



The Impact of the Physics, Statics, and Mechanics Sequence on Student Retention and Performance in Mechanical Engineering

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Abstract

Engineering curricula are known to be challenging because they require high-level technical knowledge, critical thinking, and creative problem solving skills. The curricula are characterized as having long pre-requisite chains because high-level material requires understanding of core engineering knowledge, which in turn rests on a wide spectrum of math and science courses. In mechanical engineering, one of the critical pre-requisite chains involves the so called “mechanics sequence,” which runs from Physics to Statics and then to Mechanics and Dynamics. This paper examines how performance in these key classes affects students’ persistence in engineering, as measured by GPA at graduation and time-to-graduate. It is found that Statics has the largest impact on the academic success of struggling mechanical engineering students. While some students can overcome poor grades in Physics, struggles in Physics often foretell continued problems throughout the mechanical engineering curriculum.

1. Introduction

Recent decreases in state funding and corresponding increases in tuition have transferred the financial burden of college to the student, resulting in a growing focus on improving university’s 6-year graduation rates. This becomes particularly challenging in engineering due to lengthy course sequences within the curriculum, which exacerbate high credit hour requirements. To produce more STEM graduates while maintaining graduate quality, it is critical to understand the impact of specific course sequences in engineering curricula on student success and retention. In this study, the Physics -> Statics -> Mechanics/Dynamics sequence in the mechanical engineering (ME) curriculum at the George W. Woodruff School of Mechanical Engineering at the Georgia Institute of Technology is assessed to answer three questions:

- 1) How do grades in these courses impact a student’s time to graduation and final GPA?
- 2) Is there a critical point in this sequence where students leave mechanical engineering?
- 3) Can students who struggle early in this sequence recover, and what are key factors in this recovery?

Previous research indicates that high school GPA, high school physics and calculus grades, freshmen physics and calculus grades, and SAT scores are excellent predictors of student success in college [1], [2]. However, the problem of why students choose not to enter STEM fields, and/or why they fail to persist is still an open question. For example, Seymour and Hewitt [3] identified 23 issues supplied in a survey of undergraduate students, listing a large and diverse set of reasons for dropping out of STEM fields.

The Physics -> Statics-> Mechanics/Dynamics sequence was selected for this study because the material builds on the same fundamental principles throughout the sequence. Further, Statics is a critical pre-requisite course in ME; without passing Statics a student is precluded from taking 9 of the 17 required ME core courses at Georgia Tech.

Several studies are relevant to the present investigation. For example, Suresh [4] examined attrition as students passed through “barrier courses” typically encountered in the first two years of an engineering curricula. Barrier courses are also referred to as “gateway courses” or “gatekeeper courses” [5], suggesting that they have been associated with weeding out students from engineering. In particular, Suresh mentions that Calculus, Physics, and Statics are all significant obstacles influencing a student’s decision to persist in engineering, or to drop out of STEM. Based on students’ performance in Calculus I, Calculus II, Physics I, Physics II, and Statics, Suresh divided a cohort of students into three categories: *sailers*, *plodders*, and *struggling persisters*. However, the main focus of [4] is on cognitive factors that influence the performance in barrier courses, rather than on how performance in the barrier courses influences the students’ undergraduate career.

In addition to [4], the importance of barrier courses has also been cited as a key indicator of success in engineering curricula. Marra, et al. [6] state that difficulties in a freshmen math or physics course was often stated as a reason for leaving engineering; the difficulty of the material was often compounded by attitudes and quality of instruction. Tyson [7] considers “Academic Integration” as a key factor in degree attainment, with academic integration reflected in a sequence of classes- Physics I and II and Calculus I, II, and III. Zhang, et al. [8] considered the relative importance of 20 core science and math courses taken by engineering majors, finding that grades in only 6 of them were significant predictors of retention. It is interesting that the course that they found to have the highest predictive value was General Chemistry 1 Lab, which is not a subject strongly associated with advanced topics in mechanical engineering. Indeed, one of the major motivations for the present study was to focus on mechanical engineering specifically, so that advisors, instructors, and administrators in the authors’ institution could have accurate and reliable data on student performance.

It should be noted that the focus of the present paper is on data analytics rather than on trying to discern the underlying cognitive and non-cognitive reasons for attrition in the ME curriculum and in the mechanics sequence in particular. A recent trend in higher education has been the use of large data sets of student performance as a way of predicting future performance based on early indicators. Good examples of this have appeared recently in the press and several companies have sprung up to offer these services to universities [9, 10, 11]. More relevant to the present study, is the work of Grohs, et al. [12], who used large data sets of students taking statics at Virginia Tech to uncover statistics of future performance in mechanics courses, based on whether the student took statics at Virginia Tech, or whether they received transfer credit for the course. Similarly, Laugerman, et al. [13] examined the success rates in engineering persistence for students who completed parts of their barrier classes and, at times, major-specific classes at community college prior to transferring to a four-year engineering program.

The remainder of the paper is organized as follows. Section 2 describes the research study and methodology. Section 3 describes the findings of trends in performance in the mechanics sequence as well as critical points where students leave the major. Section 4 discusses the fluidity of grades; in particular, the predictive value of grades in early classes vs. grades in later classes is examined. Finally, Section 5 gives concluding remarks.

2. Description of the Study and Methods

In this study, ‘Physics’ refers to the first calculus-based physics course engineering students take as freshmen, which focuses on mechanics and Newton’s laws. ‘Statics’ refers to the undergraduate course that follows Physics, and covers bodies at rest and forces in equilibrium. ‘Mechanics’ refers to the undergraduate solid mechanics course mechanical engineers typically take as juniors, and is also called ‘Mechanics of Materials’ or ‘Deformable Bodies’. ‘Dynamics’ is the undergraduate course that is also typically taken junior year, and covers masses in motion. At Georgia Tech, the prerequisite chain of these courses is as follows: students must pass Physics to take Statics, and students must pass Statics to take Dynamics and Mechanics. All of these courses must be completed for the student to graduate with a degree in ME. In the data set examined for this study, the following variables are accounted for: student grades in Physics, Statics, Mechanics, Dynamics, and Differential Equations, major at graduation, first term, last term, total number of terms, total number of credit hours taken, and number of credit hours enrolled in the semester the student took Physics, Statics, Mechanics, Dynamics, and Differential Equations. Three main cohorts of students are examined: ‘ME Starters’ is a cohort of roughly 1200 students that started in mechanical engineering at the Georgia Institute of Technology between 2009 and 2012, but did not necessarily graduate. ‘ME Graduates’ is a cohort of students that started in mechanical engineering at Georgia Tech between 2009 and 2012, and graduated from Georgia Tech institution in mechanical engineering. ‘ME Strugglers’ is a cohort of students that started in mechanical engineering at Georgia Tech between 2009 and 2012, and either graduated in ME with a final GPA less than a 3.0, or left the institution prior to graduation with a GPA less than 3.0.

Statistical methods

For all one-way ANOVAs and multivariate linear regressions, normality of each group is verified using QQ plots, and homoscedasticity of variances is verified by examining residuals. For one-way ANOVAs, as the groups compared have unequal sample sizes, Games-Howell post hoc tests are utilized to determine differences between groups. For the multi-level model analysis students were included as random effect and the individual courses were included as fixed effects.

3. The impact of Physics, Statics, Dynamics, and Mechanics grades on final GPA

To determine the extent of the impact of student grades in Physics, Statics, Mechanics, and Dynamics on final GPA, a cohort of students at Georgia Tech who started in

mechanical engineering between August 2009 and August 2012 and graduated in mechanical engineering is examined. As mentioned above, this cohort of students is referred to as ‘ME Graduates’, and has $n = 795$ students. Students are grouped by the grade they received in their first attempt in a course, and the final GPA is the student’s cumulative GPA at graduation. A one-way ANOVA is conducted comparing the average final GPA across all grade groups. Figure 1 shows the average cumulative GPA at graduation based on the grades that the student received in each of the courses under examination. Data for the Dynamics course is not pictured, but follows a similar trend as Physics, Statics, and Mechanics. The average final GPA at graduation of the cohort is 3.24, which is indicated by the solid black line in each subplot. In Physics, Statics, Mechanics, and Dynamics, the average final GPA of ‘A’ students is statistically higher than the average final GPA of ‘B’ students, and both ‘A’ and ‘B’ students have a statistically higher average final GPAs than ‘C’, ‘D’, and ‘F’ students. Interestingly, the average final GPA of ‘C’ students is not statistically different than the average final GPA of ‘D’ students, but is higher than the average final GPA of ‘F’ students. There is no statistical difference in average final GPA between ‘D’ and ‘F’ students. Note that the sample size of ‘F’ students is low across all courses. The ‘C’, ‘D’, and ‘F’ students in all courses have an average final GPA below a 3.0, which is the typical industry cutoff for hiring. In all courses, ‘B’ students have an average final GPA right around the average final GPA of the ME Graduates cohort.

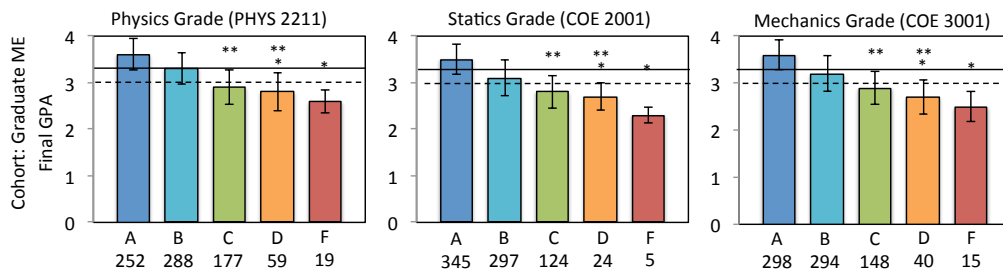


Figure 1: Average final GPA compared to student grade in Physics, Statics, and Mechanics. Cohort: ME Graduates, $n = 795$. Black line indicates average final GPA of cohort. Dashed line indicates standard industry cut off GPA of 3.0. * No statistical significance, $p > 0.01$. ** No statistical significance $p > 0.01$. Error bars show one standard deviation.

A multi-level model relating the final GPA of the students to their individual grades in each course was developed. Courses examined were Physics, Statics, Mechanics, Dynamics, and Differential Equations. Differential Equations was included in this analysis to determine if there is a difference in the impact on final GPA for foundational ME classes (Statics, Dynamics, Mechanics), as opposed to basic science and math courses that are pre-requisites to core ME classes (Differential Equations, Physics). Students were included in the model as a random factor. Students in this model fit the following three requirements: 1) started in ME at Georgia Tech between 2009 and 2012, 2) either graduated in ME at Georgia Tech or dropped out of Georgia Tech, and 3) completed Physics, Statics, Dynamics, Mechanics, and Differential Equations at Georgia Tech with a letter grade of A, B, C, D, or F. The total number of students in this cohort was $n = 760$. The final form of the model can be seen in Figure 2 and includes grades from Dynamics ($b=0.13$, $t(760)=10.27$, $p<0.001$), Mechanics ($b=0.15$, $t(760)=12.85$,

$p < 0.001$), Physics ($b = 0.14$, $t(760) = 12.20$, $p < 0.001$) and Statics ($b = 0.16$, $t(760) = 11.06$, $p < 0.001$) as individual factors. Grades from Differential Equations and second and higher-level interactions were removed due to insignificance. For students with a final GPA ranging from 0 to 4.0 the regression slopes indicate that all of the ME foundational courses (Statics, Mechanics, Dynamics) in addition to Physics have similar impact overall on the student's final grades. Differential Equations is not a good indicator of future GPA.

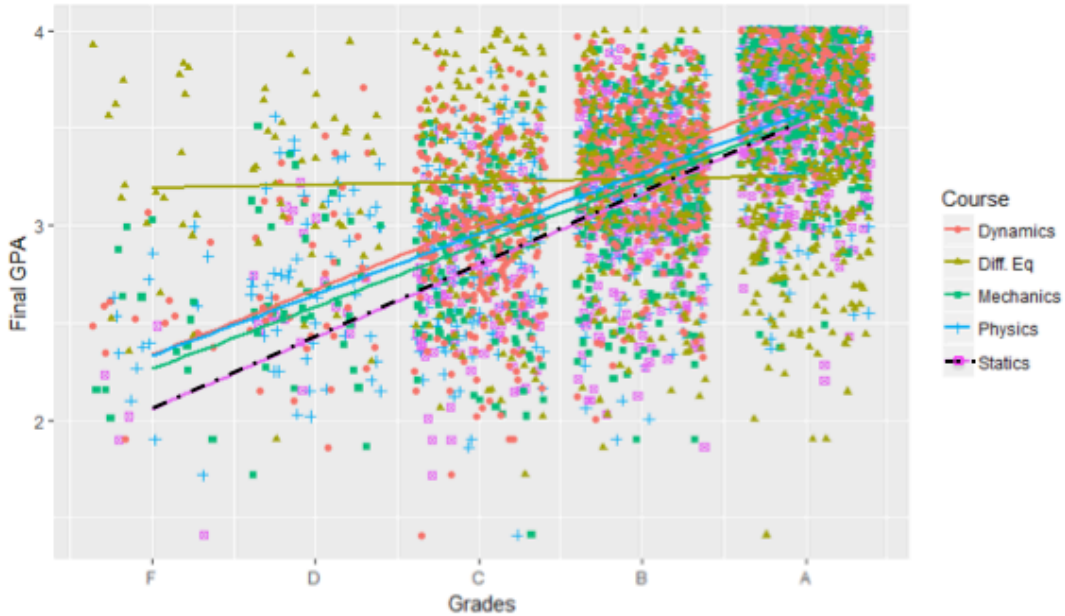


Figure 2: Multi-level model fitting student course grades to final GPA for Physics, Statics, Dynamics, Mechanics, and Differential Equations.

To determine if there is a difference in how these course grades impact the final GPA of struggling students, a sub-cohort of students who had a final GPA less than 3.0 is examined. This cohort is referred to as ‘ME Strugglers.’ The final form of the model for ‘ME Strugglers’ can be seen in Figure 3, and included grades from Dynamics ($b = 0.04$, $t(207) = 1.57$, $p = 0.1175$), Mechanics ($b = 0.07$, $t(207) = 4.08$, $p < 0.001$), Physics ($b = 0.05$, $t(207) = 2.86$, $p < 0.001$) and Statics ($b = 0.11$, $t(207) = 5.09$, $p < 0.001$) as individual factors. Grades from Differential Equations and second and higher-level interactions were removed due to insignificance. For ‘ME Strugglers’, Dynamics did not have a significant impact on final GPA, and the Statics had the largest impact on their final GPA.

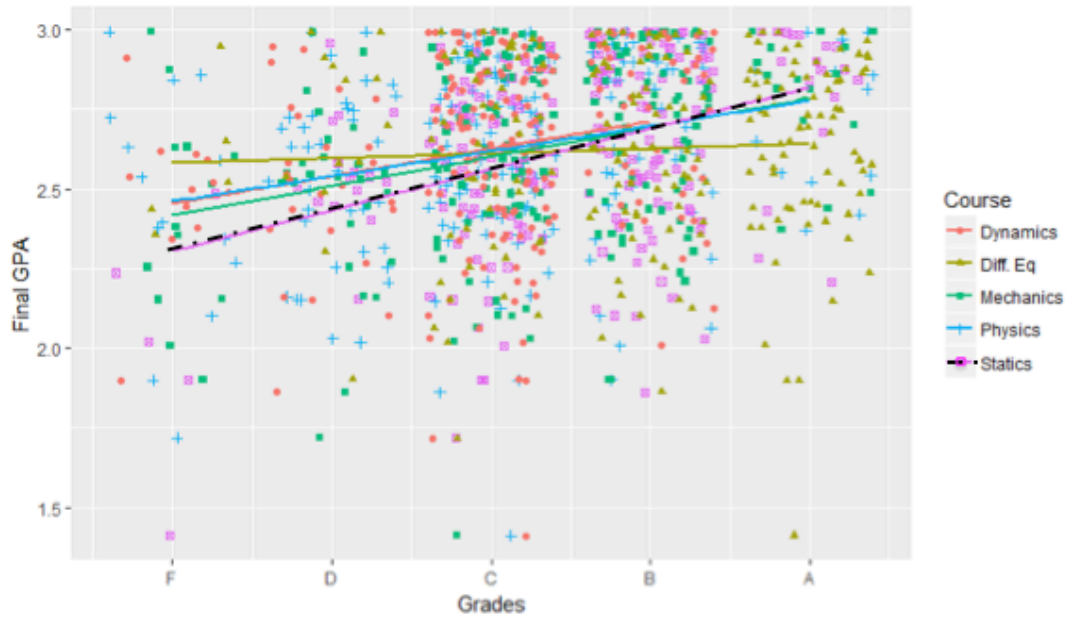


Figure 3: Multi-level model showing students who have a final GPA < 3.0. Multi level model fitting student course grades to final GPA for Physics, Statics, Dynamics, Mechanics, and Differential Equations.

3.1 The impact of Physics, Statics, Dynamics, and Mechanics grades on time to graduation

To determine how grades in Physics, Statics, Mechanics, and Dynamics affect a student's time to graduation, a one-way ANOVA is conducted for each course, comparing the average time to graduation across all grade groups. Figure 4 shows the average time to graduation for the ME Graduates cohort grouped by the grade they received on their first attempt in each course. Note again that Dynamics is not shown, but follows the trend of the Physics, Statics, and Mechanics courses. Time to graduation is calculated as the number of terms between when the student starts to when the student graduates at Georgia Tech, not counting terms when the student is on professional internship or co-op employment; terms when students studied abroad are included. The outlined ME curriculum at Georgia Tech institution suggests that a student should graduate with 129 credit hours in 8 terms, or 4 years. The average time to graduation was 9.8 terms, which is roughly 5 years. As seen in the figure, time to graduation tends to increase as the grade that they received in these foundational classes decreases. For all courses, 'A' students graduated on average in 9.4 terms, which is more than a term longer than Georgia Tech's ME curriculum plan. In general, 'F' students graduate on average two terms (1 year) later than 'A' students- however, due to small sample sizes and high variances, there was no statistical difference in time to graduation between 'F' students and 'A' students in Statics, Dynamics, and Mechanics. For Physics, 'A' students graduate in a statistically shorter time frame compared to 'B,' 'C', 'D', and 'F' students, $p < 0.01$. For Statics, Mechanics, and Dynamics, 'A' students graduate statistically faster than 'B', 'C', and 'D' students, $p \leq 0.01$. Note that in all four courses, 'A' students graduated on average an

entire term before 'C' students. Outside of 'A' students, there were no statistically significant comparisons between student grade groups.

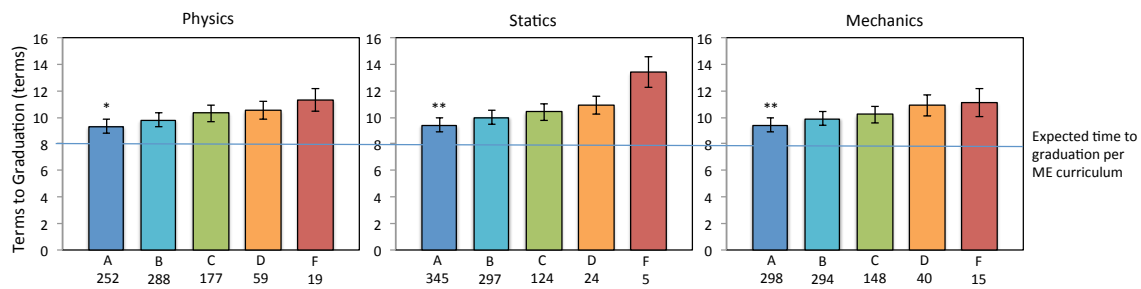


Figure 4: Time to graduation vs grade in Physics, Statics, and Mechanics courses. Cohort: ME Graduates. * average time to graduation is significantly different than B, C, D, and F grades, $p < 0.01$. ** average time to graduation is significantly different than B, C, and D grades, $p < 0.01$. Blue line indicates that 8 terms is the expected time to graduation per Georgia Tech's ME curriculum.

3.2 Is there a critical point in the Physics-Statics-Mechanics/Dynamics sequence where students leave mechanical engineering?

The ME Graduates cohort is purposely chosen to include only those students who remained ME majors throughout their undergraduate careers. But, a critical question concerns those students who leave ME: When do they leave and why do they leave? To examine this question, a cohort was formed of all students who entered Georgia Tech as ME majors between the years of 2009 and 2011, and who graduated prior to 2017. This cohort is termed ME Starters, and includes $n = 1185$ students.

Figure 5 shows graphically how many ME Starters graduate with a BSME degree. Of the 25% that leave ME (some of which actually leave the university), the largest number do so between Physics and prior to Statics. Only 8% of the ME Starters leave ME after completing Dynamics and Mechanics. Figure 6 shows the destination of ME Starters who leave ME. Of the 25% who leave ME, 10% remain in STEM fields, 6% change majors within the university to non-STEM fields, and 9% either leave the university, or did not graduate within the 6-year window that was considered. Figure 7 shows further detail into the 16% of ME Starters that graduate from Georgia Tech within 6 years. As shown in the figure, many students who leave ME pursue interests in electrical engineering (EE), computer engineering (CMPE), or computer science (CS); taken together, these three majors receive 27% of the ME change-of-majors. A fairly large percentage of students switch to industrial and systems engineering (IE); since IE is not well known as a field to high school seniors, they tend to receive many students who change majors once they learn more about the field and career opportunities. Another big recipient of students shown in Figure 7 switch to business administration (BA) or economics (ECON). While it is an overall positive scenario that these students presumably found another major that they preferred to ME, it should be mentioned that students who change majors one or more times tend to delay their graduation. Hence, changing majors has a real cost in terms of tuition and time.

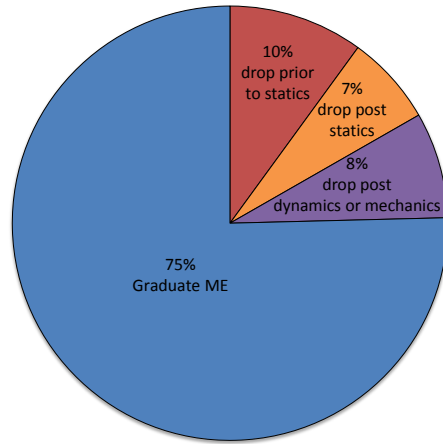


Figure 5: Percentage of ME Starters that graduate with BSME degrees vs. those that leave ME at different points in the curriculum.

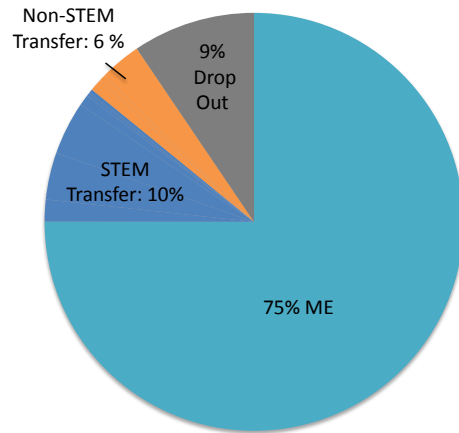


Figure 6: Percentage of ME Starters that graduate broken down by their major upon graduation from Georgia Tech.

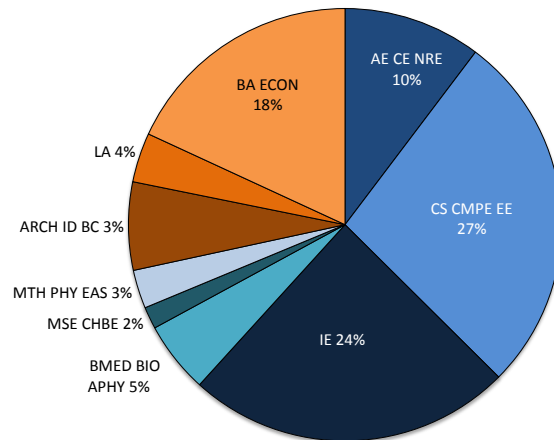


Figure 7: Majors to which ME Starters transfer at Georgia Tech.

4. Discussion

4.1 Fluidity of student grades through the physics statics mechanics sequence

The results from the ME Graduates cohort demonstrate that students who earn an ‘A’ in Physics achieve an average final GPA of 3.6, which is significantly higher than all other student grade groups. ‘A’ students in Statics, Dynamics, and Mechanics courses also outperformed their fellow students in terms of final GPA. Figure 8 shows an alluvial plot of the ME Starters cohort, illustrating the path of students who earn an ‘A’ in Physics through the Physics-Statics-Mechanics sequence. Each vertical bar indicates the grade, course, and percentage of students who earned that grade. Horizontal bars flow to show the path of students through the sequence, and if they rise or fall in course grades. For example, the vertical bar on the far left shows that $n = 297$ students earned an A in Physics. The middle vertical bar indicates that 70% of the students who earned an ‘A’ in Physics go on to earn an ‘A’ in Statics. The far right vertical bar demonstrates 62% of students who earned an ‘A’ in Physics go on to earn an ‘A’ in Mechanics. Note that 50% of students who earn an ‘A’ in Physics go on to earn straight ‘A’s’ throughout this course sequence, and 85% will earn only ‘A’s’ or ‘B’s’ throughout the sequence. Only 2% of students of ‘A’ Physics students struggle, receiving a D or an F somewhere later on in the course sequence. 5% of ‘A’ Physics students leave ME prior to completing the sequence. Clearly, students who earn ‘A’s’ in Physics tend to excel throughout the sequence, rarely falling out of the top grades. This, combined with an overall high GPA at graduation suggests that an ‘A’ in Physics may act as an indicator of a high performing student who will likely excel in many of the courses in the ME major at Georgia Tech. Note the Physics course is 4 credit hours out of the 129 credit hours required for the ME degree, and therefore only accounts for 3% of a student’s final GPA.

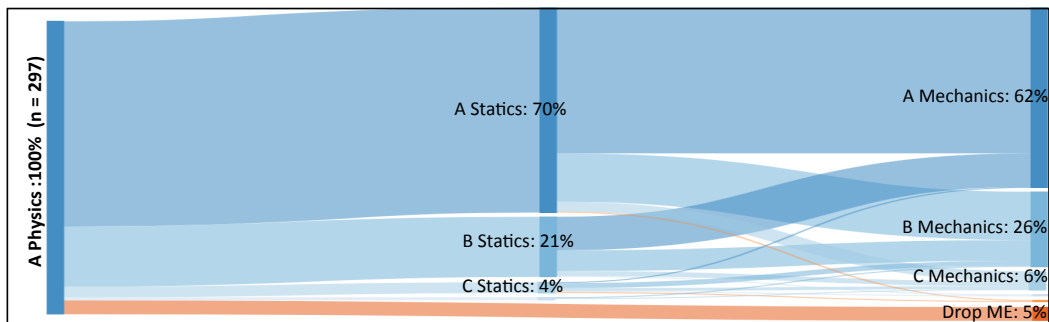


Figure 8: Alluvial plot showing path of students who earn an 'A' in Physics through the Physics-Statics-Mechanics sequence. Each vertical bar indicates the grade, course, and percentage of students who earned that grade. Horizontal bars flow to show the breakdown of grades in the next course. Note that a total of 3 students went on to earn a 'D' in Statics and 4 students went on to earn a 'F' or 'D' in Mechanics- these lines were too small to label.

Figure 9 illustrates the path of students who earn a ‘C’ in physics through the Physics-Statics-Mechanics sequence. Note that the ‘C’ students have significant fluidity in their course grades; a third of students will pull up to achieve only “A’s” and “B’s” throughout the remainder of the sequence, and 66% of students will maintain passing grades through the entire sequence. 15% of students will struggle through the sequence, dropping down to earn at least one F or D, and 18% of the students will leave the ME major prior to

completing the sequence. For ‘C’ students in Physics, the future path is difficult to predict. However, ‘C’ students who went on to earn an ‘A’ in Statics obtained a significantly higher GPA than ‘C’ students who went on to earn a ‘B’ in Statics. (3.1 final GPA of A students compared to 2.9 final GPA of B students, $p = 0.0015$ and a power of 0.82 with an α of 0.01) For the 20 ‘C’ students who went on to earn a ‘D’ in Statics, 1/3 of the students left ME, and those who stayed ended up with an average final GPA of a 2.7. These findings correspond well to the multi-level model of struggling students: for ‘C’ Physics students, the grade in Statics appears to have a strong impact on final GPA, and may act as a warning sign that intervention is necessary.

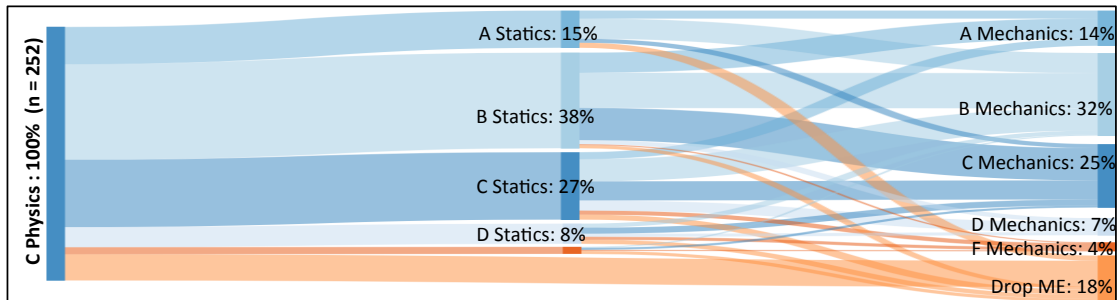


Figure 9: Alluvial plot showing progression of ‘C’ students in Physics through the Physics-Statics-Mechanics sequence. Each vertical bar indicates the grade, course, and percentage of students who earned that grade. Horizontal bars show flow to show the breakdown of grades in the next course. ‘Drop ME’ refers to students who leave the ME major. 7 students failed Statics.

Results indicate there is no statistical difference in final GPA between ME Graduates who earn a ‘C’ in Physics compared to those who earn a ‘D’ in Physics. However, if the ME Starter cohort is examined, ‘C’ and ‘D’ Physics students do have statistically different final GPAs (‘C’ students have a final GPA of 2.9, ‘D’ students a 2.6, $p < 0.01$). This cohort has $n = 1185$ students in the Physics course, and the final GPA is the student’s accumulative GPA as of the last semester they were at Georgia Tech. For the ME Starter cohort, out of the 118 students who earn a ‘D’ in Physics, 40% drop out of ME and over a quarter leave the institution prior to graduation. It is possible that the poorer performing students who earn a ‘D’ in Physics drop out of ME, while the high performing ‘D’ students recover with a final GPA closer to ‘C’ students. As suggested in the multi-level model of struggling students, the Statics grade may be critical in recovery; students who receive a ‘D’ in Physics and an ‘A’ in Statics have a final GPA of 2.98, which is significantly higher than the final GPA of students receive a ‘D’ in Physics and a ‘C’ in Statics (2.61). ($p = 0.0078$, a power of 62%.) Only 5% of students who get a ‘D’ in Physics and an ‘A’ or ‘B’ in Statics leave the ME major, while roughly a third of students who get a ‘D’ in Physics and a ‘C’, ‘D’, or ‘F’ in Statics leave the ME major. Note that 20% of students who receive a ‘D’ in Physics will leave the ME major prior to taking Statics. In the ME major at Georgia Tech, a ‘D’ in Physics should act as a red flag- the student is at significant risk of leaving the major and the institution.

Figure 10 below shows the path of students who fail physics through the Physics, Statics, and Mechanics sequence. Note that 65% of students who fail Physics will switch out of mechanical engineering. It is noted that in the ME school at Georgia Tech, a student who has failed Physics must retake the course prior to moving on to statics. This fact may

dissuade some students from retaking physics and may contribute to the decision to leave ME and other majors that require Physics.

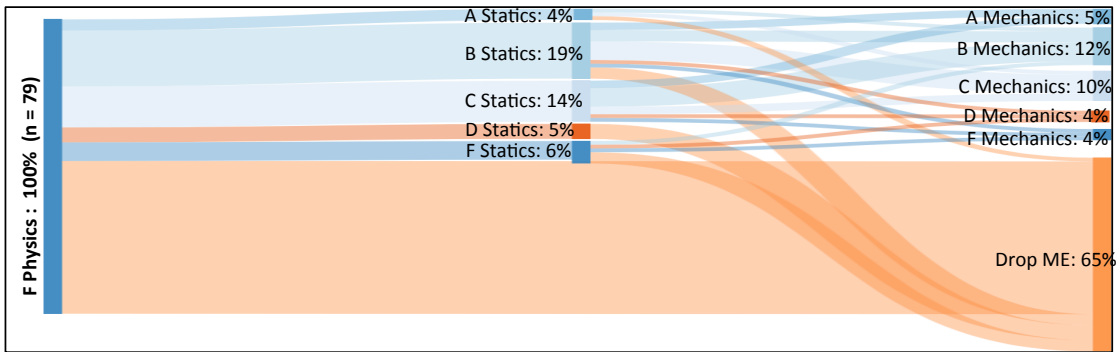


Figure 10: Alluvial plot showing progression of students who fail Physics through the Physics-Statics-Mechanics sequence.

Figure 11 shows that roughly 50% of students who fail Physics will leave the institution. 21% of students remain in ME and pass the remainder of the sequence, and 5% will remain in ME and continue to struggle. While these statistics are grim, they are also encouraging- it is clear that some students who fail Physics are fully capable of recovering in the sequence and graduating with a ME degree. Out of the 26% that transfer out of mechanical engineering but remain at the institution, only 5% will remain in STEM. It appears that at Georgia Tech, students who fail Physics are at great risk of not only leaving STEM, but also leaving the institution.

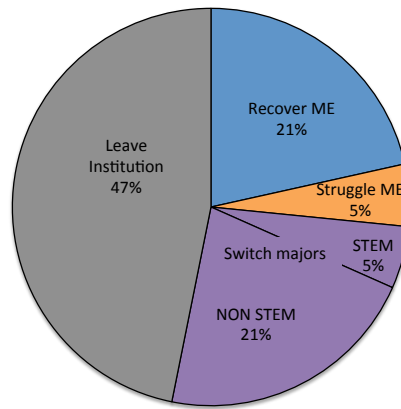


Figure 11: Final landing place of students who failed Physics. 'Recover ME' means that students pass Statics and Mechanics and graduate ME. 'Struggle ME' means that students continue to earn grades in the sequence below passing, but graduate with an ME degree.

Interestingly, there is no statistical difference in the final GPA of students who received a D or F in Physics and graduated in STEM (2.74) vs. students who received a D or F in Physics and graduated in non-STEM major (2.89). (n = 30 students non STEM, n = 109 students STEM, p = 0.168 for Welches unpaired t-test.) It appears that at Georgia Tech, struggling in Physics may be an indicator that a student will not only struggle in mechanical engineering, but may also struggle in non-STEM curriculums such as history, industrial design, or business administration. Note that as Georgia Tech has selective acceptance rates (25 percent), it may be that Physics is an indicator of a student's overall studying and time management skills.

4.2 Effect of total semester hours on Physics and Statics grades

To determine if students who struggle in Physics overload themselves in terms of course workload, the number of credit hours students enrolled in the semester they took Physics is examined. There is no statistical difference in the average number of credit hours between students who passed Physics with an 'A', 'B', or 'C' ($p > 0.05$, 14.98 credit hours, $n = 1050$) and students who received a 'D' or 'F' in Physics (14.81 credit hours, $n = 211$). Additionally, there was no statistical difference in the average number of credits enrolled in between students who failed Physics the first time and then passed Physics with an 'A', 'B', and 'C' in the second attempt ($p > 0.05$, 13.13 credit hours, $n = 45$) compared to students who failed Physics the first time and then received a 'D' or 'F' in Physics in the second attempt (13.58 credit hours, $n = 24$). Further, there was no statistical difference in the average number of credit hours between students who passed Statics with an 'A', 'B', or 'C' ($p > 0.01$, 14.15 credit hours, $n = 961$), and students who received a 'D' or 'F' in Statics (14.62 credit hours, $n = 64$). The sample size of students who failed Statics the first attempt and then repeated Statics was too low to draw any statistical conclusions in terms of course grade vs. number of credit hours.

Note that Georgia Tech's ME curriculum recommends students take 17 credit hours the semester they take Physics and 16 credit hours the semester they take Statics; all groups of students have an average credit hour load well below this recommendation. There is significant variation in the number of credit hours students take the semester they take Physics and Statics, ranging from 12 credits to 21 credits. At Georgia Tech, it does not appear that the number of credit hours a student takes has a consistent or clear impact on their Physics or Statics grade. It may be that the impact a course load has on GPA is highly specific to the individual.

5. Concluding Remarks

The study has revealed a number of interesting statistics about the performance of undergraduate mechanical engineering students at the Georgia Institute of Technology. In particular, the study focused on the mechanics sequence (Physics, Statics, Mechanics, and Dynamics) to examine how performance is influenced by the courses that precede it, and how each course predicts the student's performance in follow-on classes. The study also examined the likely spots in the ME curriculum where students leave the major and where they go when they leave. Among the findings that emerged from this study, we have shown the following observations for ME students at Georgia Tech:

- While all grades have an impact on the decision of ME students to stay or to leave their major, early grades seem more important, and grades in Physics seem exceptionally important.
- Students who receive an 'A' in Physics tend to exhibit fairly consistent and high performance throughout their mechanics sequence, while 'C' students show significant fluidity.

- Students who receive ‘F’s early in the mechanics sequence can recover, but few do.
- For students who are in the middle to lower quintiles, in terms of the mechanics sequence it appears Statics has the largest impact on final GPA.
- There is no significant difference in final GPA between students who struggle in Physics and switch out of STEM majors compared to those who remain in STEM majors
- The number of credit hours a student is taking did not seem to have a clear impact on their performance in Physics

In future work, the results of this study will be refined to determine the influence of other variables which may or may not be important, such as the number and type of AP/transfer credits and the impact of other ME courses taken concurrently with Physics or Statics. A specific focus will be to determine which variables have greatest impact on the success of students who are in the middle to lower GPA quintiles, as these are the students most vulnerable to not receiving a job offer at graduation, leaving the ME major, or leaving the institution.

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