Factors Influencing Student Graduation Rates

Amir Karimi, Randall D. Manteufel

Department of Mechanical Engineering
The University of Texas at San Antonio

Abstract

In recent years pressure has been placed on the public universities to increase their four and six year graduation rates. As faculty, we are aware of some factors that slow down student progress towards graduation. A large number of students enrolled in universities in urban locations are non-traditional students. Some entering freshmen are not prepared for college courses and are required to complete remedial courses. In a structured degree program such as engineering, students are required to satisfy prerequisites in order to proceed through the curriculum. Lack of course offerings, especially offering all required courses every semester, can delay progress towards graduation for some students. This paper surveys a cohort of senior engineering mechanical engineering students to determine the causes for delays in graduation. In responding to survey questionnaire, students provide such information as whether they attend school full time or part-time, how many years to graduation, whether they attend summer school, the courses that students have difficulty passing, and other questions related to length of study for the degree. Feedback from students is essential as public universities are looking for ways to improve graduation rates.

Introduction

In the recent years there has been a major discussion on the time it takes for students enrolled in public institutions of higher education to receive a four year undergraduate degree. The numbers for four-year and six-year graduation rates are typically very low for most public institutions that do not have selective admission policies. The numbers are as low as 10% graduation rates in four year and lower than 30% in six years. Pressures from public and state authorities are rising for the public university to increase their four and six year graduation rates. Many states are providing some incentives for students who graduate in four years and penalizing those students who accumulate a large number of semester credit hours (SCH) before they receive their four year degree. For example, Texas Education Code, § 54.0065 "The Tuition Rebate Program" offers students who have enrolled for the first time in an institution of higher education in the

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Fall 1997 semester or later, up to $1,000 in tuition rebates, if they have attempted no more than three hours in excess of the minimum number of semester credit hours required to complete their degree.[1] For example, if the degree requires a minimum of 120 semester credit hours, student must graduate with no more than 123 attempted hours in order to qualify for a rebate. There is an additional requirement for those students who enrolled in college for the first time in the Fall 2005 semester or later. For these students, the degree must be completed within four calendar years for a four-year degree. For some degree programs such as engineering that typically require more than four years to complete, the student must graduate within five calendar years.

State of Texas legislatures have established credit hour limitation for funding students enrolled in undergraduate programs in public institutions of higher educations. In these cases state of Texas do not provide funds for students who have exceeded the established undergraduate credit limitation. Section 54.068 of the Texas Education Code was amended during the 76th legislative session to allow institutions of higher education to charge resident students a higher tuition rates for attempting more than 45 SCH above the minimum SCH required for a degree program. The law applies only to new undergraduate resident students who started college in a public institution in Fall 1999 or later. The 79th legislative session reduced the SCH to 30 semester credit hours for all new undergraduate resident students who started college in a public institution for the first time in Fall 2006 or thereafter **(**§ 54.014 of the Texas Education Code[2]). The total attempted hours contains all those taken by students at any public institution including all those repeated, duplicated, withdrawn after the Census date in which the student received a grade of "W." Starting in Fall 2006, UTSA has been charging an additional fee of $121 per SCH for students who have exceeded the 30 or 45 hour credit limits.

Depending on the type of calculation methods used, graduation rates can be strongly influenced by students who initially seek an engineering degree but later change their mind and pursue another degree. The factors that influence a student's decision to leave engineering are linked to both academic and non-academic factors[3]. Academic factors include teaching, advising and curriculum. Non-academic factors are related to cohorts and a sense of community. Students who believe they belong in engineering are more likely to be retained in engineering.

The impact of freshmen-level courses on student retention have been studied[4,5]. The freshman level classes do have an impact on 4-year retention. This finding is consistent with the understanding that curriculum and instruction have strong impacts on retention. Students who build connections between theoretical academic aspects of the curriculum and professional engineering practice, are more likely to be retained in engineering. Likewise, those who build connections with other students develop a sense of belonging and are less likely to change majors.

The American Society for Engineering Education (ASEE) promotes practices and strategies for retaining students in engineering[5]. Based on best-practices submitted by College Deans from

many universities, a common theme found is that creating a "community" is important for student retention. There are a number of ways to create such a community and no single solution is sufficient. The best recommendation is for the university to have a holistic approach employing multiple strategies such as: tutoring, mentoring, learning centers, first-year students, at-risk students, academic advising, and career awareness.

Much has been done to understand and improve the retention of students[6-10]. Universities use problem solving recitations, and the integration of math/science/engineering into more exciting engineering courses with more active design project for students. Much of these efforts have limited success and can often be overwhelmed by changes in the student body attending the university, changes in faculty teaching key engineering courses, and changes in seemingly insignificant aspects such as classroom scheduling. In many cases, modest changes impact the rate of progress through particular classes and the overall program.

In this work, it is proposed to study the students who have succeeded to their senior-year and final semester of a mechanical engineering program of study. These students have succeeded and are soon to graduate. Much of their academic experience is fresh and they offer unique perspectives on how to improve the system. One can interview these students, ask them to complete a survey directed at retention issues, and one can review their academic path to better understand how they were able to progress to their current level. Through the examination of students' academic record and surveys, we have attempted to determine the possible root causes of student graduation delay. We have analyzed the academic record of 60 mechanical engineering students who are completing their capstone design project in the Spring 2013 and conducted surveys in two upper-division courses to determine areas that have contributed in delaying student graduation.

Analysis of Student Academic Record

The mechanical engineering program at UTSA requires 128 SCH of course work in order for a student to receive a Bachelor of Science in Mechanical Engineering (BSME) degree. The degree requirement includes 42 SCH of the University Core Curriculum. Courses in general chemistry, engineering physics, and calculus are parts of both the University Core Curriculum and mechanical engineering degree requirements. In examining the academic records of 60 students who are completing their senior design project in spring 2013 we made several observations as are summarized below. Including courses taken in spring semester 2013, these students have between 6 to 21 SCH remaining in their degree program. Almost all of these students will complete their degrees either in May 2013 or August 2013. The examination of student transcripts reveals that these senior students have attempted as low as 129 and as high as 239 SCH by the time they graduate. On the average these students have attempted 166 SCH for completing their degrees. There are several factors contributing to excess number of credit hours required for the degree. One student has already completed a degree in communication. Several

others are either double major (seeking a second degree in either mathematics or business) or taking additional courses for a minor. Several students started in a different major and then changed major into mechanical engineering. A large number of students have transferred from community and four year colleges to UTSA. Twenty eight (28) students have more than 30 SCH of transferred courses and more than 40 students have at least 15 SCH of transferred courses. In some cases, not all transferred courses applied to the degree program.

Table 1. Recommended program of study for 2010-14 BSME degree

Semester I			**Semester II**		
CHE 1103	General Chemistry	3	MAT 1224	Calculus II	4
MAT 1214	Calculus I	4	ME 1402	M.E Practice & Graphics	2
ME 1302	Mechanical Engineering Practice	3	PHY 1903	Engineering Physics I	3
WRC1013	Freshman Composition I	3	PHY 1911	Engineering Physics Lab	1
COR 1203	Freshman Seminar/Soc.Behav Sci	3	WRC 1023	Freshman Composition II	
			CORE	U.S. History & Diversity	
Semester Total		15	Semester Total		16
Semester III			**Semester IV**		
EGR 2103	Statics	3	EGR 2513	Dynamics	3
EGR 2323	Applied Engineering Analysis I	3	EGR 3323	Applied Engineering Analysis II	3
ME 2173	Numerical Methods	3	ME 3244	Materials Engineering & Lab	4
PHY 1923	Engineering Physics II	3	ME 3293	Thermodynamics I	3
PHY 1931	Engineering Physics II Lab			Math/Science Elective	3
CORE	U.S. History & Diversity				
Semester Total		16	Semester Total		16
Semester V			**Semester VI**		
EE 2213	Electric Circuits & Electronics	3	ME 3113	Measurements & Instrumentation	3
ME 3543	Dynamic System & Control	3	ME 3263	Manufacturing Engineering	3
ME 3663	Fluid Mechanics	3	ME 3823	Machine Element Design	3
ME 3813	Mechanics of Solids	3	ME 4313	Heat Transfer	3
ME 4292	Thermodynamics II	3	CORE	Political Science	3
CORE	Literature	3	CORE	Visual & Performing Arts	3
Semester Total		18	Semester Total		18
Semester VII			**Semester VIII**		
ME 4543	Mechatronics	3	ME 4813	Design II	3
ME 4733	Mechanical Engineering Lab	3		Technical Elective	3
ME 4812	Senior Design I	2		Technical Elective	3
	Technical Elective	3		Economics 2003, 2013, or 2023	3
	Political Science (Texas)	3		World Society & Issues	3
Semester Total		14	Semester Total		15

The examination of transcripts revealed that many students had to take introductory courses in chemistry, mathematics, and physics, before they were allowed to take CHE 1103-general Chemistry, MAT 1214-Calculus-I, or PHY 1903-Engineering Physics. Of the 60 students, 46 students had to take 3 SCH to 19 SCH of additional introductory courses in chemistry, mathematics, and physics during their freshman year.

Unsuccessful attempts of required courses also delays student graduation. Figure 1 shows those courses that a number of students have difficulty passing. The transcript analysis reveals that out of 60 students, 24 students had to repeat EGR 2323-Engineering Analysis-I, 18 students repeated ME 3293, and 17 students repeated ME 3543-Dynamics System and Control at least once. Figure 1 shows that some students had difficulties with such freshman level courses as MAT 1224-Calculus II, CHE 1103, PHY 1903-Engineering Physics-I, PHY 1923-Engineering Physics-II. Few students repeated some of the courses shown in Fig. 1 more than once. One student repeated MAT 1214-Calculus-I five times.

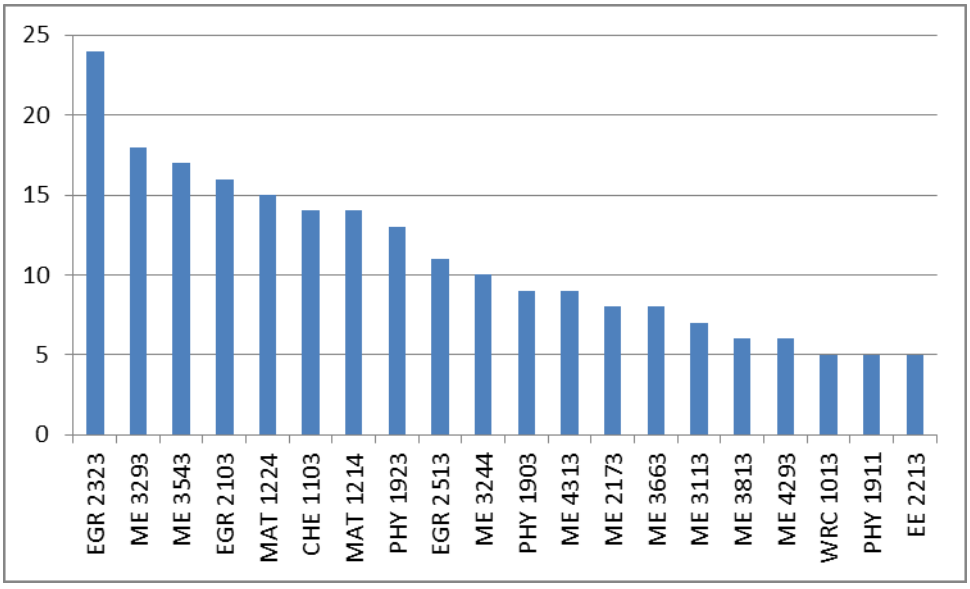

Fig. 1. Number of students repeating courses required for the BS degree in mechanical engineering

Survey

A survey was conducted to assess the perception of students on graduation rate issues. It is relatively well-known that faculty have ideas about retention. These ideas are reflected in the curriculum and in the assignment of instructors to particular classes. There is less information

about the beliefs of students concerning their progress toward graduation, especially their thoughts on impediments to them earning an engineering degree in 4-years.

A survey on graduation rate was given to senior-level engineering students. Fourteen questions provide the main part of the survey. Given the following statement:

The following have slowed down your progress towards graduation

		Disagree				Agree
a)	Financial difficulties	1	2	3	4	5
b)	Failing/withdrawing from courses	1	2	3	4	5
c)	Starting in pre-Calculus math courses	1	2	3	4	5
d)	Changing majors	1	2	3	4	5
e)	Difficulties taking prerequisite classes	1	2	3	4	5
f)	Difficulties transferring courses to UTSA	1	2	3	4	5
g)	Poor study habits	1	2	3	4	5
h)	Poor time management skills	1	2	3	4	5
i)	Immature attitude toward college	1	2	3	4	5
j)	Lack of seats in classes	1	2	3	4	5
k)	Lack of summer classes	1	2	3	4	5
l)	Lack of on-campus study space	1	2	3	4	5
m)	Lack of on-campus jobs	1	2	3	4	5
n)	Personal or family issues outside of school	1	2	3	4	5

In total, 49 students responded to the survey. Results are shown in Fig. 2. The numeric value of 1 to 5 was recorded for each student for each response. The numerical results were first normalized for each student. The student's average response for the fourteen questions (a-n) was calculated and thensubtracted from each of the student's responses. If the resulting number was below zero, it was set to zero. The non-zero results are for those above the average for the individual student. The sum of these was computed and then each non-zero result was multiplied by a weighting factor so that the sum was equal to 5.0 for each student. Once each student's response has been normalized, the average class response was calculated for each question. This was done by summing the normalized response across all students. The relative score indicates the group consensus for which is most important.

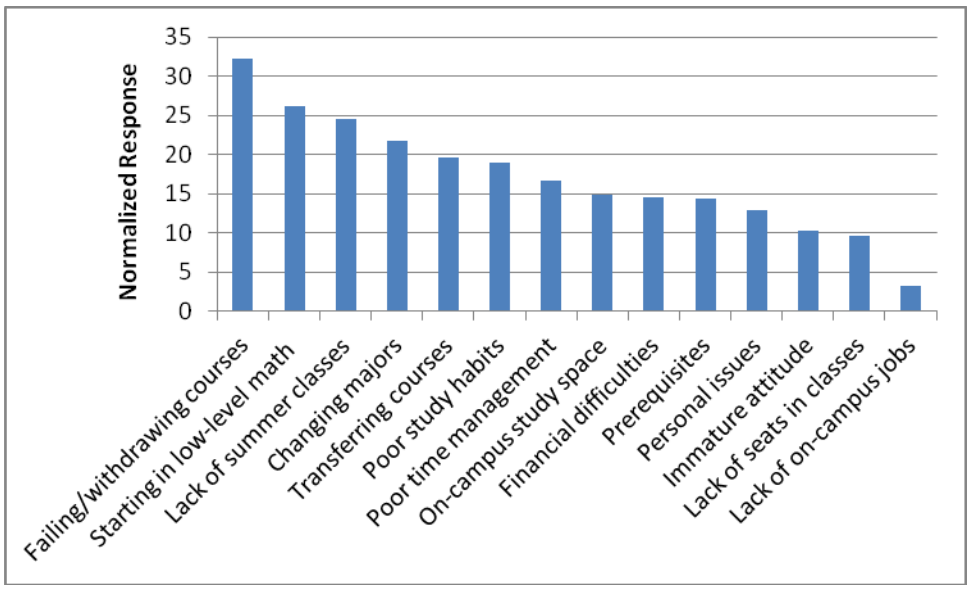

Fig. 2. Normalized results from senior-level student survey to "identify things that have slowed down your progress towards graduation." From left to right, responses showing strongest positive response.

Most of the results are self explanatory by the description used in Fig. 2. The most significant result is understandable: if a student fails or withdraws from a class this often delays their graduation by a semester. Senior-level students know this by either first-hand experience or by seeing the effect on fellow students. There is little forgiveness for failing a class.

The second highest response is associated with students not being "Calculus ready" when they start college. In the recommended four-year degree program (Table 2), it is essential that students take and pass Calculus I their first semester. If not, this delays taking Calculus II and Calculus-based Physics. These are important prerequisites in the engineering program. This was explored further in the same survey. Students were asked to list the "first math course you took in college" with the choices being: below College Algebra, College Algebra, Pre-Calculus, Calculus I, Calculus II or Above Calculus II. The results are shown in Fig. 3.

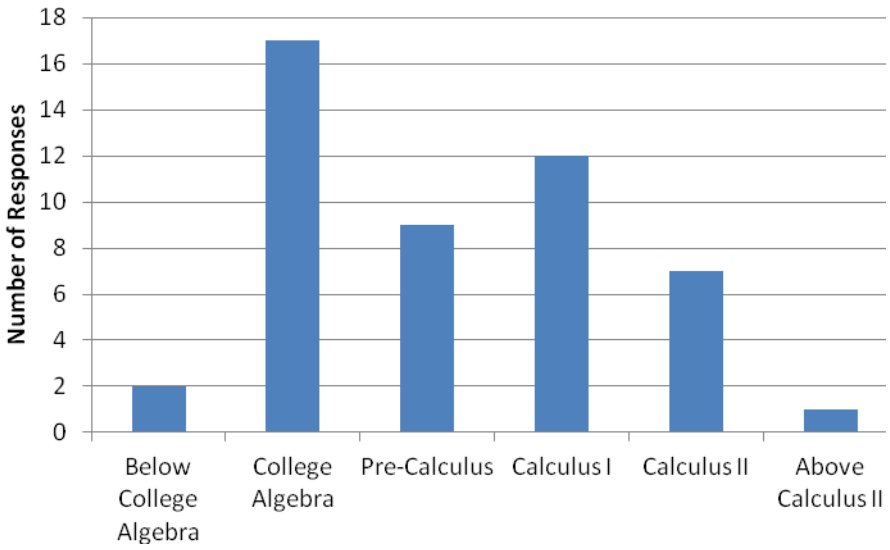

Fig. 3. Response to "The first math course you took in college was".

Figure 3 show that nearly 60% of the senior-level engineering students were not calculus-ready when they started taking college classes. The same is expected to be true for many other engineering programs at other universities. If a student starts in College Algebra, then they must take pre-calculus before Calculus, hence they are one-year behind and already working toward a 5-year engineering program. Students can take summer classes to catch-up, but many freshmen don't recognize the importance of math classes. The authors of this paper have taught introduction to engineering classes for freshmen. In the first week, students were told to enroll into a math class. The importance of math was emphasized during the first few lectures, because it is relatively straightforward for a student to add a math class early in the semester. After the census date, the instructor asked the advising office to run a report on the 200+ students in the introduction to engineering class. It was found that 15% of the class was not enrolled in any math class. Regardless of the advice from faculty, freshmen often have the misconception that math is optional or it can be delayed with little consequence. The results from the survey presented in this paper support the idea that senior-level students understand the importance of math, and it is one of the major reasons they are not going to graduate in 4 years. As freshmen, they may not have understood. But as seniors, they see where their progress was delayed.

The third highest response was about the lack of summer classes. Summer is often a time when students catch-up or get-ahead. It is critical for those who have failed or withdrawn from a class, or those who need to take remedial Mathematics, Chemistry, or English classes. It is a little surprising that this response was so high since the Department of Mechanical Engineering has been offering numerous summer classes for well over 10+ years.

The next highest response concerns changing majors. It is understandable that students who never change majors are the most streamlined in taking classes, while those who change may find that courses taken don't count toward the new major. There is another surprise in that one doesn't think about students changing into the mechanical engineering major. One often thinks of those changing away from engineering. An additional survey question was

You started college as (circle one): mechanical engineering major
other engineering major
non-engineering major

Results are shown in Fig. 4. About 50% of the students claim to have started college as either "other engineering" or "non engineering" majors. This is a surprisingly high number.

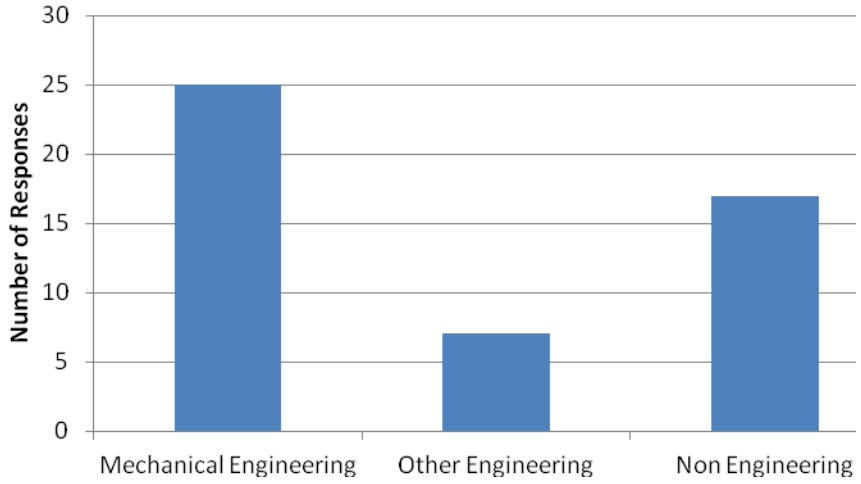

Fig. 4. As what major students started college.

The next most significant issue identified by students was transferring courses to the University. This is similar to changing majors. Anytime one changes institutions, there is the possibility that some courses aren't accepted or they don't contribute to the degree program. This could be for "Core" academic courses or required engineering courses. An additional question on the survey determined the number of transfer students. An additional survey question was

You started college at (circle one): UTSA
another 4-year University/College
Community College

Results are shown in Fig. 5. About 55% of the students claim to have started college either "at another 4-year University/College" or "2-year Community College". Again, this is a surprisingly high number and contradicts many of the ideas held by somefaculty. The perception is that retention is an issue at the freshmen level. Retention initiatives often focus on the development of cohorts in freshmen classes. It is just as important that transfer students be integrated into the new university. Likewise, some faculty have the mentality of building hurdles for transfer students, instead of bridges to allow a smooth transition between institutions. UTSA has active 2+2 transfer agreements with local junior colleges. These agreements can be either strong or weak, based on the standardization of the first two years curriculum. Some faculty purpose to make unique prerequisite courses so they can't be offered at a junior college and hence can't be transferred. This then make the 2+2 program more of a 2+3 program, hence a 5 year program. Over the years, one can see changes to courses as shifting bace and forth between being more or less accommodating to transfer students.

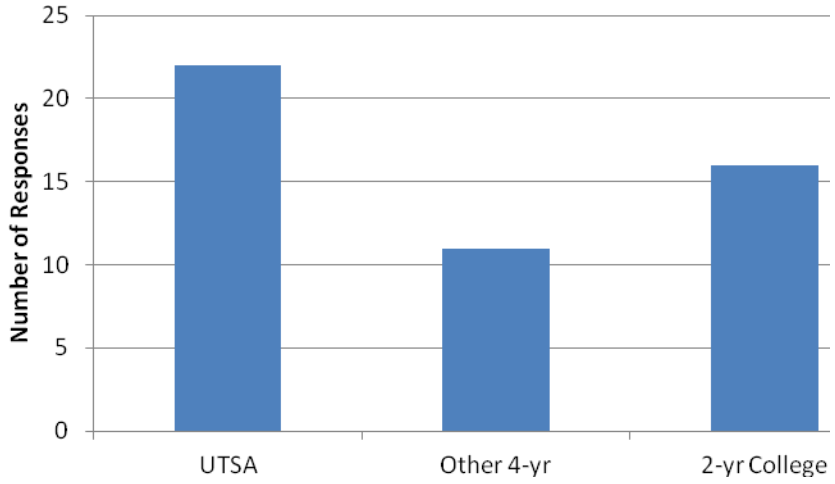

Fig. 5. Where students started college.

There are other issues students identify in the survey on graduation rate. The next two are concerned about poor study habits and time management. Learning these are essential to becoming a successful student. Many courses cover these topics, but they must be embraced by the student. Once students realize the importance of strong study habits and good time management, they will work hard to be better in these area.

Another question explored how many years it will take to complete an undergraduate degree in mechanical engineering, and the responses are shown in Fig. 6. Only 13% of the students will finish in 4 years. The most frequently given response is 5 years. There are some students who

are working full-time and will take 6 or more years to finish. It appears that the pressure is on to accommodate a wide spectrum of students so that higher education is more accessible, yet some students can only attend part-time, hence they will never be able to finish in four years. This appears to be a contradiction in directives and it is feared that institutions with the greatest accessibility will be penalized for having more non-traditional students who take longer to complete a degree.

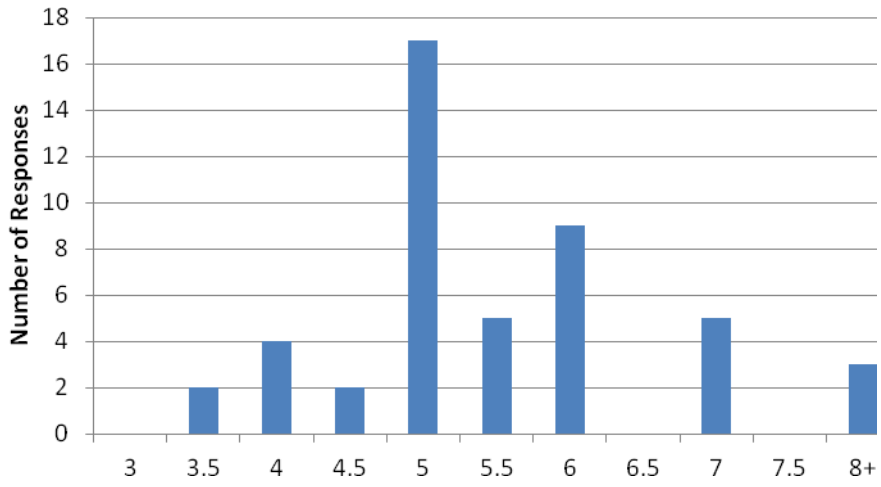

Fig. 6. Number of years to complete an undergraduate mechanical engineering degree.

In the recommended 4-year program of study, students are expected to take 16 and 17 semester credit hours in many semesters. The minimum is 15 SCH. In reality, many student take fewer classes per semester. Fig. 7 shows that only 20% of the respondants completed 16 or more SCH last semester. At that rate, it will be difficult to complete a degree in 4-years. It will be a challenge to have students take 16+ SCH per semester required to finish a 128 SCH in 4 years. An alternative would be to reduce the number of hours to 120 SCH to earn a BSME, but it is doubtful if it could be implemented.

Summary

Senior-level engineering students were surveyed to identify issues important to their prompt completion of a BSME program. There is increased emphasis on institutional accountability and the need for universities to track and improve graduation rates. The survey highlights some key areas. After having identified the key reasons for students to have slow progress toward

graduation, a university is better prepared to address the most meaningful issues and improve their graduation rates.

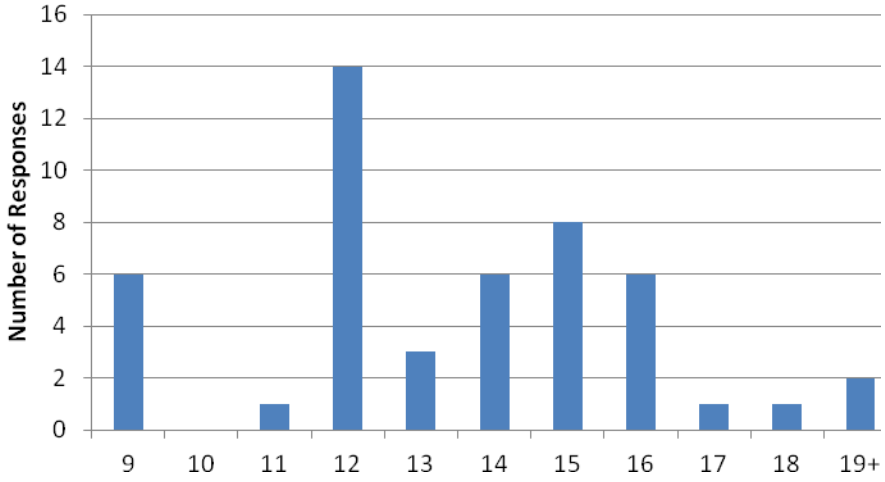

Fig. 7. Number of SCH completed last semester.

Student feedback is overwhelming that failing or withdrawing for a course is the most important issue. If this is true, then a university should focus on things like (1) instructor effectiveness, (2) early detection of at-risk students, and (3) intervention strategies for at-risk students. Students often give valuable feedback to identify unreasonable impediments to their progress through the program. It is less common for engineering programs to have active detection mechanisms in place and follow-up action which are designed to prevent a student from failing a class. Universities have mentoring and tutoring program, but this survey highlights that it is important for a university to seek to do more in this area.

There is little a university can do to fix the problem of unprepared high school graduates. This has been a persistent problem and is expected to continue to be so. If students are not ready for Calculus, but start in College Algebra, then the program becomes a de-facto 5-year program because the student has 1-year to remediate math deficiencies.

Universities should consider treating the summer as equivalent to spring/fall long semesters. It is apparent students seek more opportunities to learn during the summer.

The first two years of an engineering program should be as generic as possible. It does little good to develop a unique course or sequence of courses that are inconsistent with the majority of

other 4-year institutions or community colleges. More emphasis should be on building curriculum bridges to ease the transfer of courses between institutions.

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AMIR KARIMI

Amir Karimi is a Professor of Mechanical Engineering and an Associate Dean of Undergraduate Studies at The University of Texas at San Antonio (UTSA). He received his Ph.D. degree in Mechanical Engineering from the University of Kentucky in 1982. His teaching and research interests are in thermal sciences. He has served as the Chair of Mechanical Engineering (1987 to 1992 and September 1998 to January of 2003), College of Engineering Associate Dean of Academic Affairs (Jan. 2003-April 2006), and the Associate Dean of Undergraduate Studies (April 2006-present). Dr. Karimi is a Fellow of ASME, senior member of AIAA, and holds membership in ASEE, ASHRAE, and Sigma Xi. He is the ASEE Campus Representative at UTSA, ASEE-GSW Section Campus Representative, and served as the Chair of ASEE Zone III (2005-07). He chaired the ASEE-GSW section during the 1996-97 academic year.

RANDALL D. MANTEUFEL

Randall Manteufel serves as an Associate Professor of mechanical engineering at The University of Texas, San Antonio (UTSA), where he has been on the faculty since 1997. His teaching and research interests are in the thermal sciences. He is currently the Faculty Advisor for ASHRAE at UTSA.