed by civil engineering faculty in Texas, is show in Figure 2 below. The key competencies profile is a schematic diagram that lists for each learning outcome (columns) the required competency levels according to Bloom's taxonomy (rows) that must be gained at each of four educational levels: (1) core competencies needed to enter higher education in civil engineering (HS); (2) pre-engineering competencies gained during the first two years of study (CC); (3) baccalaureate-level engineering competencies (BS); and (4) graduate-level engineering competencies (G). Full learning outcome descriptions for each of the outcome titles of the competency table explain the knowledge, skills, and attitudes that should be achieved by the graduates of baccalaureate degree programs in Civil Engineering.

Civil Engineering Key Competencies Diagram

Lumina Foundation Grant Civil Engineering Committee

	Mathematics	Natural Sciences	Materials Science	Mechanics	Experiments	Design	Teamwork	Problem Recognition and Solving	Ethics	Communication	Contemporary Issues and Historical Perspectives
Evaluation				G	G	G				G	G
Synthesis				G	G	BS		G	G	G	G
Analysis	G	G	G	BS	BS	BS	G	G	BS	BS	G
Application	BS	BS	BS	BS	BS	BS	BS	BS	BS	CC	BS
Comprehension	CC	CC	CC	CC	CC	BS	CC	CC	BS	HS	CC
Knowledge	HS	HS	HS	CC	HS	CC	HS	HS	CC	HS	HS

G	graduate-level experience competencies
BS	baccalaureate-level competencies
CC	pre-engineering competencies
HS	high school graduate competencies

Figure 2: Example of a discipline's body of knowledge

The development of such key competency tables and detailed learning outcome descriptions lead to the development of completion curricula wherein baccalaureate programs build upon the associate's degree to complete the expectations for a baccalaureate engineering degree. In other words, the focus shifts from what specific courses have been completed to what portion of the body of knowledge has been assimilated in a degree program, the Associate of Science in Engineering Science program in this particular case, and what portion must be achieved in the completion curriculum.

Associate of Science Program

To be beneficial for students and the state in terms of cost and time-to-degree, the Associate of Science in Engineering Science had to be structured so that students would not lose much coursework, if any, if they decided to change their intended field of engineering after two years. In other words, the associate's degree needed to be a generic foundational degree that would lead to completion of various selected baccalaureate engineering programs at the university. To achieve this, the curriculum had to contain minimal elective courses that tended to be discipline specific, or contain no electives at all. Further, as the curriculum of the first two years of engineering programs tends to vary widely, some compromise had to be made regarding the programs to which a student could migrate. For this reason, the decision was made to develop the program to support migration to civil engineering, electrical engineering, industrial engineering, and mechanical engineering. These tend to be the foundational engineering disciplines and are the most populous engineering degree programs in Texas[9].

The degree curriculum that was developed is presented in Appendix I of this paper. It contains a total of 65 credit hours, which is consistent with the first two years of most baccalaureate engineering programs in Texas. In Texas, the average number of credit hours in all engineering degrees is 128. As such, this degree represents approximately 50 percent of the total credit hours in a baccalaureate engineering degree.

Texas has a state-mandated common core curriculum that contains 42-44 credit hours depending upon the implementation at an institution. Normally, this entire common core curriculum must be completed by the time an associate's degree is awarded. However, there is an exemption in the THECB rules that permits an associate's degree to contain less than the complete common core curriculum, if the degree is intended to lead to another degree and the core curriculum is completed in the follow-on degree. As the degree discussed herein is intended to lead to a baccalaureate engineering degree, this exemption was used in development of the curriculum. The Associate of Science in Engineering Science degree program contains 35 credit hours of the common core curriculum. So that transcript analysis is not necessary at the baccalaureate institution, the components of the core curriculum that are completed are explicitly stated as degree requirements. This enables the 4-year programs to develop completion curricula and know precisely which components of the core curriculum must be completed by the student.

The only decision that must be made by the student is in regard to the engineering elective in the second semester of the second year. At that time, a student should have been speaking with advisors at the institution to which he or she intends to complete the degree and can select this course properly. Even if a "bad" decision is made regarding this course, the student will lose at most three credit hours.

Completion Curricula

The departmental faculty at the participating 4-year institutions developed completion curricula based on the body of knowledge contained in the Associate of Science in Engineering Science degree program. Presented in Appendix II are completion curricula from one of the partnering baccalaureate-granting institutions. These curricula are published in the undergraduate catalog beside the traditional 4-year curricula at that institution. These curricula for a given discipline will vary from one institution to another depending upon the “fabric” at the institution. At this particular institution, the graduating students who followed this pathway will have completed no more than three credit hours more than a student who entered the institution as a freshman. Note that the curricula contain nine credit hours of history, government, and social studies that are necessary to complete the Texas Common Core Curriculum.

Campus Implementation Issues

Credentialing the students on campus for admission to the program and enrolling them in the completion curriculum was not as easy as first expected. The issues that had to be resolved are as follows:

- All undergraduates apply to a Texas public university through the web-based ApplyTexas application. This is the same application that students use when migrating to a 4-year program from a 2-year program. The ApplyTexas application had to be modified to include the associate of science degree program as well as the completion programs at the 4-year institutions.
- On campus, the total credit hours earned by the student that are applicable to the degree program must be tracked so that financial aid is not impacted and so that the students status (FR, SO, JR, SR) is retained.
- The completion programs must fit within campus student services recording systems so that registration and prerequisite requirements are tracked appropriately, and so that student aid can be properly awarded.

As of this writing, these issues are still being addressed in the long-term. In the short-term, the students following this pathway are being processed manually.

Benefits of the Degree Program

The traditional pathway from the 2-year to the 4-year engineering degree is course based. While partnerships and articulation agreements exist to assist with this transfer process, the pathways tend to be institutionally course focused. The arrangement of courses is appropriate when students stay at one institution for the entire baccalaureate program. Changes in the field can be readily reflected in adjustments to the curriculum while the student is studying at the university. Unfortunately, this is not the case when the student transfers among institutions. To ameliorate these issues, the traditional articulated foundation curriculum tends to be overloaded with an abundance of challenging courses in the later semesters.

The tuning process is based on a body of knowledge and skills to be acquired across the four years. The process replicates what universities establish for the university student. The tuning process allows the arrangement of courses across the baccalaureate pathway to incorporate changes in the field and provide a better distribution of courses across the four years and institutions.

Combining the tuning process with ABET accreditation from pre-engineering programs at community colleges can increase the number of students choosing baccalaureate engineering, improve preparation for university coursework, and increase baccalaureate degree completion.

Assessment of the Program

Programmatic assessment is a critical component of success for the Associate of Science in Engineering Science degree program to be effective. Because the students are moving across institutional boundaries, the consistency of outcome achievement needs to be the same.

Because students completing the degree program can migrate to any of a number of institutions, the program ideally should be assessed across the entire state. However, with a state the size of Texas, and with the number of institutions that would need to participate, this is operationally impossible. For that reason, programmatic assessment will be conducted on a regional basis.

Texas has five basic geographic regions: Piney Woods of East Texas, the Rio Grande Valley, the Coastal Plains, the Hill Country, and the High Desert. Assessment will be conducted in each of these regions and reviewed at the THECB level for consistency. Important to note is that the THECB is not approving the assessment; rather, the THECB is reviewing the assessment for consistency across regions.

As the institutions will seek ASAC/ABET accreditation of the program on their respective campuses, the programmatic assessment must be conducted in the context of that expected by ABET. Further, students completing the courses can transfer those courses to a non-participating institution or under the terms of the transfer compacts if they do not complete a degree before migrating. Contained in Appendix III is the assessment plan for the degree.

Within Texas, the model for program assessment is extremely important because it must also fit into the framework for the voluntary articulation compacts. Within the transfer compacts, the signatory institutions have agreed to conduct regional course assessment every three years. To date, programmatic assessment has not been conducted because, as of this writing, the oldest articulation compacts have been in place for only two years and the ASES program was just initiated. Nevertheless, the assessment structure needs to be in place so that at the beginning of the 2012-2013 academic year, the necessary information could be collected so that a thorough assessment could be conducted in early summer 2013.

Conclusion and Current Status

The Associate of Science in Engineering Science degree program discussed herein was approved by the Texas Higher Education Coordinating Board on 9 November 2011 and publically announced on 11 November 2011. At the time of this writing, which is less than two months after approval and announcement of the program, three baccalaureate-granting institutions, two community colleges, and one community college system have signed on to participate in the program. Discussions are underway with four other community colleges and community college systems regarding participation.

A natural question regarding this degree program is "Can this program be implemented in other states?" The answer to that question is "Absolutely." Implementation is likely to be even easier than in Texas for smaller states that do not have the number of institutions involved with complete implementation.

One of the most critical elements for the program to work is that everyone must "play nice in the sand box." Both the 2-year and 4-year institutions must recognize the benefit of their collective collaboration for the student and do away with ill-perceived (although sometimes justly deserved) stereotypes and campus "arrogance." Two-year and 4-year programs need each other to make it work, and making it work is extremely important with the increasing costs of higher education, and especially if we are going to educate the number of engineers necessary to retain the technological superiority of the United States.

There are a number of advantages to combining the tuning process and ABET certification from pre-engineering programs at community colleges:

- More community college students, including minorities and first-generation college students, will choose engineering as a program of study;
- Community college students will be consistently better prepared for university study;
- Community college students will not be locked into transferring to one university but can transfer to any participating university in the state upon acceptance;
- Degree completion rates will improve;
- Time to degree will decrease; and
- Students, the state, and institutions will improve financially as a result of lowered costs and decreased time to degree.

References

(1) National Academy of Engineering. (2004). *The Engineer of 2020, Visions of Engineering in the New Century*. Washington D.C.: The National Academies Press.

(2) The American Society for Engineering Education (2010). Engineering Education for a Changing World. Retrieved from http://www.asee.org/papers-and-publications/publications/The-Green-Report.pdf.

(3) National Science Foundation (NSF), 2009. Doctorate Recipients from US Universities. Arlington, VA: NSF-11-306. www.nsf.gov/statistics/nsf11306/data_table.cfm.

(4) Texas Higher Education Coordinating Board. (2011). Closing the Gaps Progress Report 2010. Retrieved from http://www.thecb.state.tx.us/reports/PDF/2357.PDF?CFID=16095327&CFTOKEN=58659160.

(5) THECB(2008). Transfer success summit. Austin, TX Feb. 18, 2008.

(6) American Association of Community Colleges (AACC), 2011. 2011 Fact Sheet. Washington, DC: AACC www.aacc.nche.edu/Aboutcc/Pages/fastfacts.aspx.

(7) Texas Higher Education Coordinating Board. (2009). Making Opportunity Affordable Engineering Articulation Fact Book Texas Public Institutions of Higher Education. Retrieved from http://www.thecb.state.tx.us/reports/pdf/1832.pdf.

(8) American Society of Civil Engineers (2008). *Civil Engineering Body of Knowledge for the 21st Century: Preparing the Civil Engineer for the Future (2nd edition).* Reston, Virginia: American Society of Civil Engineers.

(9) Texas Higher Education Coordinating Board (2011). Texas Higher Education Accountability System [Data file]. Available from the THECB Website, http://www.txhighereddata.org/Interactive/Accountability/.

(10) Ellis, M M (2009) Successful community college transfer students speak. Austin, TX: University of Texas System.

Appendix I: Associate of Science Curricula

Freshman Year

First Semester (Fall)

Course		Hrs
HIST 1301	American History	3
ENGL 1301	Grammar and Composition I	3
MATH 2413	Calculus I	4
CHEM 1311	General Chemistry I	3
CHEM 1111	General Chemistry I Laboratory	1
ENGR 1201	Introduction to Engineering	2
	Semester Credit Hours	**16**

Second Semester (Spring)

Course		Hrs
ENGR 1204	Engineering Graphics	2
ENGL 1302	Grammar and Composition II	3
MATH 2414	Calculus II	4
PHYS 2325	University Physics I	3
PHYS 2125	University Physics I Laboratory	1
GOVT 2306	Texas Politics	3
	Semester Credit Hours	**16**

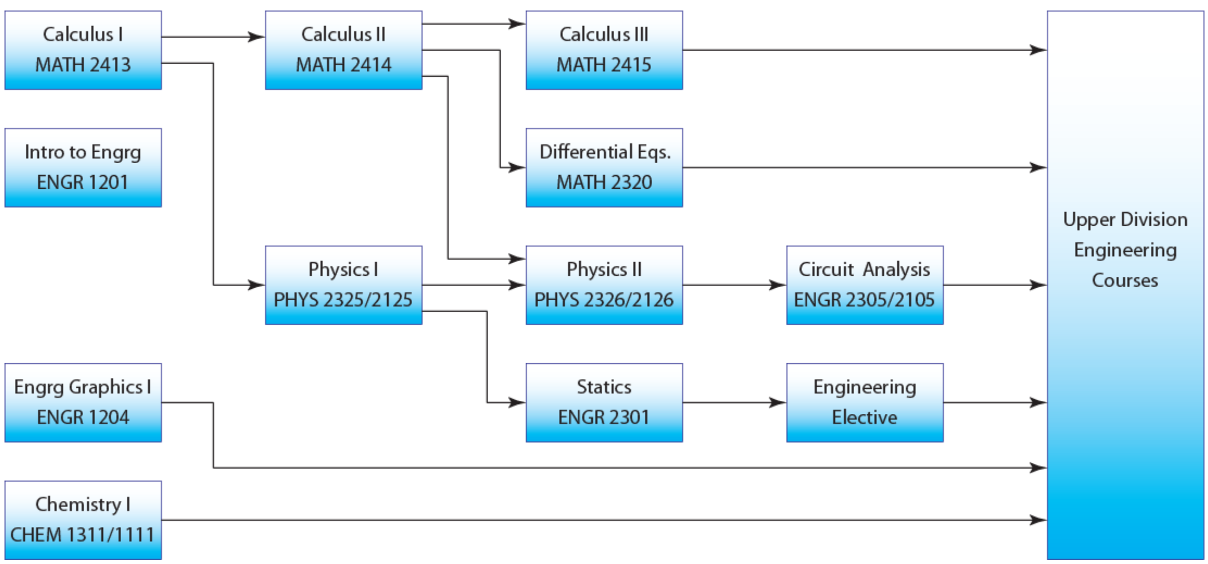
Sophomore Year

First Semester (Fall)

Course		Hrs
ENGR 2304	Programming for Engineers	3
ECON 230x	Economics 2301 or 2302	3
ENGR 2301	Engineering Mechanics—Statics	3
MATH 2415	Multi-Variable Calculus	4
PHYS 2326	University Physics II	3
PHYS 2126	University Physics II Laboratory	1
	Semester Credit Hours	**17**

Second Semester (Spring)

Course		Hrs
ENGR 2305	Circuit Analysis I	3
ENGR 2105	Circuit Analysis I Laboratory	1
MATH 2320	Differential Equations	3
	Engineering Elective	3
	Visual and Performing Arts Core Curriculum	3
	World or European Literature	3
	Semester Credit Hours	**16**



Notes:

1. Courses shaded in yellow are courses that satisfy the Texas Core Curriculum Requirements. The curriculum contains 35 credit hours of the required 44 credit hours. The remaining 9 credit hours will be attained in the completion curriculum.
2. Texas Common Course Numbers (TCCN) were used for all TCCN-numbered courses.
3. The courses indicated in green are courses that may need to be created at the community college.

4. Engineering Elective:
    a. Students interested in pursuing mechanical or civil engineering should take ENGR 2302: Engineering Mechanics—Dynamics as the engineering elective.
    b. Students interested in pursuing electrical engineering should take COSC 1420—C/C++ Structured Programming or equivalent, as the engineering elective.
    c. Students interested in pursuing industrial engineering should ENGR 2308—Engineering Economics as the engineering elective.

Visual and Performing Arts Elective: The Visual and Performing Arts Core Curriculum elective should be selected from MUSI 1306, DRAM 1310, or ARTS 1301.

Appendix II: Sample Completion Curricula

College of Engineering and Computer Science
BSCE Completion Curriculum for Civil Engineering
2011-2012 Academic Year

Junior Year

First Semester (Fall)

	Course	Hrs
CENG 2336	Geomatics	3
CENG 3310	Fluid Mechanics	3
MATH 3351	Probability & Statistics for Engineers	3
CENG 4339	CE Construction Management	3
CENG 3306	Mechanics of Materials	3
	Additional Science Elective	3
	Semester Credit Hours	**18**

Second Semester (Spring)

	Course	Hrs
CENG 3361	App Eng Hydrology & Hydraulic Design w/lab	3
CENG 3351	Transportation Engineering Systems	3
CENG 3371	Intro to Environmental Engineering	3
CENG 3325	Structural Analysis	3
CENG 3336	Soil Mechanics	3
	Semester Credit Hours	**15**

Senior Year

First Semester (Fall)

	Course	Hrs
CENG 4351	Traffic Eng Operations and Control w/lab	3
CENG 4317	Structural Concrete and Steel Design	4
CENG 4371	Environmental Engineering Design	3
CENG 4115	Senior Design I	1
CENG 3434	Civil Engr. Materials, Codes, & Specs	4
ENGR 4109	Senior Seminar	1
	Semester Credit Hours	**16**

Second Semester (Spring)

	Course	Hrs
CENG 4241	Ldership, Business, Public Pol, Asset Mgt	2
CENG 4315	Senior Design II	3
HIST 1302	United States History II	3
CENG XXXX	Technical Elective	3
PHIL 2306	Introduction to Ethics	3
POLS 2305	American Government	3
	Semester Credit Hours	**17**

1. Students who have not completed ENGR 2302 Engineering Mechanics—Dynamics will be required to complete that course as part of the curriculum of study and prior to taking any course for which ENGR 2302 is prerequisite.

College of Engineering and Computer Science
BSEE Completion Curriculum for Electrical Engineering
2011-2012 Academic Year

Junior Year

First Semester (Fall)			Second Semester (Spring)		
	Course	Hrs		Course	Hrs
MATH 3203	Matrix Methods for Engineers	2	ENGR 3314	Design Methodology in Engineering	3
EENG 3302	Digital Systems	3	ENGR 4308	Automatic Controls	3
EENG 3303	Electromagnetic Fields	3	EENG 3307	Microprocessors	3
EENG 3305	Linear Circuit Analysis II	3	EENG 4309	Electronic Circuits II	3
EENG 3306	Electronic Circuits I	3	EENG 4109	Electronic Circuits II Lab	1
EENG 3106	Electronic Circuits I Lab	1	EENG 4311	Signals and Systems	3
	Semester Credit Hours	**15**		**Semester Credit Hours**	**16**

Senior Year

First Semester (Fall)			Second Semester (Spring)		
	Course	Hrs		Course	Hrs
POLS 2305	Intro. American Government	3	HIST 1302	American History	3
MATH 3351	Probability and Statistics	3		Humanities Core Curriculum Elective	3
ENGR 4109	Senior Seminar	1	EENG 4315	Senior Design II	3
EENG 4115	Senior Design I	1		Technical Elective	3
EENG 4310	Electric Power Systems	3		Technical Elective	3
EENG 4312	Communications Theory	3		**Semester Credit Hours**	**15**
	Technical Elective	3			
	Semester Credit Hours	**17**			

1. Students who have not completed COSC 1420 C/C++ Structured Programming will be required to complete that course as part of the curriculum of study and prior to taking any course for which COSC 1420 is prerequisite.

UT TYLER

College of Engineering and Computer Science
BSME Completion Curriculum for Mechanical Engineering
2011-2012 Academic Year

Junior Year (UT Tyler)

First Semester (Fall)

	Course	Hrs
MATH 3351	Prob. & Statistics	3
MENG 3301	Thermodynamics I	3
MENG 3303	Dynamics of Machinery	3
MENG 3306	Mechanics of Materials	3
MENG 3310	Fluid Mechanics	3
MENG 3210	Mech. Engr. Lab I	2
	Semester Credit Hours	**17**

Second Semester (Spring)

	Course	Hrs
ENGR 3314	Design Methodology	3
MENG 3304	Thermodynamics II	3
MENG 3309	Mech. Systems Design	3
MENG 3316	Heat Transfer	3
MENG 3319	Materials Sci. & Mfg.	3
MENG 3211	Mech. Engr. Lab II	2
	Semester Credit Hours	**17**

Senior Year (UT Tyler)

First Semester (Fall)

	Course	Hrs
MATH 3203	Matrix Methods1	2
ENGR 4109	Senior Seminar	1
MENG 4115	Senior Design I	1
MENG 4311	Electro-Mech. Design	3
MENG 4313	Thermal/Fluid Design	3
	Technical Elective	3
HIST 1302	American History II	3
	Semester Credit Hours	**16**

Second Semester (Spring)

	Course	Hrs
MENG 4315	Senior Design II	3
	Technical Elective	3
	Humanities Core Curriculum Elective	3
	Technical Elective	3
POLS 2305	**American Government**	**3**
	Semester Credit Hours	**15**

1. MATH 3315 (Linear Algebra and Matrix Theory) can be substituted for MATH 3210.
2. Students who have not completed ENGR 2302 Engineering Mechanics—Dynamics will be required to complete that course as part of the curriculum of study and prior to taking any course for which ENGR 2302 is prerequisite.

Appendix III: Program Assessment Plan

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

The Degree Program

The Associate of Science in Engineering Science curriculum was developed to provide students with the foundational knowledge, skills, and attitudes necessary for successful pursuit of a baccalaureate engineering degree, or for employment in an engineering firm if they do not pursue the baccalaureate degree. The model Associate of Science in Engineering Science curriculum specifically provides students with the knowledge, skills, and attitudes necessary for completion of a baccalaureate degree in one of the "high needs" engineering fields as reported by the Texas Workforce Commission: civil engineering, electrical engineering, industrial engineering, and mechanical engineering. Consideration was given to the necessary attributes of engineers in the future identified by the National Academy of Engineering in the report *The Engineer of 2020, Visions of Engineering in the New Century*. Consideration was also given to the criteria of the Applied Science Accreditation Commission of ABET, Inc. (ASAC/ABET), the Engineering Deans Council and Corporate Roundtable recommendations in the report *Engineering Education for a Changing World*, and the requirements of the Texas Higher Education Coordinating Board.

The Assessment Plan

The faculty, in cooperation with the partner universities, developed this assessment plan to evaluate and improve the academic degree program. It embodies the strategic objectives for associate's degree program. Central to the assessment plan is the objective to maintain ASAC/ABET accredited associate's degree program and to develop engineers who understand the practice as well as the theory of design. Comments and recommendations of the external advisory council were incorporated into the assessment plan.

Use of the Assessment Plan

This assessment plan is the basis for evaluating the effectiveness of the associate's degree program. Each summer, the faculty will convene and review all assessment data collected during the previous year in the context of the metrics stated in the assessment plan for each educational objective and outcome. Results of the review can be: a) the program is achieving the outcome and no change is necessary; b) achievement of the program outcome appears to be marginal, but change in the program is not now recommended; and c) the program outcome is not being achieved and curricular change is necessary.

Review of the Assessment Plan

The external advisory council, in conjunction with faculty at participating institutions, will conduct a review of this assessment plan annually to ensure: a) that it is still relevant to changes that may have occurred, and b) that the data being collected and the metrics established provide relevant information regarding the quality of the graduates. When necessary, changes will be implemented in this assessment plan.

Assessment Philosophy

The participating institutions view a curriculum in an engineering program as an engineered system designed to achieve particular outcomes and objectives. The institutions do not view a curriculum as the assemblage of a group of independent courses. Rather, the curriculum is a complex system composed of highly inter-related components (courses, seminars, conferences, *et cetera*) that as a whole achieve the expected objectives and outcomes.

As such, the assessment plan developed is used to evaluate the performance of that system and to provide the necessary information to improve that system. To the greatest extent possible, quantitative measures are used in the assessment process.

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 1: Graduates can apply knowledge of traditional mathematics, science, and engineering skills, and use modern engineering tools to solve problems.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
1a. Graduates have proficiency in mathematics through differential equations, calculus-based physics, and general chemistry.	Degree Curriculum	All students graduating have completed a curriculum of study that includes these elements.	A	Faculty
	Gateway Examinations	Sufficient progress at the particular point in the curriculum.		Faculty
1b. Graduates can apply knowledge of mathematics, science, and engineering.	Gateway Examinations	Sufficient progress at the particular point in the curriculum.	A	Faculty
	Stakeholder Survey[1]	At least 75% of all respondents at least agree with this statement.	B	College
1c. Graduates can use techniques, skills, and modern engineering tools necessary for engineering practice.	Laboratory Courses	All students complete laboratory courses with a C or better	A	Faculty
	Stakeholder Survey[1]	At least 75% of all respondents at least agree with this statement.	B	College

[1] For these purposes, the stakeholder would go to the graduates' employers if they do not enroll in a baccalaureate completion, or to the university they are attending if they continue to a baccalaureate degree, as is intended for this degree.

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 2: Graduates can design and conduct experiments, as well as analyze and interpret data in more than one discipline.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
2a. Graduates can design and conduct experiments, as well as analyze and interpret data.	Laboratory Syllabi	All laboratory courses have at least one undefined experimental project.	A	Faculty
	Curriculum	The curriculum contains a laboratory in at least one major area of engineering.	A	Faculty

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 3: Graduates can work independently as well as part of a multidisciplinary design team.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
3a. Graduates can work independently when necessary.	Course syllabi in ENGR courses	All courses include at least one individual project.	A	Faculty
	Selected required courses	All students earn a grade of at least C on assigned projects	A	Faculty
3b. Graduates can work as part of a design team.	Course syllabi in technical courses	All courses include at least one team project.	A	Faculty
	Selected required courses	At least 80% of the students agree that all members of the team contributed to the final project.	A	Faculty

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 4:	Graduates can analyze a situation and make appropriate professional and ethical decisions.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
4a. Graduates have knowledge of engineering ethics and ethical responsibility.	ENGR 1201	All students earn a grade of at least C in the course.	A	Faculty
4b. Graduates have an understanding of the importance of professional registration.	Exit Interview	All graduating seniors have passed the Fundamentals of Engineering examination	A	Faculty

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 5: Graduates have effective oral, written, and graphical communication skills.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
5a. Graduates demonstrate effective oral communication skills.	Stakeholder Survey[1]	At least 75% of the respondents at least agree with this statement.	B	Faculty
5b. Graduates demonstrate effective graphical communication skills.	Stakeholder Survey[1]	At least 75% of the respondents at least agree with this statement.	B	Faculty
5c. Graduates demonstrate effective written communication skills.	Stakeholder Survey[1]	At least 75% of the respondents at least agree with this statement.	B	Faculty

[1] For these purposes, the stakeholder would go to the graduates' employers if they do not enroll in a baccalaureate completion, or to the university they are attending if they continue to a baccalaureate degree, as is intended for this degree.

Texas Statewide Associate of Science In Engineering Science Degree Program

Program Assessment Plan

Program Outcome 6:	Graduates demonstrate a commitment to learning and continued professional development outside the classroom, incorporate contemporary issues during problem solving, and understand the impact of engineering solutions in a global and societal context.

Program Outcome	Assessment Means	Metric	Frequency (A-Ann., B-Biann.)	Responsibility
6a. Students regularly participate in professional society activities.	Participation in student chapter	At least 50% of the students regularly participate.	A	Faculty
	Participation in society meetings	At least 15% of the students regularly participate.	A	Faculty
6b. Graduates regularly participate in professional society activities.	Alumni Survey	At least 50% of all respondents respond positively to this statement.	B	Faculty
6c. Graduates recognize the need for, and engage in life-long learning activities.	Alumni Survey	At least 50% of all respondents participate in professional development activities at least annually..	B	Faculty
6d. Graduates have knowledge of the impact of engineering solutions on contemporary issues.	Stakeholder Survey[1]	All projects relate to a problem with the national infrastructure.	B	Faculty
	Alumni Survey	At least 80% of the respondents at least agree with this statement.	B	College