AC 2012-3363: RETENTION ANALYSIS OF WOMEN ENGINEERING STUDENTS

Ms. Ann M. Blasick, Georgia Institute of Technology

Ann Blasick earned her B.S. in mechanical engineering from Wilkes University and M.S. in mechanical engineering from Georgia Tech. After working in industry for Lucent Technologies and Nortel Networks, as well as in the non-profit arena for several years, she returned to Georgia Tech in 2005 as an Assistant Director in the Division of Professional Practice, advising co-op and internship students. In August 2011, she transitioned to her position as Associate Director of the Women in Engineering Program within the Georgia Tech College of Engineering.

Dr. Christine Valle, Georgia Institute of Technology
Dr. John D. Leonard II, Georgia Institute of Technology

John Leonard is Associate Dean in the College of Engineering and Associate Professor in civil and environmental engineering at Georgia Tech.

Retention Analysis of Women Engineering Students

Abstract

There has been recent attention given to the issues of retention of women and under-represented minorities in engineering. Most analyses are based on data collected at multiple institutions and seek to derive general conclusions across a very diverse selection of universities and student population, without 'drilling in' with much depth regarding what mechanisms may be at play from year to year when students decide to leave engineering altogether. One interesting result of such surveys that hasn't been explored in much depth is the fact that most engineering students take 5 years to graduate, even though the curriculum is based on 4 years to graduation.

In contrast, this study seeks to analyze retention rates at a single institution, the Georgia Institute of Technology (GT), from year to year. GT graduates more engineers and more women engineers than any other institution in the United States, so the numbers there are large enough to provide meaningful data. Also, the College of Engineering at GT is currently rated 4th in the nation, and therefore quite selective. Yet, the data indicates GT is more successful at retaining engineering students than the national average – though similar to the national studies, most GT engineering students take 5 years to graduate. This study aims to determine whether this extra year is due to good reasons, such as work experience (co-op, internships) or living abroad experience (study or work), gained while at school – all unquestionably valuable experiences that make for a better rounded engineer – rather than because of bad reasons, such as the curriculum being too difficult for students to successfully navigate in 4 years.

Introduction

Retention studies of undergraduate students in engineering have received considerable attention in recent years. There is widespread concern from both industry and academe that not enough engineers are produced in the USA. This has nefarious consequences on the ability of American companies to remain globally competitive. In addition to the low number of engineers produced overall, there is long-standing worry regarding the persistent under-representation of minorities (URM) and women in engineering. The lack of diversity in the engineering workforce may make it more difficult for companies to innovate and meet the Grand Challenges (as defined by the National Academy of Engineering) that the world faces in the future.

While women earn over half of all undergraduate degrees, they receive only about 20% of all degrees awarded in engineering [1]. This number has plateaued for at least a decade. In contrast, the representation of women in other fields like law or medicine was as bad as in engineering thirty years ago but has now almost reached parity. As a result, in the last decade a number of programs have been developed at institutions around the country to identify the factors associated with this consistent under-representation of

women in engineering, and to help implement solutions, such as Women in Engineering programs.

Factors contributing to the under-representation of women students in engineering may include retention: are there significant numbers of students who start out studying engineering in college, but then drop out? And if so, why? A large body of research has shown that women who choose to major in engineering upon starting college tend to graduate at rates similar or higher to those of their male counterparts [2, 3]. The picture is less clear for URMs and seems to be institution-dependent: in general, Asian women persist to the eight semester the most, followed by Asian males, Hispanic female, White students (women first, men second), Hispanic Males and Black females. Black males have the lowest persistence rate [4].

One issue is how to define retention. Success can be measured using four-year, five-year, or six-year graduation rates [5, 6] or the analogous semester measure (i.e. eight semester persistence instead of four-year graduation rate, assuming continuous enrollment).

Ohland et. al. [4] present an extensive analysis of retention measures and student educational experiences at the undergraduate level. This paper uses the large, multi-institution dataset MIDFIELD (Multiple-Institution Database for Investigating Engineering Longitudinal Development) which contains records of over 75,000 students in engineering during the years of 1988 through 1998. Ohland and his colleagues [4, 7] determined that eight-semester persistence is highly predictive of six-year graduation rates. But, using eight-semester persistence can underreport the persistence of women to graduation. In general, it is shown that paths of persistence are nonlinear, gendered and racialized, so that it's important to use multiple measures to assess retention when dealing with diverse populations of engineering students.

Consentino et. al. [8] found that retention is not the primary reason for the low percentage of women in engineering, but rather, recruitment. That is, when women and URMs enter college intending to study engineering, they usually do eventually graduate with an engineering degree and don't transfer to a non-engineering field. However, very few female high school seniors do in fact choose engineering as a field of study in college.

Marra and her collaborators [9, 10] looked at retention best practices in a large representative sample of engineering schools, and also found that what works for women or URMs doesn't necessarily work for white males.

In this paper, we focus on a single institution, the Georgia Institute of Technology (GT). GT produces a very large number of engineers, including very large numbers of female engineers, and as such its numbers are sufficient to disaggregate results by gender and still provide meaningful results. This is usually not possible at most American institutions. This will help uncover interesting features that are not possible to analyze in depth when multiple institutions' data are pulled together: some of the finer grained analyses cannot be done on multi-institution data due to the lack of consistency in how the data is measured from one institution to the next. Also, the variability in campus

experiences, such as support available to students and atmosphere in classes, can negatively affect the analysis by muddying the results.

While the student experience at GT will not be readily applicable to other engineering campuses, the fact that there is no variability in our data (when it comes to campus environment) will provide for a much more meaningful and in-depth analysis. The very success of GT at producing large numbers of engineers who are highly sought after by industry means that whatever best practices can be discerned at GT will potentially offer great value at other institutions, even if their characteristics (liberal arts colleges, private versus public, etc.) are quite different.

Some of the characteristics of GT include:

1. Most students at GT major in some field of engineering, and most faculty are affiliated with its College of Engineering (COE).
2. GT is not a comprehensive university. Rather, its focus and renown is in engineering and technology-oriented fields.
3. GT is highly selective and all its engineering programs rank in the top 10 in the country (per US News and World report). Many rank in the top 5.
4. GT has a very popular, non-mandatory co-op program, which up to 30% of its student body participates in.
5. GT has a large, successful study and work abroad program, with significant student participation.
6. GT is a large, research 1, state-supported public school located in an urban environment.

The research questions we wanted to address in depth include:

1. At GT most students graduate after 5 years of full-time enrollment, yet the BS in engineering degree (whatever the specific discipline of engineering) is still presented as a 4-year degree. Is the reason that most students take 5 years to graduate due to their involvement in significant and valuable extra-curricular activities, such as co-op program, internships, study or work abroad? Or is it primarily due to their struggle in coursework, i.e. having to repeat courses multiple times to pass and complete their degrees; or, to switching majors multiple times while still remaining in engineering (for example, switching from aerospace engineering to industrial engineering, whose curricula differ quite a bit if the transfer is done after the 1st year on campus)? Do those reasons change based on the student's gender?
2. Do the analysis results differ appreciably if the student is female or male?
3. Does retention data change appreciably if it's calculated based on semesters versus years? That is, do many students take significant breaks from being enrolled in school?

Due to the difficulty of tracking transfer students, they are excluded from our analysis and we restricted ourselves to students admitted to GT in their 1st year (first-time freshman students).

Analysis

In this paper, data is provided for 11 cohorts of students, ranging from 2001 until 2011, enrolled at GT within that window of time. A year (such as 2002) is defined as the spring, summer and fall semesters of 2002. This is different from the usual academic year definition, which would include fall 2002, spring and summer 2003.

Retention to n^{th} year is defined as the number or percentage of students majoring in any engineering discipline who are still enrolled in any engineering discipline at the time of the n^{th} year (though they may have switched majors in between). An enrolled student may be taking classes, or be a co-op or intern currently at work, or be studying or working abroad in any combination.

In general, GT is largely very successful at retaining students. Below are tables representing freshman cohort retention and graduation rates, first for the overall population, then for females and then for various URM groups:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	27.6%	68.8%	79.0%	82%	83%
2002	28.4%	71.0%	79.3%	81%	82%
2003	26.0%	70.5%	80.7%	83%	83%
2004	29.4%	71.9%	81.1%	83%	83%
2005	27.2%	72.6%	79.7%	80%	80%
2006	29.1%	72.0%	72.0%	72%	72%
2007	36.2%	36.2%	36.2%	36%	36%
2008	2.1%	2.1%	2.1%	2%	2%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 1 – Graduation rate at GT for overall undergraduate population in the COE

We also have the data in terms of retention rates:

Cohort group	Retain to 2nd year	Retain to 3rd year	Retain to 4th year	Retain to 5th year	Retain to 6th year	Retain to 7th year	Retain to 7th fall
2001	86.5%	74.2%	77.9%	81.0%	82.1%	82.4%	83%
2002	84.7%	72.3%	78.2%	80.7%	81.7%	82.1%	82%
2003	86.5%	74.1%	79.0%	82.2%	83.2%	83.1%	84%
2004	87.7%	75.8%	79.9%	82.0%	83.1%	83.6%	83%
2005	88.1%	75.4%	78.1%	81.9%	82.6%	82.9%	80%
2006	88.8%	78.4%	81.2%	83.7%	83.1%	72.0%	72%

2007	89.4%	80.1%	82.5%	84.8%	36.2%	36.2%	36%
2008	90.4%	77.4%	79.8%	2.1%	2.1%	2.1%	2%
2009	91.5%	78.3%	0.1%	0.0%	0.0%	0.0%	0%
2010	92.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%
2011	0.0%	0.0%	0.0%	0.0%	0.0%	0.0%	0%

Table 2 – Retention rate at GT for overall undergraduate population in the COE, by percentage

We have the same data in terms of counts:

Cohort group	Count in group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7 yrs or less	Grad > 7 years
2001	1263	348	869	998	1,031	1,044
2002	1375	391	976	1,090	1,113	1,129
2003	1364	355	962	1,101	1,126	1,133
2004	1624	478	1,167	1,317	1,343	1,343
2005	1501	409	1,089	1,196	1,196	1,196
2006	1743	508	1,255	1,255	1,255	1,255
2007	1635	592	592	592	592	592
2008	1656	34	34	34	34	34
2009	1749	0	0	0	0	0
2010	1790	0	0	0	0	0
2011	1771	0	0	0	0	0

Table 3 – Graduation rate, by counts, at GT for overall undergraduate population in the COE

Next we look at the data for male students:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	24.9%	65.2%	77.0%	80%	81%
2002	26.5%	69.0%	78.1%	80%	81%
2003	24.6%	68.2%	79.3%	81%	82%
2004	27.9%	70.0%	79.8%	82%	82%
2005	23.6%	70.3%	78.3%	78%	78%
2006	26.1%	68.7%	68.7%	69%	69%
2007	33.2%	33.2%	33.2%	33%	33%
2008	1.7%	1.7%	1.7%	2%	2%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%

2011	0.0%	0.0%	0.0%	0%	0%

Table 4 – Graduation rate by percentage at GT for male students in the COE

Here is the same data in terms of counts:

Cohort group	Count in group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7 yrs or less	Grad > 7 years
2001	998	248	651	768	798	808
2002	1079	286	744	843	863	877
2003	1108	273	756	879	903	910
2004	1273	355	891	1,016	1,038	1,038
2005	1169	276	822	915	915	915
2006	1318	344	906	906	906	906
2007	1246	414	414	414	414	414
2008	1249	21	21	21	21	21
2009	1307	0	0	0	0	0
2010	1265	0	0	0	0	0
2011	1207	0	0	0	0	0

Table 5 – Graduation rate by counts at GT for male students in the COE

We have similar data for female undergraduate engineering students:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	37.7%	82.3%	86.8%	88%	89%
2002	35.5%	78.4%	83.4%	84%	85%
2003	32.0%	80.5%	86.7%	87%	87%
2004	35.0%	78.6%	85.8%	87%	87%
2005	40.1%	80.4%	84.6%	85%	85%
2006	38.6%	82.1%	82.1%	82%	82%
2007	45.8%	45.8%	45.8%	46%	46%
2008	3.2%	3.2%	3.2%	3%	3%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 6 – Graduation rate, by percentages, at GT for female students in the COE

Cohort group	Count in group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7 yrs or less	Grad > 7 years

2001	265	100	218	230	233	236
2002	296	105	232	247	250	252
2003	256	82	206	222	223	223
2004	351	123	276	301	305	305
2005	332	133	267	281	281	281
2006	425	164	349	349	349	349
2007	389	178	178	178	178	178
2008	407	13	13	13	13	13
2009	442	0	0	0	0	0
2010	525	0	0	0	0	0
2011	564	0	0	0	0	0

Table 7 – Graduation rate, by percentages, at GT for female students in the COE

Next we look at graduation rates for URMs. This will include Asians, Blacks, Hispanics, and students who identified as being of 'two or more' ethnicities. Native Americans and Polynesians are not included because their numbers are too small to be meaningful.

For Asian students:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	43.3%	71.0%	78.3%	83%	83%
2002	36.5%	75.0%	82.7%	84%	86%
2003	32.9%	70.5%	77.3%	79%	79%
2004	33.8%	75.4%	83.5%	85%	85%
2005	38.2%	79.7%	85.5%	86%	86%
2006	37.5%	75.6%	75.6%	76%	76%
2007	46.6%	46.6%	46.6%	47%	47%
2008	3.0%	3.0%	3.0%	3%	3%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 8 – Graduation rate at GT for Asian students in the COE

For Black students:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	24.5%	61.2%	69.4%	76%	78%
2002	18.6%	64.3%	74.3%	77%	81%
2003	10.6%	53.0%	69.7%	71%	71%

2004	13.6%	61.7%	77.8%	78%	78%
2005	5.7%	48.3%	60.9%	61%	61%
2006	12.1%	56.0%	56.0%	56%	56%
2007	16.4%	16.4%	16.4%	16%	16%
2008	1.6%	1.6%	1.6%	2%	2%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 9 – Graduation rate at GT for Black students in the COE

For Hispanic students:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	25.7%	74.3%	85.7%	91%	91%
2002	46.7%	82.2%	88.9%	89%	91%
2003	19.5%	75.6%	90.2%	90%	90%
2004	24.6%	68.1%	79.7%	81%	81%
2005	25.3%	67.5%	73.5%	73%	73%
2006	26.5%	71.1%	71.1%	71%	71%
2007	23.7%	23.7%	23.7%	24%	24%
2008	1.3%	1.3%	1.3%	1%	1%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 10 – Graduation rate at GT for Hispanic students in the COE

For students of ‘two or more’ ethnicities:

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	30.8%	69.2%	84.6%	92%	92%
2002	27.3%	72.7%	81.8%	82%	82%
2003	50.0%	75.0%	91.7%	92%	92%
2004	23.5%	70.6%	85.3%	91%	91%
2005	32.6%	83.7%	90.7%	91%	91%
2006	30.2%	71.7%	71.7%	72%	72%
2007	45.7%	45.7%	45.7%	46%	46%
2008	2.6%	2.6%	2.6%	3%	3%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%

2011	0.0%	0.0%	0.0%	0%	0%

Table 11 – Graduation rate at GT for students identifying as being of 'two or more' ethnicities in the COE

Female numbers include all students regardless of visa status (US citizens, permanent residents and aliens). URMs include only US citizens or permanent residents and exclude aliens.

The table below provides the same data for women, this time excluding aliens (only US citizens and permanent residents).

Cohort group	Grad 4 yrs or less	Grad 5 yrs or less	Grad 6 yrs or less	Grad 7yrs or less	Grad > 7 years
2001	36.9%	81.9%	86.5%	88%	89%
2002	33.8%	78.2%	83.5%	84%	85%
2003	30.6%	79.8%	86.4%	87%	87%
2004	34.7%	78.1%	85.4%	87%	87%
2005	39.6%	79.6%	84.0%	84%	84%
2006	37.4%	81.6%	81.6%	82%	82%
2007	44.7%	44.7%	44.7%	45%	45%
2008	3.4%	3.4%	3.4%	3%	3%
2009	0.0%	0.0%	0.0%	0%	0%
2010	0.0%	0.0%	0.0%	0%	0%
2011	0.0%	0.0%	0.0%	0%	0%

Table 12 – Graduation rate at GT for female students, excluding foreign nationals, in the COE

The difference between Tables 6 and 12 is that Table 6 includes women who are not US citizens or permanent residents. As can be seen from the data, female foreign nationals tend to graduate at a slightly faster rate than women born in, or naturalized to, the US. However, the difference is very small (less than 1%), and so we will not differentiate between those groups in the rest of the analysis.

In general, one can see that the average overall graduation rate after 5 years of school is slightly above 70%. This is significantly more than the rate for graduation at 4 years or less, which is consistently below 30%, but close to the graduation at 6 years or less which is around or below 80%. Therefore, as stated previously, most of the students at GT graduate in 5 years or less. For males, on average the graduation rate at 5 years is around 70%, whereas for females, it's around 80% or more.

Such figures are well above more general results looking at multiple institutions, such as those from MIDFIELD data analysis [4]: for all 75,000 students captured in this dataset, the average graduation rate at 6 years is around 53.4%. For white women, graduation

within 6 years is on average 54.2%, whereas for men, it's marginally higher at 54.7%. The MIDFIELD data shows that minority women tend to graduate slightly sooner than men, and that URMs (except for Asian-Americans and Hispanic women) tend to graduate later than White or Caucasian students consistently. This makes the high graduation rate of GT all the more impressive, and even more so when considering its selectivity.

We will now focus our analysis on female students only. Since most students graduate within 7 years, we will also only focus on cohorts for the years 2000 until 2005. Based on the previous results, for those 6 cohorts 89% of women who originally enrolled in the College of Engineering have now graduated. Some of the questions we want to assess for that group are:

1. How many students did at least 1 semester of co-op, internship, study or work abroad?
2. How many repeated at least 1 class during their enrollment at GT? If the majority of students repeat at least 1 class, that would explain why most of them take 5 years to graduate.
3. Do the retention analysis results change appreciably if the data is based on semesters versus years?

Let's start with some general statistics on that population – first in terms of counts:

Gender	2000	2001	2002	2003	2004	2005	(All)
M	997	998	1080	1110	1275	1171	6631
F	296	268	298	256	351	332	1801
(All)	1293	1266	1378	1366	1626	1503	8432

Table 13 – Counts of female and male students in the College of Engineering at GT

And now in terms of percentages:

Gender	2000	2001	2002	2003	2004	2005	(All)
M	77.1	78.8	78.4	81.3	78.4	77.9	78.6
F	22.9	21.2	21.6	18.7	21.6	22.1	21.4
(All)	100	100	100	100	100	100	100

Table 14 – Percentages of female and male students in the College of Engineering at GT

Next let's look at ethnicity:

Gender	Asian (Z)	Black (B)	Foreign-born	Hispanic (H)	Native American (I)	Two or more (T)	Unknown (U)	White (W)	(All)
M	1003	288	298	250	7	109	28	4648	6631
F	285	134	61	66	5	34	4	1212	1801

(All)	1288	422	359	316	12	143	32	5860	8432

Table 15 – Counts of female and male students, by racial or ethnic group, in the College of Engineering at GT

Next we look at the first department or school within the College of Engineering that the students select when they enroll at GT, by gender:

Gender	AE	BMED	CEE	CHBE	ECE	ISYE	ME	MSE	(All)
M	1060	332	411	467	1887	586	1652	236	6631
F	175	269	152	266	197	382	269	91	1801
(All)	1235	601	563	733	2084	968	1921	327	8432

Table 16 – Counts of female and male students, per school of choice at time of enrollment, in the College of Engineering at GT

Some of these schools offer more than 1 major, such as ECE which offers a BS degree in electrical engineering or computer engineering, and ME offers a BS degree in mechanical or nuclear engineering. GT does allow students to choose 'Undecided' as an engineering major, but because their numbers are typically very small (90% of the freshman students pick a major before the 1st day of classes), we can disregard them in this analysis.

GT has a very active, voluntary co-op program in which students commit to working for the same company for at least 3 semesters, in alternance with school. It also has a strong internship program, where students work for a company for at least 1 semester (which can be a spring, summer or fall semester). We looked at participation in either program by gender, for all 6 cohorts together:

Gender Participation	F	M	(All)
Coop/Intern	992	3657	4649
Not	809	2974	3783
(All)	1801	6631	8432

Table 17 – Counts of female and male students who participate in the co-op or internship programs for at least one semester, in the College of Engineering at GT

We now look at average SAT and leadership scores by gender:

Test Variable	Gender	2000	2001	2002	2003	2004	2005	(All)
Leadership	F	62.4	60.3	41.1	37.1	38.4	36.3	45.5
Leadership	M	53.3	54.7	39.4	34.7	34.1	32.9	40.8
Sat_math_verb	F	1303.7	1307.6	1336.7	1312.5	1330.5	1330.5	1321.2
Sat_math_verb	M	1330.3	1338	1340.8	1336.8	1344.4	1343	1339.2
Sat_math	F	664.8	674.9	674.7	691.5	676.1	695.1	679.6
Sat_math	M	697.3	700.3	707.5	706.4	703.8	701.1	702.8

Sat_verbal	F	631.6	622.3	626.5	628.3	631.7	654.2	632.8
Sat_verbal	M	637.7	637.7	629.4	639.7	639.2	645.4	638.3

Table 18 – SAT and leadership scores for female and male students, in the College of Engineering at GT

On average, women tend to have slightly higher leadership scores than men, and slightly lower SAT verbal and math scores.

We look at how many students received a poor grade (defined as D or F) at least once during their time at GT, by percentage:

Grade	2000	2001	2002	2003	2004	2005	(All)
D or F	63.2	62.5	59.9	63	57.8	58.9	60.7
Not	36.8	37.5	40.1	37	42.2	41.1	39.3
(All)	100	100	100	100	100	100	100

Table 19 – Percentages of engineering students who receive a D or F grade at least once during their time at GT

Table 19 shows that almost 61% of the students in these cohorts received at least 1 D or F during their time at GT.

Let's look at how many got at least 1 W (withdrew from a class) during their time at GT:

Grade	2000	2001	2002	2003	2004	2005	(All)
W	72.4	70.5	75.5	77.6	77.9	73.3	74.7
Not	27.6	29.5	24.5	22.4	22.1	26.7	25.3
(All)	100	100	100	100	100	100	100

Table 20 – Percentages of engineering students who withdraw from a class at least once during their time at GT

Table 20 shows that almost 75%, ¾ of all students in those cohorts, withdrew from at least 1 class during their time at GT.

The next table shows how many took advantage of at least 1 AP credit from high school:

Cohort	2000	2001	2002	2003	2004	2005	(All)
AP credit	47.2	48.6	50.2	52.4	52.9	56.2	51.4
Not	52.8	51.4	49.8	47.6	47.1	43.8	48.6
(All)	100	100	100	100	100	100	100

Table 21 – Percentages of engineering students who used advanced placement credit at the start of their enrollment at GT

Table 21 shows that slightly more than half of all students in those cohorts used AP credit when they first enrolled at GT.

The next table shows how many students, within each of the 6 cohorts, took classes during the summer semester:

Summer School?	2000	2001	2002	2003	2004	2005	(All)
N	21.8	23.1	23.5	24	23	25	23.4
Y	78.2	76.9	76.5	76	77	75	76.6
(All)	100	100	100	100	100	100	100

Table 22 – Percentages of engineering students who took summer classes at least once during their time at GT

Table 22 shows that over ¾ of all students in those cohorts spent at least 1 summer taking classes at GT prior to graduating.

In light of the high number of students who participate in summer school, we decided to analyze time to graduation based on numbers of terms, or semesters enrolled at school, versus the more commonly used number of years to graduation. For example, a student who graduates in a perfect 4 years, starting his or her freshman year in a fall semester and graduating in a spring semester, would be enrolled in 11 semesters: 3 (fall + spring + summer) for the 1st 3 years, then 2 for the final year (fall + spring), for a total of 11 terms of continuous enrollment, which represents 11/12*4 = 3.67 years. A student graduating in what is considered to be 5 years would be enrolled in 14 semesters: 3 semesters (or terms) times 4 for the 1st 4 years, plus an additional 2 semesters, i.e. 14/15*5 = 4.67 years.

The next two tables look at the numbers of terms a student took to graduate, by gender, first in counts:

Number Terms	7	8	9	10	11	12	13	14	15	16	17	18
F	2	14	16	51	431	141	312	403	60	66	25	12
M	6	69	45	143	1168	288	1101	1418	318	362	233	44
(All)	8	83	61	194	1599	429	1413	1821	378	428	258	56

Table 23 – Counts of engineering students by the numbers of terms (semesters) of continuous enrollment that it took them to graduate from GT with an engineering degree

Though we have data up to and including a 22-term elapsed time between first-time enrollment and graduation, numbers drop off sharply after 16 semesters, so we decided to truncate the table at 18 semesters.

The next table shows the same data in percentages:

Number Terms	7	8	9	10	11	12	13	14	15	16	17	18
F	0.1	0.9	1	3.3	27.8	9.1	20.2	26	3.9	4.3	1.6	0.8
M	0.1	1.3	0.8	2.7	21.9	5.4	20.6	26.6	6	6.8	4.4	0.8
(All)	0.1	1.2	0.9	2.8	23.2	6.2	20.5	26.4	5.5	6.2	3.7	0.8

Table 24 – Percentages of engineering students by the numbers of terms (semesters) of continuous enrollment that it took them to graduate from GT with an engineering degree

These results indicate that while the majority of students graduate in 14 or 13 terms, i.e. around 5 years of continuous enrollment, women overwhelmingly graduate in a perfect 11 terms, compared to men (27.8% versus 21.9%). We have seen that roughly half of students participate in at least 1 semester of work (either co-op or internship) while at school, and exercise AP credit as they start their studies at GT. Well over half of students get a W, D or F in at least 1 class and take part in summer school.

Therefore, it seems that the additional 1 or 2 semesters that most students take to graduate, from the "nominal" 3.67 years or 11 continuous terms enrolled, is due neither to nefarious reasons (poor academic performance) nor to good reasons (co-op or internship participation). Students offset delays with AP credit and summer classes, especially women, so that the largest group of them (27.8%) manage to graduate in 11 semesters.

Conclusion

Results show that while half or over half of GT engineering students experience both sets of situations (the good and the bad), the largest group of women (27.8%) manage to graduate in a perfect 11 continuous enrolled terms, which corresponds to the typical 4-year to graduation schedule, by taking advantage of summer classes and advanced placement credit. That is not the case for men, who still overwhelmingly graduate in 13 or 14 semesters.

Future work includes looking at student-athletes, students involved in the Greek system or other similar organizations on campus that take a lot of time outside of class, the influence of on-campus housing versus off campus, and under-represented minorities.

Literature Review

1. National Science Foundation, Division of Sciences Resources Statistics, 2004. "Women, minorities, and persons with disabilities in science and engineering," Arlington, VA.
2. Hartman, H. & Hartman, M., "Leaving engineering: Lessons from Rowan University's College of Engineering," *Journal of Engineering Education*, 95(1), 49-61, 2006.
3. Lord, S., Camacho, M., Layton, R., Long, R., Ohland, M. and Wasburn, M., "Who's persisting in engineering? A comparative analysis of female and male Asian, Black, Hispanic, Native American and White students," *Journal of Women and Minorities in Science and Engineering*, 15(2), 167-190, 2009.

4. Ohland, M., Brawner, C., Camacho, M., Layton,R., Long, R., Lord, S., and Washburn, M., "Race, Gender and Measures of Success in Engineering Education," *Journal of Engineering Education*, Vol. 100(2), 225-246, 2011.
5. Kroc, R., Howard, R., and Hull, P., "Graduation Rates: Do students' academic program choices make a difference?," Retrieved from http://aer.arizona.edu/AER/Enrollment/Policy_Analyses/GradRates.pdf
6. Alvord, C.J., "First time freshman graduation rates Fall 1980-Fall 1997 entering classes," (Biennial Report). Retrieved from http://ms7.dpbwin2k.cornell.edu/documents/1000024.pdf
7. Ohland, M.W., Camacho, M., Layton, R., Lord, S., and Wasburn, M., "How we measure success makes a difference: Eight-semester persistence and graduation rates for female and male engineering students," *2009 ASEE Annual Conference Proceedings*.
8. de Cohen, C., Deterding, N., "Widening the Net: National Estimates of Gender Disparities in Engineering," *Journal of Engineering Education*, 98(3), 211-226, 2009.
9. Ro, H., Marra, R., Terenzini, P., Trautvetter, L., Walser, A., and Lord, S. "If You Build it, They Will Come (and Stay): Recruiting and Retaining Women and URM Students," *2011 ASEE Annual Conference Proceedings*.
10. Trautvetter, L., Marra, R., Lattuca, L., Piacentini, K., and Knight, D., "Programs and Practices Making a Difference: a Cross-Case Analysis Identifying Programs and Factors that Influence Recruitment and Retention of Women Engineering Students," *2011 ASEE Annual Conference Proceedings*.