# A Student's Perspective on Impediments to Retention and Graduation in Mechanical Engineering

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## Abstract

This paper provides a student's perspective on factors that cause students to drop out before graduation or take more than four years to earn a Bachelor of Science degree in Mechanical Engineering. On a larger scale, this paper aims to contribute to the ongoing effort to improve the graduation rate of the students of any state University without compromising the quality of the education or the value of the engineering degree.

In this paper, several categories of impediments to students' academic success are presented and analyzed. The impediments were hypotheses by current students at the end of the engineering program at the University of Texas at San Antonio (UTSA). The impediments are: (1) cost of attending, (2) dissatisfaction with the faculty members, (3) strict course prerequisite chains, (4) availability of courses, (5) high school preparation, and (6) difficulty of courses.

The analysis of the problems a student faces during their academic journey aims to consolidate the research in the form of a unified data, and present a statistical correlation of this data to the student's level of general interest in mechanical engineering, socio-economic background, and history of previous scholastic performance. The information obtained from the statistical data was collected in the Fall semester of 2012 at UTSA, and from the interviews of the current and former mechanical engineering students during the same semester. The analysis stage of the paper is followed by solutions for the problems identified. The proposed solutions include the changes to the curriculum structure, more classes offered in a semester to accommodate all the students trying to register for a class, and better core preparation of the student in the areas of mathematics and physics.

The results can be generalized to a model that fits other colleges offering degrees in science and technology. One of the implications of this work is that programs should create road maps for the beginning engineering students highlighting the potential impediments identified on their path with the accumulated shared experience and success stories of those who completed the curriculum themselves.

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## Introduction

The life of a college student studying engineering is difficult and has many challenges and road blocks, some foreseen by an incoming freshmen student and others not. Along the way, many students leave engineering for a variety of reasons.[1] The average engineering degree calls for four years of studying assuming the student is able to attend and complete a minimum of sixteen hours per semester. This is improbable because the tuition cost alone of an average university is high enough to put any family in a situation where they are requiring their son or daughter to work during the semesters. When taking engineering courses, the average class calls for at least three to four hours of studying a week, and when taking five to six classes a semester that turns out to be fifteen to twenty-four hours of studying. A student's time will quickly burn up and that is still without adding the time to work or do other important activities necessary in everyday life.

These impediments weigh heavily on the fact of graduation succession rates and that of the attendance rates of incoming freshman that are willing to take on the journey as an upcoming engineering major. Engineering is known to be a prestigious degree in that it is very difficult to pass classes, understand the various topics of engineering, etc. But what should not make students deter from the road of engineering is the degree plan set forth by the college of engineering. In a four year degree, the average semester calls for five to six classes and that is without remedial courses such as College Algebra or Pre-Calculus for Engineering students. The problem is that even for the brightest students, completing five or six engineering courses per semester with good grades is challenging, due to the fact of the vast amount of material covered in each and every class. In the end, the average engineer will graduate in five to six years with a bachelor's degree where other majors will have had their bachelor's and possibly a master's degree in the same amount of time.

## Program Impediments

There are many impediments that a student faces when attending college. The first impediment is the cost of attending college, as college can be a financial burden on the student. As rigorous as an engineering degree may be, some students can take up to seven years to finish an engineering program. As one can imagine, seven years of college just for a bachelor's degree can be very costly. Once a student recognizes the steep price, on an already intellectually demanding degree, dropping out and working immediately does not seem like a bad idea.

The second impediment is the dissatisfaction with professors. A student may become highly discouraged from getting through an engineering program if the program has a professor that has the inability to reach the students in terms of teaching the course. Often times, if the student does not like a particular professor, the student may have a difficult time in more than just one class as they could be required to take the same professor for multiple classes. As a below average professor can come in many different forms, typically a professor that is hard to


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understand during lecture, disorganized, or is not helpful, this may lead the student into dropping the class or dropping the entire program.

The third impediment is the amount of prerequisites assigned to a significant number of classes and the string of required classes in an engineering degree. With such a strict sequence of courses every engineering student must follow each semester, failing, withdrawing, or dropping a course can set the student back a semester or more, or force them to take summer classes. This can be a major problem for a student due to the fact that it can affect them financially, as the student will have to pay for the class again, and remain in the program for another semester or two.

The fourth impediment is the availability of courses in a semester. With such rigid course prerequisites, students are forced to take certain classes each semester at the time it is offered. This means the student has little choice in the class meeting time and must take the class regardless of the instructor. This introduces time conflicts for many students. The student that may be working can be taking another class only offered at that specific time during their work hours. This often is the result of a lack of professors at a university, but the students are the ones who have to pay for it. With such little scheduling flexibility, students are often forced to delay taking a class they to graduate promptly. As a result, a lack of course availability pushes their graduation back, and increases the amount of tuition they have paid at the end of their college career.

The fifth impediment is the poor course preparation students have coming into the engineering program. Being placed into various math or science classes can have a lingering affect later on in a student's academic career because of the knowledge gaps the students may have. The gap in a student's knowledge may never be filled, and will be repeatedly exploited as the student progresses to harder classes. It may result in lower grades, and additional studying for certain classes as the gaps cause the student to not understand or recognize concepts to their fullest

The sixth impediment is that engineering courses are difficult. The courses require a grasp of mathematics and physics. Any weakness in academic preparation make it especially difficult for students since engineering classes are often fast paced. The amount of material covered in a typical class does not allow the instructor time to re-teach prerequisite material. Also, students can't fall behind in a face-paced class because the material often builds throughout the semester. Failing to understand material early in the semester is often devastating as the semester progresses.

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## Survey


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A survey was designed and given to one hundred mechanical engineering students at the University of Texas at San Antonio (UTSA). Over 90% of the respondents were upperclassman. The survey consisted of twenty-five questions, to illicit a student's perspective on the impediments. The types of questions that were asked were as follows, "on average how many hours a week do you study", "overall GPA", "what math did you start at in college", "have you ever dropped a course…", and "do you understand the applications of the material in the courses you study".

With a sizable pool of one hundred respondents, statistical analysis of different questions could be made. The processes of analyzing the data and reaching conclusions were as follows. Each survey was inputted into Excel, each of the twenty-five questions were assigned a letter from a to x. Then, each of the choices a student could have picked for each of the twenty-five questions was assigned a number one through five. For example, a question that only had two choices, were assigned one and two for simplicity. After all the data was in Excel, correlations were made by using various nested if and then statements. The if and then statements were used to see which student answered each of the various questions. If there was a great or lack of significance for the questions answered by all one hundred students, then there was a correlation between the two questions and the two answers a student had chosen. From those correlations, engineering programs can recognize what is really significant to get students through a rigorous engineering program based on students who are making it through the program and are almost finished. Ninety percent of the respondents of the survey were upperclassmen. With the impediments already presented from a student's perspective, changes could be made to engineering programs based on significant statistical correlations. There are two areas that should be revamped or implemented, (1) curriculum structure, and (2) additional class availability.

## Analysis of Responses

Curriculum structure is an aspect of any program not to be overlooked. It can affect students on the topics of learning, and financial. Based on how well a curriculum is made, students can come out of engineering programs very knowledgeable or not. A key to being a good practicing engineer is what concepts, relationships, and information you retain and take away from college. To achieve a higher percentage of engineering students fully grasping and making connections between various engineering topics, the curriculum is the foundation at which that starts. A well thought out curriculum is also very useful due to the fact that if more students can successfully move through the program quicker, that is more appealing since the student is paying for college one way or another. The survey showed that 56% of the students take only four engineering classes a semester, and only 25% take five engineering classes a semester. As a result, the engineering program becomes more, and more expensive and lengthy.


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Further, curriculum structure needs to be changed in a number of areas such as, (1) prerequisites, and (2) co-requisites, to help students benefit in how much they learn, and to reduce college costs. Having proper prerequisites is needed for most if not all the design engineering courses. But, many prerequisites are not needed for classes that revolve almost completely around theory. An exception is, for example, Statics, which should indeed be a prerequisite for Dynamics. The problem with unnecessary prerequisites is that it locks the student in for a semester on what they can and cannot take for courses. This possibly affects their graduation date, and in turn their financial situation. The issue with changing prerequisites is that whether or not the student can learn and pass the class without the prerequisite. The survey showed that 44% of the students have requested a prerequisite override, and of that 44%, 92% of the students were able to comprehend the material and pass the course they received the prerequisite override for. Thus, showing a lack of correlation of the pre-requisite class to the next class.

Co-requisites need to be better implemented throughout an engineering program. Often times, a student does not fully understand what exactly is being learned, as the real problem lies in why and how this concept is used in direct applications. Co-requisites can be very useful for understanding mathematical and engineering theory when shown more applications than just the ones introduced in a particular class, if they are even introduced in the same class. Having better co-requisites instead of some prerequisites for theory and application would result in higher retention when a student uses concepts from one class in three or four other classes they are taking that same semester. With a curriculum that incorporates better co-requisites, students can also reduce the amount of studying they do per week. Taking from the survey, 30% of students take 12 to 16 credits per semester and study from 10 to 30 hours a week. Also, 13% take 12 credits per semester and study 10-30 hours a week. Couple this with going to lecture and lab, studying outside of class for up to 30 hours a week plus the possibility of working a job can become taxing on a student. The survey shows that 46% of the students work on or off campus to help pay their tuition, so if proper co-requisites were in place and material in the majority of the students classes overlapped, studying time would be reduced[1].

Something interesting to take away from the surveys was that 50% of the students understand the applications of the material taught in engineering classes after they have finished the course. With half of the students not recognizing the real world engineering applications of some of these mathematical concepts, that is half of every class just memorizing, regurgitation, and forgetting while they are taking the class to attempt to pass it. An added benefit of showing students the direct applications of theory through another class that would otherwise be a prerequisite, make that class a co-requisite and students may perform better academically. Students will be taken out of the mindset of forgetting what they have learned to make room for new concepts, as what they are learning now is needed and used in all these other classes they are taking right now. Granted some courses involve material in lower level courses, but should


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not be taken as a co-requisite because of other required knowledge needed to understand the material, such as design courses.

The availability of classes is the next area of interest that must be considered. Availability of classes incorporate the impediments cost of attending and dissatisfaction with teachers. This area affects the student in (1) learning and (2) financially. The faculty at the UTSA is probably understaffed. Some upper division classes only have one professor teaching a particular course. This means a student is forced to take that class at that time, with no schedule/professor mobility. With no schedule mobility that could entail the student not being able to take all the classes they need to take that semester due to schedule conflicts. The following semester, they may run into the lack of available prerequisites, thus their graduation date falls behind and the student suffers financially by having to pay for another semester of tuition. With no professor mobility, the student can run into the issue of not being able to learn from that particular professor for a variety of reasons. The reasons may be the professor is hard to understand, was not helpful, or was not organized. Almost a third of the survey respondents have said they have dropped a course due to the professor being one of those reasons previously listed.

The lack of availability of classes being taught has a simple cookie cutter solution of just adding more sections of that particular class. The survey shows that typically the student body of the Department of Mechanical Engineering does not like the idea of weekend classes nor classes longer than 75 minutes. The results are as follows, 45% of student respondents would not be interested in weekend classes if made available and 50 minute lectures are the optimal duration for class. Twenty seven percent responded that they would not be interested in weekend classes if made available and 75 minute lectures are the optimal duration for class. Although the topic of adding more sections to more of the engineering classes offered is a very sensitive issue for a university due to availability of funds to hire more professors, actual physical classroom availability, and more macro-management needed to avoid the issue of a student "professor shopping". Professor shopping is where a student will take a specific section for a course due to the professor being very favorable in grading compared to another professor teaching another section during the same semester.

## Conclusion

Through this paper, different impediments to retention and graduation rate were identified by senior-level engineering student's currently near the end of the engineering program. With six impediments stated, and a solution provided that incorporates four out of the six impediments, a University can easily recognize if they have not already the various problems that a student may face. The one impediment that will be more difficult for a University to address is the poor preparation of high school students. The issue of poor preparation could possibly be identified by the University through another solution, such as increased admission


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standards, but one could not be incorporated here in this paper. Universities should recognize the student as ultimately paying a great deal of money to attend college and get a full education. With a possibly popular program, coupled with prospective students that may be very inclined to start such an engineering program, the University should eliminate roadblocks which have little educational value or justification. The University benefits from having a large number of students interested in earning an engineering degree, and in large numbers of successful graduates starting careers in engineering.

## Appendix

Table 1. Responses to Questionnaire. Total of 100 respondents.

| Question | Choices | % Answered | Count |
|---|---|---|---|
| Major | ME | 93% | 93 |
| | EE | 3% | 3 |
| | CE | 4% | 4 |
| Classification by Year | Freshman | 1% | 1 |
| | Sophomore | 7% | 7 |
| | Junior | 37% | 37 |
| | Senior | 55% | 55 |
| Overall GPA | 2.0-2.5 | 7% | 7 |
| | 2.6-3.0 | 44% | 44 |
| | 3.1-3.5 | 32% | 32 |
| | 3.6-4.0 | 17% | 17 |
| Years left till graduation | Less than 1 year | 9% | 9 |
| | 1 Year | 53% | 53 |
| | 2 Year | 35% | 35 |
| | More than 3 Years | 3% | 3 |
| How many hours do you take per semester | Less than 12 | 4% | 4 |
| | 12 | 29% | 29 |
| | 12 to 16 | 66% | 66 |
| | More than 16 | 1% | 1 |
| Have you ever dropped a course because the professor was hard to understand | Yes | 33% | 33 |
| | No | 67% | 67 |
| Have you ever dropped a course due to the professor being unhelpful | Yes | 31% | 31 |
| | No | 69% | 69 |
| Have you ever dropped a course due to the professor being unorganized | Yes | 28% | 28 |
| | No | 72% | 72 |
| Method of Payment (select all that apply) | Financial Aid | 61% | 62 |
| | Parents | 48% | 47 |
| | Work off campus | 36% | 36 |
| | Work on campus | 10% | 10 |
| | Other | 19% | 19 |
| On average how many hours a week do you study | Less than 3 hours a week | 7% | 7 |
| | 3-10 hours a week | 32% | 32 |
| | 10-30 hours a week | 45% | 45 |
| | More than 30 hours a week | 16% | 16 |


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|---|---|---|---|
| Did you transfer credits into UTSA from another college(select all that apply) | None | 23% | 23 |
| | SAC | 19% | 19 |
| | VISTA | 14% | 14 |
| | UT Austin | 6% | 6 |
| | Other | 48% | 48 |
| Have you taken any science or math courses at another college | Yes | 64% | 64 |
| | No | 36% | 36 |
| What level of mathematics did you start at in college | Lower than College Algebra | 9% | 9 |
| | College Algebra | 34% | 34 |
| | Pre-calculus | 16% | 16 |
| | Calculus I | 27% | 27 |
| | Calculus II | 14% | 14 |
| Are the courses always available when you need to register for them | Always Available | 18% | 18 |
| | 1-2 unavailable | 65% | 65 |
| | More than 2 unavailable | 17% | 17 |
| How many times did the prerequisites prevent you from taking the full load(12 hours) during a semester | Never | 50% | 50 |
| | Once | 21% | 21 |
| | Twice | 14% | 14 |
| | More than twice | 15% | 15 |
| Have prerequisites ever pushed your graduation date back | Yes | 66% | 66 |
| | No | 34% | 34 |
| Do you understand the applications of the material in the courses you study | During the course | 60% | 60 |
| | After the course | 38% | 38 |
| | Never | 3% | 3 |
| Have you ever requested a prerequisite override | Yes | 45% | 45 |
| | No | 55% | 55 |
| If "yes" was your request approved | Yes | 77% | 34 |
| | No | 21% | 10 |
| If "yes" were you able to comprehend the material and pass the course you got the override for | Yes | 89% | 31 |
| | No | 11% | 5 |
| How many engineering courses do you feel you can complete successfully per semester | 3 | 16% | 16 |
| | 4 | 57% | 57 |
| | 5 | 25% | 25 |
| | 6+ | 1% | 1 |
| If there were weekend classes available would you be interested in them more than weekly classes | Yes | 22% | 22 |
| | No | 78% | 78 |
| What in your opinion is the optimal duration of a class | 50 minutes | 54% | 54 |
| | 75 minutes | 32% | 32 |
| | 90 minutes | 14% | 14 |
| | 120 minutes | 0% | 0 |
| | More than 120 minutes | 0% | 0 |
| What in your opinion is the optimal distribution of the grade throughout the course | Equally distributed between midterms and final | 66% | 66 |
| | More weight on midterms | 20% | 20 |
| | More weight on the final | 14% | 14 |


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