A Longitudinal Retention Study in an Urban Engineering School

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Introduction

The retention of undergraduate students in engineering programs has attracted considerable attention at Colleges and Universities across the Country. From an academic institutional standpoint, losing students from engineering programs can have serious resource and resource allocation ramifications. From a broader perspective, however, losing engineering students exacerbates the already serious problem of the shortage of engineers in the National workforce. While the number of undergraduate engineering degrees has decreased from roughly 85,000 in the mid-1980's to roughly 60,000 at the turn of the century, the anticipated increase in the number of engineering positions by 2008 over that existing at the turn of the century is roughly 290,000. Attracting more students (particularly women and minorities) into engineering and **retaining them** are critically important concerns. While losing some students from engineering programs is expected, even desirable, it is important to measure and to evaluate the reasons for migration away from engineering in order to help determine optimum levels of retention for a given institution.

Manhattan College is a small, private, Catholic college located in the Riverdale section of the Bronx in New York City. The total enrollment is roughly 2800 with approximately 2500 undergraduate students and 300 Masters-level students. The ratio of male to female undergraduates in the College is roughly 52%/48% and 78%/22% in the School of Engineering. The undergraduate diversity (ratio of Caucasian to non-Caucasian) in the College as well as the School of Engineering is roughly 72%/28%. The ratio of commuting to resident undergraduate students in the College is roughly 27%/73% and 38%/62% in the School of Engineering. The School of Engineering offers BS and MS degrees in Civil, Chemical, Computer, Electrical, Environmental, and Mechanical Engineering. The Mission of the College is to provide a contemporary, person-centered educational experience characterized by high academic standards, reflection on values and principles, and preparation for a life-long career. In this regard it is also important to note that, consistent with this Mission, there is a strong emphasis on providing educational opportunities to first generation college students.

As mentioned earlier, retention of students has both institutional and global ramifications. Considering the stringent economic constraints facing most colleges and universities, the "costs"

of operating schools of engineering, and the manner in which resources are often allocated to cover those costs, the management of enrollment assumes an important, fundamental role in the operation of the institution. An issue being looked at more and more in engineering schools is the balance between increasing the number of admitted students and increasing retention. Because engineering students do not, in general, take many of their major courses until the junior and senior years, increasing engineering enrollments significantly impacts other units in the institution (e.g. service courses, financial aid, housing, infrastructure, etc.). Further, if retention is not optimum, a rather large number of these students never get to those major engineering course classrooms. Quite often, resource allocation is tied to student credit hours taught and this, then, negatively impacts engineering schools and departments. A simple calculation shows that by increasing retention a relatively small amount, and not simply admitting more students, significant resource advantages accrue to the engineering unit, as well as the institution in general (e.g. less demand on service units, less financial aid, reduced infrastructure demands, larger enrollments in major engineering courses, increased overall engineering enrollments, etc.).

Finally, since increasing retention of engineering students is generally presumed to be important, the issue to be addressed is the best way to affect retention to achieve desired results. A question that routinely seems to be asked is what can the engineering unit do to "increase retention?" However, it may be that there are very real limitations as to what such units can directly do to have significant effects on retention rates. In fact, it may well be that opportunities for significant impact on engineering student retention are to be found in other areas of the educational unit. It is toward these issues that this paper is addressed.

Overall Retention Data

The Engineering Dean's Office at Manhattan College has been collecting data that tracks the numbers of students in the School of Engineering (SOE) since the 1995-1996 academic year. Prior to that time little attention was paid to accumulating such institutional data. In this paper, we define **retention** to be the number of first time, full time freshman students entering the SOE that are retained in the SOE on a semester by semester basis. This study does not address the number of transfer students that enter the SOE in mid-program and does not consider a student that has made an internal transfer to another school at Manhattan College as "retained". We also define **graduation rate** as the number of first time, full time freshman that enter the SOE and actually graduate four years later. At Manhattan, we find that, in general, 95% (or more) of Engineering students finish in four years.

In Table 1 we list the enrollment history of the School of Engineering beginning with the Class of 1999 to the present. We point out that students in the Class of 1999 actually enrolled in the fall of 1995. The data in Table 1 are arranged such that an entry represents an enrollment figure for the beginning of a semester in one of four years. For example, the first entry in the 1999 column represents the number of first year, full time freshmen **entering** the School at the beginning of the fall 1995 semester. The second entry in this same column represents the number of those students **remaining** in the School of Engineering at the beginning of the Spring 1996 semester. And, finally, the last entry in the 2002 column represents the number of seniors that remain from the original group of entering freshman (first entry in the column) at the beginning of the spring 2002 semester. We lose few students during the spring semester of their senior year,

hence the graduation rate will be, to a good approximation, the same as the enrollment figures listed in the bottom row of the Table (i.e. Spring of Year 4).

Table 1: Engineering Enrollment History

Beginning of	Class	1999	2000	2001	2002	2003	2004	2005	2006
Year 1	Fall	92	114	92	125	117	125	140	165
	Spring	75	105	82	115	102	112	127	154
Year 2	Fall	66	89	70	89	85	96	109	
	Spring	57	80	60	71	78	87	102	
Year 3	Fall	54	78	58	66	72	83		
	Spring	49	78	56	65	70	78		
Year 4	Fall	49	74	56	63	70			
	Spring	49	74	55	61	69			

In Table 2 we present the data shown in Table 1 as a cumulative percentage of the original freshmen enrollment in each year that were lost (migrated away) by the beginning of each subsequent semester in each of the four years. For example, the second entry in the 1999 column represents the percentage lost of the number enrolled at the beginning of the fall 1995 semester (the first entry in the column). The third entry in this same column represents the percentage of the number enrolled at the beginning of the fall 1995 semester lost by the end of the spring 1996 semester. The data in Table 2 are presented graphically in Figure 1. In that figure we represent the migration of students away from the School of Engineering during these seven years by plotting the percent leaving as a function of the beginning of each semester for each class. In the figure the first entry along the abscissa pertains to the beginning of the first semester (hence the value of zero). The third entry, for example, represents the percent leaving as of the beginning of the third semester (equivalently the end of the second semester) for each class.

Table 2: Per Cent Lost (Migration)

Beginning of	Class	1999	2000	2001	2002	2003	2004	2005	2006
Year 1	Fall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Spring	18.5	7.9	10.9	8.0	16.2	10.4	9.3	6.7
Year 2	Fall	28.3	21.9	23.9	28.8	27.4	23.2	22.1	
	Spring	38.0	29.8	34.8	43.2	33.3	30.4	27.1	
Year 3	Fall	41.3	31.6	37.0	47.2	38.5	33.6		
	Spring	46.7	31.6	39.1	48.0	40.2	37.6		
Year 4	Fall	46.7	35.1	39.1	49.6	40.2			
	Spring	46.7	35.1	40.2	51.2	41.0			

In order to tease a bit more information from the data in Table 1, we plot in Figure 2 the slopes of each of the curves plotted in Figure 1 as a function of the beginning of each semester for each class. The actual values of these slopes are listed in Table 3. The data in Table 3 or, equivalently, plotted in Figure 2 represent the incremental change each semester in the number of students lost (migrating away) from the School of Engineering out of the original enrollment at

the beginning of each first fall semester.

Specific Analysis of Retention Data

The data listed in Table 3 and shown graphically in Figure 2 indicate clearly that most of the students lost (migrating away) from the School of Engineering do so by the beginning of the fifth semester (e.g. start of the junior year). Consequently, further study of retention can effectively be focused on the first four semesters of the Engineering program.

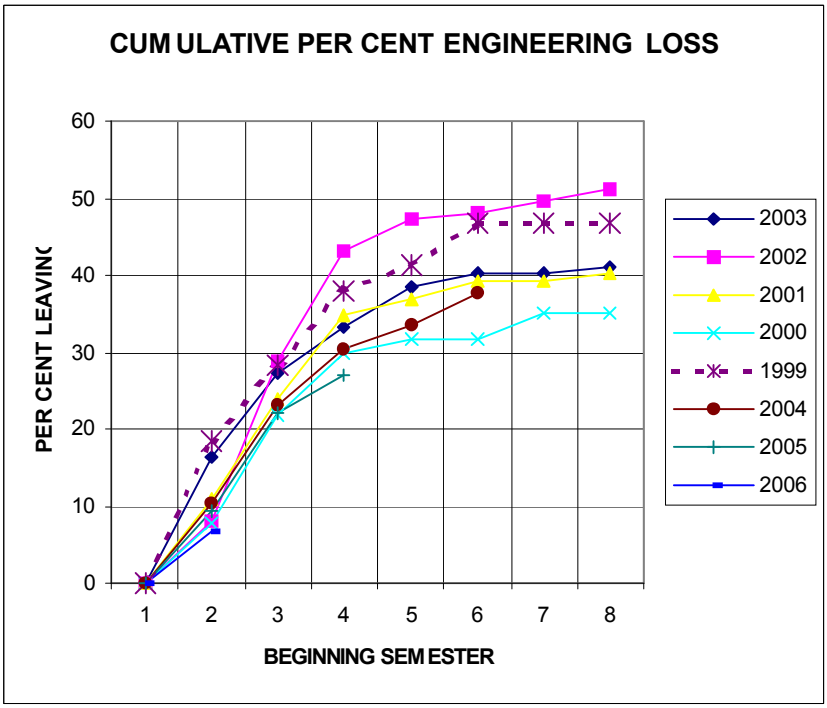

Figure 1: Per cent (cumulative) of Engineering students leaving by semester.

It is clear from the data shown in Tables 1-3 and Figures 1 and 2 that the SOE loses the majority of its students by the end of the freshman year even though these students have had very limited contact with the engineering faculty. Indeed, before 1996 freshmen engineering students had zero contact time with engineering faculty. During the 1995-96 academic year, the Engineering curriculum was modified, in part, to include two introductory freshman engineering courses largely to address the issues of retention and making it easier for students to decide upon a major by the end of the freshman year. As a result of that change, contact time in the freshman year has increased to 20% (two of ten courses). As a direct result of that modification to the engineering curriculum, migration away from SOE

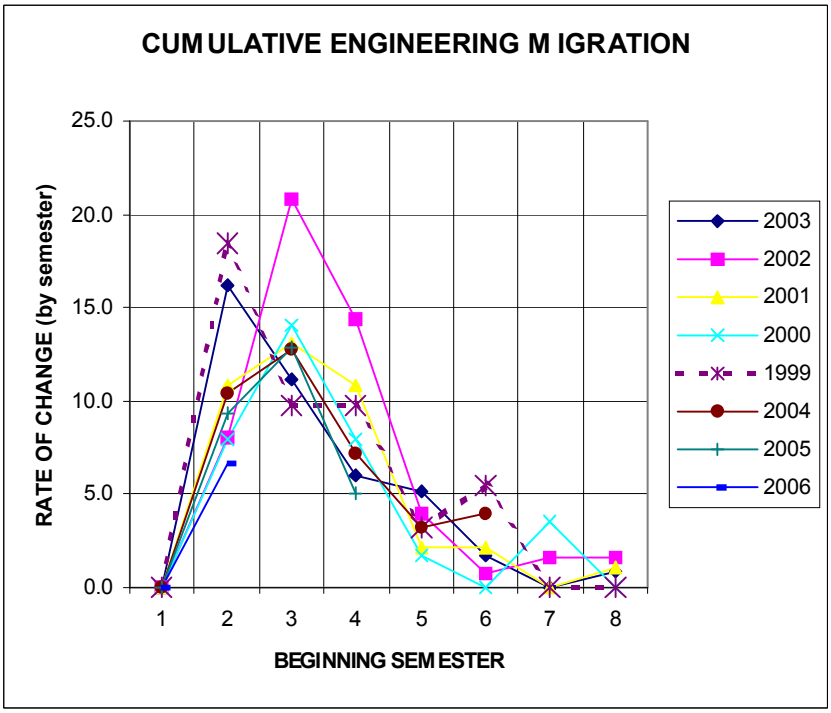

Figure 2: Rate of change of cumulative loss of Engineering students.

decreased by an average of 10% (i.e., compare class of 1999 data to that of 2000 – 2004 classes). Interestingly, from the class of 2000 on, we notice little variation in the amount of migration away from SOE in spite of our curriculum modification and our increased engineering presence in the freshman year. What this seems to suggest is that if a further decrease in migration away from SOE (increase in retention) is the goal, then action outside the SOE will be required.

Math SAT Scores As A Predictor

One of the issues we must deal with is the quality of secondary preparation of our students in math and science. One commonly used indicator that has evoked much concern in education circles is the math SAT (MSAT) score. Traditionally, a low MSAT score has been considered a harbinger of poor performance in engineering programs. While there is much evidence, anecdotal and otherwise, to support this proposition, there is movement away from using SAT scores, in general, for admission purposes (e.g., California). Nevertheless, it is our belief that the MSAT score distribution does serve as a useful indicator of probable student performance (and the need for remedial action).

For example, in Figure 3 we show the performance (in terms of retention) of four class years of students following the first four semesters of their engineering programs as a function of their MSAT scores. In Figure 3 we plot the average number of students in the School of Engineering retained in each of the MSAT ranges listed on the abscissa for the four classes, 2002 through 2005, inclusive. It should be noted that spring '03 data for the class of 2005 will be available by June 2003.

Table 3: Rate of Change of Per Cent Lost (Migration)

Beginning of	Class	1999	2000	2001	2002	2003	2004	2005	2006
Year 1	Fall	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
	Spring	18.5	7.9	10.9	8.0	16.2	10.4	9.3	6.7
Year 2	Fall	9.8	14.0	13.0	20.8	11.1	12.8	12.9	
	Spring	9.8	7.9	10.9	14.4	6.0	7.2	5.0	
Year 3	Fall	3.3	1.8	2.2	4.0	5.1	3.2		
	Spring	5.4	0.0	2.2	0.8	1.7	4.0		
Year 4	Fall	0.0	3.5	0.0	1.6	0.0			
	Spring	0.0	0.0	1.1	1.6	0.9			

What seems clear from the data in Figure 3 is that the higher the MSAT score is, the greater the probability that the student will be retained by (not migrate away from) Engineering at Manhattan. There are several points that need to be emphasized. First, consistent with our Mission at the College, we are more liberal in where we place the MSAT "bar" on the admissions ladder. That is to say, we tend to admit some students that otherwise might not be admitted if our goal was to report a higher range of SAT scores for our entering freshman classes. That being said, we point out that our goal is to graduate students capable of entering the engineering workforce and having successful careers. What this means is that we do admit students with MSAT scores in the 500 – 600 range (and above, obviously) and even a few with scores below 500 (after careful scrutiny).

The data listed in Tables 1-3 and Figures 1 and 2 show what appears to be anomalous behavior for the class of 2002, e.g. 51.2% migration away from SOE over eight semesters – significantly greater than all other years in the study. The apparent reason for this behavior is an interesting example of the utility of MSAT scores in predicting some types of performance. Specific MSAT data for all the classes involved in our study are shown in Figure 4 where the percentage of the incoming freshman class with MSAT scores less than 550 are plotted. In recent years, it appears that typically 20- 26% of the incoming freshman classes have a MSAT less than the required 550. However, 37% of the 2002 class (40% more than usual) had MSAT scores of 540 and below – with some scores as low as 380 and 390! While it is not entirely clear why such a large number of freshman with low MSAT scores were admitted as freshman in 1998, it may well have been in response to a perceived need to increase enrollment in order to achieve other goals.

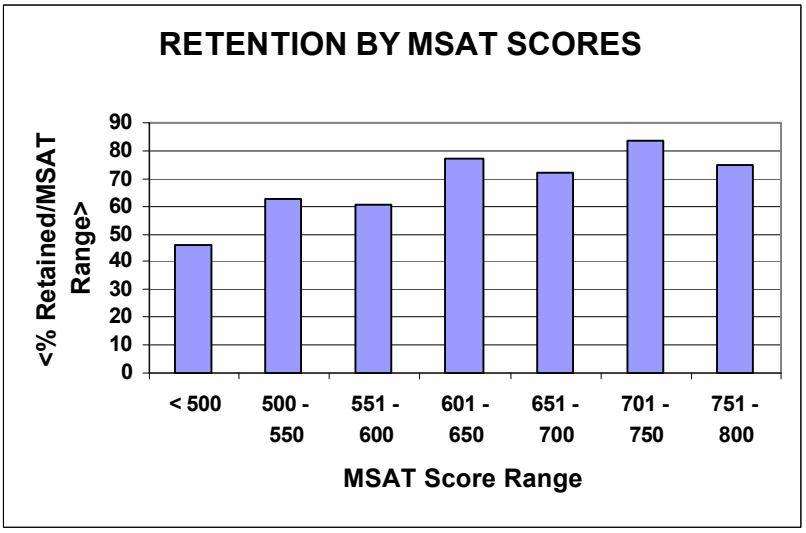

Figure 3: Relation of Engineering students retained to Math SAT scores.

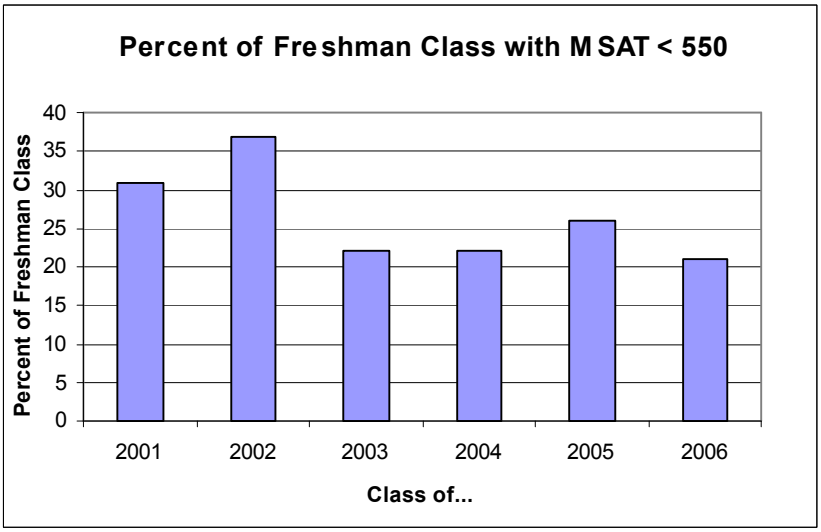

Figure 4: Percent of freshmen admitted to SOE with MSAT ≤ 540.

Actions Taken to Identify and Monitor At-Risk Students

As a result of years of experience, we have come to recognize that the lower range of MSAT scores is a useful tool for identifying students that either require initial remedial action and/or close monitoring and assistance during the first few semesters. Even with this higher level of attention, the probability that they will be lost is still large, but considerably smaller than if we left them to their own devices. This is why the retention of students in Engineering at Manhattan College with MSAT scores less than 500, as shown in Figure 3, is still nearly 50%. The sorts of remedial action and monitoring we employ at Manhattan College

includes the following:

Orientation Pre-tests: Before a student even starts class at Manhattan, the Math department tests all incoming freshmen engineers that have MSAT below 550. This exam is essentially a test in Pre-Calculus proficiency. Those students who do not pass the pre-test must take one semester of Pre-Calculus before they take Calculus I and II. This class does not count towards their degree and is graded on an A-F scale (as opposed to P/F). Many students complain about having to take an extra Math class. However, once a student is identified as having a weakness in Pre-Calculus, successful completion of this course is not negotiable.

Reporting of Test Scores: Since there is minimal interaction between the engineering faculty and the engineering students during their first year at Manhattan College (see below), the individual test scores in Physics, Chemistry and Calculus are reported to the Engineering Academic Advisor on a fairly regular basis during the first semester of the freshman year and on an as-needed basis during the second semester. This allows early identification of those students who appear to be struggling with either the course material or the transition from High School to college or both. Initially, there is no intervention that takes place between the student and the SOE. Rather, this tool is simply a monitoring device used as a first pass when attempting to recognize those students who will most likely need tutoring in the near future.

Absence Notification: An internal policy exists at Manhattan College whereby the Academic Advisor in the SOE is notified in writing by faculty when a student misses four or more classes in a particular subject. It should be noted that faculty members outside of the SOE participate in this absence notification process also. The student then receives a letter from the Academic Advisor that calls attention to the excessive number of missed classes and the policy on class attendance (as outlined in the Student Handbook and the Manhattan College catalogue) is restated. Again, this is simply used as a monitoring tool to identify those students who are or will be in academic jeopardy as there are no formal academic repercussions for class absence.

Academic Letters: Academic letters are sent by the Engineering Academic Advisor to all students in the SOE who receive unsatisfactory mid-term grades as well as unsatisfactory final grades. For example, a letter is sent to every engineering student who receives a grade of D or F in any subject at the mid-term. The letter begins by stating "It appears that you have received one (or more) unsatisfactory grades at the mid-term". The letter continues to highlight the suggested course of action, which includes a meeting with the Academic Advisor as well as participation in available tutoring. A letter such as this often serves as the first wake-up call to freshman students and starts the process of one-on-one meetings with the student and the Academic Advisor. When this monitoring tool is coupled with the individual test grades as well as the absence notification letters, the Academic Advisor has a rather comprehensive list of those students who should and will be *strongly* encouraged to participate in tutoring.

Other Reasons for Migration Away From Engineering

It is instructive to examine, on a student-by-student basis, the reasons why we lose students even with higher MSAT scores as shown in Figure 3**.** However, it should be noted that these reasons are not unique to Manhattan College and tend to fall into either one of two

categories:

Misplaced: These are typically students who have little or no interest in the field of engineering, regardless of their academic potential. Typical responses from these students when asked why they are leaving engineering include: "My parents wanted me to do it (engineering)" or "I just thought I'd give it a try". In the 2001-2002 academic year, the SOE at Manhattan College lost two students with MSAT > 740. Coincidentally, both students gave the reason that their real passion was to write poetry and both students transferred to the School of Arts at Manhattan College.

Uncontrollable Reasons: There will always be students who leave engineering for many reasons beyond the control of the School of Engineering and these reasons affect students with high and low MSAT scores equally. However, it should be noted that these 'uncontrollable" reasons tend to affect resident students more as they tend to focus on things like geographical location and support services. One of the more common reasons is that students simply miss home. In 2002 Fall, the SOE lost a student with 700 MSAT simply because he missed being able to go to his younger brother's basketball and football games on the weekends. He transferred to a Community College closer to home. In the 2001-2002 year, the SOE lost a student with 760 MSAT because he did not like the weather in the northeast. He transferred to a Community College in California. A school-wide retention committee that consisted of both faculty and students highlighted the fact that while the academic expectations (class size, teacher involvement) of the incoming student were usually met or exceeded, the quality of the support services on campus was often inferior. For example, it seemed that students thought the lines were too long at dinner, the people at the registrars and bursars office were not often friendly or helpful, housing issues were not taken care of in a timely fashion, etc.

Gender

There is a 4/1 to 5/1 ratio of male to female students in the School of Engineering. Interestingly, the retention rates of both males and females are remarkably similar in the School. These retention data are shown in Table 4.

Table 4: Retention by Gender After Four Semesters

Class	2002		2003		2004	
Gender	Females	Males	Female	Male	Female	Male
Total	33	92	22	95	24	101
Retained	19	52	15	63	18	69
% Retained	0.58	0.57	0.68	0.66	0.75	0.68

In Table 4 we compare the number of female and male engineering students retained following four semesters in the engineering program. The female students tend to be academically as strong as the male students with average MSAT scores of 575 as compared to the average MSAT score of 592 for the males. Table 4 shows that the rate of loss (migration from Engineering) is not that different from that of the males. However, it should be noted that the cumulative number of students that received academic letters at the end of the last four semesters was 222, and only 26 of those students were female (11%). Of those 26 academic letters, 17 were

academic warnings – the mildest of the academic letters. Only 1 female student has been academically suspended from the SOE in the last 4 semesters and there have been none dismissed.

Anecdotally, conversations between the female students and the SOE Academic Advisor at Manhattan College have shown that it is unusual to find a female student in the SOE that puts forward a lack-luster effort, regardless of academic performance. Females seem to be more tenacious than the males when it comes to improving their grades and doing what it takes to be academically successful and they tend to address their academic weaknesses very directly. For example, it would be extremely unusual to have to bring a female student into the Academic Advisor's office to discuss poor grades. Instead, **they** would have made an appointment first. At the risk of being cliché, it is as though they cannot give up because they have something to prove.

Diversity

As stated earlier, 28% of the students in the School of Engineering at Manhattan College are non-Caucasian – the majority of those students being Hispanic. Table 5 illustrates the retention by ethnicity in the SOE after four semesters. In this report Caucasian refers to white students. Non-Caucasian refers to all other students including white-Hispanic.

In keeping with the mission statement of the College, the SOE makes an earnest attempt to increase awareness of the opportunities afforded by receiving an engineering education to first generation, minority students. For example, the Civil Engineering department hosts a two-week summer program for approximately 60 minority high school students (only) where students get the opportunity to visit all of the engineering labs, perform various experiments, complete a design project (such as a bridge), and spend time with the engineering faculty (other than the department of Civil Engineering). This two-week program culminates with an award ceremony attended by both parents and faculty. Data collected from this event shows that between 30-40% of those students end up matriculating at Manhattan College and entering the SOE.

Because Manhattan College is located in the Bronx, most of its minority students are drawn from the large number of local, inner city, public schools. While many of the students are able to graduate from high school having achieved satisfactory college entrance requirements, the conditions under which many of these students achieved these requirements were significantly less than satisfactory. Many of the schools are over-crowded with few if any extra-curricular facilities for the students. Indeed, more important, many of the schools suffer safety and discipline issues. In addition, many of the students come from single parent homes where there are severe financial burdens. As a result, low retention would be expected from these particular students due to limited academic success in an engineering curriculum – not because of ability, but simply due to circumstance. However, Table 5 shows quite the opposite. It can be seen that retention of non-Caucasian students compared to the retention of Caucasian students has been higher every year for the last four years (based on four semesters) – and in some cases by as much as 19%. This was an unexpected, pleasant result. Unfortunately, there can be few if any quantitative explanations that can be extracted from this data to explain why. However, anecdotally, the reason appears quite clear. For many of our minority students, there is more to get away from and less to go back to. The aggravation and rigors of an engineering program are viewed as a vehicle away from what is familiar. Indeed, some students have written about rat-infested slums and how they are using an

education to make those memories distant. Even though some minority students may meet with intermittent academic failure (D and F grades in required courses), they appear to be relentless in improving and moving forward towards the ultimate goal – the degree. In a real sense this is a version of the "American Dream" – a motivation that has played a key role in the history of our country.

Table 5: Retention by Ethnicity After Four Semesters

Class	**2002**		**2003**		**2004**		**2005**	
Ethnicity	Non Caucasian	Caucasian	Non Caucasian	Caucasian	Non Caucasian	Caucasian	Non Caucasian	Caucasian
Total	43	82	35	82	45	80	44	96
Retained	27	44	26	52	32	55	36	72
% Retained	63%	54%	76%	64%	71%	69%	82%	75%

Retention Strategy

Engineering Specific

The components that serve to retain students in engineering and indeed, increase the retention of students in engineering are varied and many. The philosophy of retention however, is simple:

- Make sure everyone knows the rules of the game.
- Save those who can be saved.

The actual process of retention in the SOE is also quite simple:

1. Make students aware of what is expected
2. Monitor students' academic process
3. Evaluate whether retention is possible or appropriate
4. Implement retention tools

Awareness: At Manhattan College, retention of students starts even before classes start – at Freshman Orientation. Freshman Orientation is a 2½ day orientation that all new freshman and transfer students are required to attend. Students have a choice of four different sessions held throughout the summer prior to attending Manhattan College with approximately 30-50 engineering students attending each one. During these orientations, the Dean and Academic Advisor of Engineering meet with all of the incoming engineering students (and some of their parents) for two 2½ hour sessions. During which time, the students are presented with the "lay of the land", i.e., what is expected of them. The students are told that if they follow these rules as presented, they will graduate in four years. If they don't they won't. These rules include items such as:

- A grade of C or higher is required in all Chemistry, Physics and Math courses. If a student receives a grade lower than a C, the student must repeat the class at an additional cost before moving to the next course.
- Students are allowed no more than three D grades in their core courses.

- A student is not allowed to graduate with a cumulative G.P.A. less than 2.000.

There are four or five other " basic" rules, but these examples are indicative of the others. In many cases, the students' parents are also present for these "how to" sessions. Then, to make sure that everyone is aware of the importance of these guidelines, the student is given an Awareness Agreement. The Awareness Agreement is essentially a written version of these rules/guidelines. The students are asked to place their initials beside each guideline, print and sign their name. This agreement is then placed in their permanent folder in the Dean's office.

At Manhattan College, experience has shown this initialing and signing "exercise" is a very useful tool when attempting to have the students assume ownership of their own academic success. This up-front awareness of what is expected helps to eliminate a myriad of excuses, complaints and general whining on the part of the student. In addition, it tends to reduce the overall student traffic in and out of the Dean/Academic Advisor's office. For example, when a student receives a grade of D or F in Calculus I in the Fall semester, it is no longer necessary for the Academic Advisor to have to "hunt down" the student to make them aware of the necessary scheduling changes for the Spring - because now the student is acutely aware of the rules. Instead, the student simply either (a) enrolls in Calc I over the winter session or (b) changes his/her own schedule from Calc II to Calc I on Web-for-Students. It should also be noted that the presence of the parents in these information sessions is also very useful in that now the parents also know what is expected from their sons and daughters. This helps to eliminate the end of semester conversations with parents that begin with "nobody ever told us…" or "I wish we had known….". In fact, providing parents with this knowledge helps to create a virtual, surrogate Academic Advisor who is in much more contact with the student than the actual Academic Advisor could ever be. With this information imparted to the students and the summer sand removed from between everybody's toes, the retention process has begun.

Monitoring: As stated earlier, there are many tools that are used at Manhattan College to monitor the academic success of the engineering students.

- Reporting of test scores – an effective tool in that it highlights those students who are heading in the "wrong direction". However, we have found that the Academic Advisor is at the mercy of faculty who are willing to participate and take the time out to forward the grades. At Manhattan College, we have been lucky in that most teachers appear to be only too happy to forward the grades to the Academic Advisor. However, there is the reality that since 100% of the faculty do not participate, 100% of the students are not monitored.
- Absence Notification – another useful and effective tool used by the Academic Advisor to identify those students that may be "straying". However, as with the reporting of test scores, it is limited by faculty participation. Again, even though most (but not all) faculty feel compelled to report absences, most (but not all) students are identified.
- Mid-term Academic Letters – a very useful and effective tool used by the Academic Advisor to (1) create a data base of students in academic difficulty and (2) alert students that their academic performance is unacceptable while there is still time to take remedial action
- Full-term Academic Letters – probably the most useful tool available to the Academic Advisor for monitoring students in difficulty. Currently, an eight-semester database is being generated

that tracks a student once they have received an academic letter. Once a student is on the list, they typically do not come off until they graduate or are dismissed from the College. By doing this, an academic letter history is generated which produces data much more valuable that a simple semester by semester list. A typical list would resemble the following:

Name	SSN	F'98	S'99	F'99	S'00	F'00	S'01	F'01	S'02
Smith, J		W	W		W		W		
Jones, R		W	W	P	C	D			
Brady, C				W					

where W represents an academic warning; P represents academic probation; C represents academic contract; and D represents academic dismissal.

Evaluation: Once a student has been monitored and, as result, identified as having difficulty in the engineering program, an evaluation must take place as to how to proceed further. At Manhattan College, we are keenly aware that "engineering is not for everybody and everybody is not for engineering". Hence, the philosophy of "saving those who can be saved". From an engineer's perspective, the most sophisticated process is useless if the raw materials do not meet the requirements. When dealing with the process of retaining engineering students, the raw materials are (1) the student's ability or potential and (2) the student's desire to be successful. The shaded, gray area in Figure 5 illustrates the combination of "raw materials" that we require from our students in the SOE at Manhattan College.

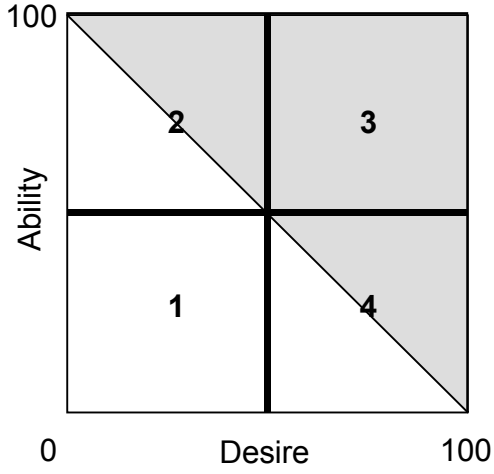

Figure 5: What is required of students in Engineering at Manhattan College

Ideally, we would prefer to have all of our students in quadrant 3 – where their ability and desire to succeed academically are at a maximum. Realistically, it is the philosophy of the SOE that we attempt to retain only those students whose characteristics can be found in the shaded area – where there exists a certain required, minimum ability and desire to succeed in a rigorous engineering environment.

End of semester academic letters tend to precipitate many face-to-face meetings with the

student, the Academic Advisor and/or the Dean, and sometimes one or both parents. It is at these meetings (that last anywhere from 30 minutes to 2 hours) that the Academic Advisor evaluates whether the student has the required ability and desire to be successful in the SOE. This is done simply by examining the student's academic history and asking as many questions as possible of the student or parent(s) – but usually both. In many cases, the determination as to whether the student should proceed in the SOE is straightforward. Either the student's academic history clearly shows that the student will not be successful, e.g., failing Calculus I three times, or the student exhibits zero enthusiasm towards completing the degree. However, in other cases, the evaluation process is quite difficult, e.g., the student has a strong desire to become an engineer but the potential for academic success is questionable or the student has great potential with minimal motivation. In general, the former is preferred to the latter because with little or no motivation, even the brightest student will struggle to be successful. It is often suggested that struggling students with little motivation should take a Leave of Absence for a semester or be required to seek professional counseling. Students in very poor academic standing are often placed on contract – a last chance, one-shot opportunity to "show us what you got".

However, in all situations, there is some action taken. It is believed that without intervention, **if a student does what he did, he will get what he got** ("he" being gender neutral in this case).

Implementation: Once the student has been identified as high risk, the implementation of retention takes the form of tracking, tutoring, and counseling. The high-risk students are closely tracked until their cumulative G.P.A reaches 2.0. Students are then expected to attend tutoring sessions. Typically, engineering faculty tutors freshman classes and sophomore classes are tutored by the various honor societies. Finally, the students are either required to seek professional counseling or meet with the Academic Advisor regularly.

Non-Engineering Specific

Tutoring: In regard to our earlier observation that actions outside the SOE may be necessary to affect retention of SOE students, the performance of engineering students in Math and basic Science courses becomes an increasingly important issue. The faculty that teach Chemistry, Physics and Calculus to the freshman engineering students are always available during their office hours to meet with the students to provide extra help and answer any additional questions that the students may have. However, experience has shown that engineering students are reluctant to avail themselves of this extra help – even when those students with poor grades were expected to get Science and Math faculty signatures as proof of their seeking extra help.

Since the SOE retention data clearly show that the freshman year is a key link in strengthening the retention chain, Engineering faculty have been asked to carry out an experiment to determine how effective a more intensive effort at providing supporting academic assistance to the freshman would actually be. These faculty, mostly associated with the introductory engineering courses, have been asked to provide outside-of–the-classroom tutoring in the subjects of Chemistry and Physics to a subset of the freshman engineering class. The tutoring typically takes the following format. Either one three-hour session or two 1½- hour sessions held on the same day(s) every week for at least 12 of the 14 weeks during the semester (students typically do

not attend the first two weeks of class). The Chemistry tutoring generally takes the form of a lecture with time given at the end of the each session to answer questions and to explain sample problems from the text. The Physics tutoring sessions tend to focus less on lecture and more on solving problems and problem solving techniques. However, it should be noted that care is taken not to "do the homework" for the students. In addition, the tutoring sessions generally mirror the material that has been covered in the classroom that week. This tutoring philosophy is based on the notion that if material is presented to the student from more than one perspective (by virtue of the fact that more than one person is presenting it), the student has an increased probability of quite simply "getting" it. These tutoring sessions culminate with a "marathon" tutoring session in each subject at the end of the semester. These marathon sessions typically last 7-7½ hours and they attempt to review all of the material covered in the course that semester and are generally attended by 35 - 45 students each semester. So far, over the course of two semesters, the mid-term and final grades of those students who have regularly attended these sessions have been compared and results show that, of the students participating, 74% increased their course grade from the mid-term to the final.

It is also interesting to note that the data in Tables 1 – 3 and plotted in Figures 1 and 2 seem to suggest a significant decrease in migration for the freshmen student members of the class of 2006. While our tutoring experiment described above was only able to involve a relatively small portion of the class of 2006 and involves a small set of data, it appears to already have a measurable impact upon the retention of the students in that class. These data support our proposal that a collaborative, intensive effort involving the faculty in Chemistry and Physics in both Science and Engineering Schools and Departments will significantly affect the retention of Engineering students and will be of value to the Institution.

Summary

Results of our retention study for the School of Engineering at Manhattan College are as follows:

Retention Based on MSAT: Not surprisingly, Figure 3 clearly showed that retention of students increased with MSAT scores. After four semesters, students with MSAT scores below 500 were retained at a rate of approximately 50% while the retention rate increased to approximately 75% for students with MSAT scores above 750.

Retention of Minority Students: As discussed earlier, Table 5 shows that non-Caucasian students (predominantly Hispanic) are retained at a consistently higher rate than Caucasian students in the SOE. Even though their average MSAT score is lower than that of the Caucasian students (average MSAT for non-Caucasian 565, average MSAT for Caucasian 601), it is proposed that since many of these minority students are familiar with hardship and struggle in their home life, they succeed due to a relatively strong work ethic and relentless determination.

Retention of Female Students: Even though female engineering students enter a predominately male environment (considered intimidating by some), Table 4 shows that female students are not lost any faster than male students. In addition, since only 11% of the academic letters sent to students are sent to females and only one female has been suspended from the school in the last four semesters, it is proposed that female students leave engineering for reasons other than

inability to succeed in the program. It is believed that these reasons range from lack of female support services and infrastructure within the SOE to finding oneself in the wrong major.

Retention of Students at the End of Freshman Year versus Sophomore Year: Table 6 is essentially an analysis of Table 2 and a re-casting of Figure 2. It shows that retention is no longer an issue by the junior year since approximately 85% of the total number of students lost over four years are lost by the end of the third semester with an additional 5-7% lost during the fourth semester. Indeed, two-thirds of the students lost over four years are lost by the end of the first year – a time during which students that have chosen engineering as a major have had minimal exposure to engineering classes or faculty. Poor performance and low retention of first year engineering students due to lack of success and/or an unsatisfactory experience with science courses is not unique to Manhattan College. At Manhattan College, however, we have attempted to respond to this concern by addressing the issue(s) directly: Can we increase the academic success and overall experience of the first year student in the science courses (specifically Chemistry and Physics) through freshman tutoring based in the SOE? The continued, significant attendance of the students involved in our pilot experiment and the increase in the student performance (as manifested by their improvement in grades) suggests that a collaborative effort between the School of Engineering and Science Departments can have a significant impact on the retention of engineering students.

Table 6: Percentage of Students Lost First Year versus Second Year

	Class			
	1999	**2000**	**2001**	**2002**
% Lost 1st Year	61%	63%	60%	57%
% Lost 3rd Semester	21%	23%	28%	27%
% Lost 4th Semester	7%	5%	4%	8%
Total Lost by 2nd Year	89%	91%	92%	92%

Conclusions

Clearly, retaining students in the fashion described in this paper is labor intensive. At Manhattan College and at other small schools like it, much of the effort expended to advise, counsel, and keep track of students and actually do all those things just described is done by one person – the Academic Advisor (or someone in a similar position). Furthermore, as we mentioned earlier, retention of our engineering students is made even more challenging because of the constraints placed on the imposition of admission requirements, e.g. Math SAT score, on incoming students because of the Mission of the College. Simply stated, it is the Mission of the College to provide an education to first generation college students – some of whom enter with lower than average grades and standardized test scores.

Perhaps the most important observation has been that the SOE loses the majority of its students by the end of the freshman year even though these students have had very limited contact with the engineering faculty. As described earlier, before 1996 freshmen engineering students had zero contact time with engineering faculty. As a result of including two introductory engineering

courses in the freshman year in 1995-96 and adopting the principle that the best engineering faculty should be teaching these freshmen introductory courses, we increased engineering faculty exposure to the freshmen students and retention immediately improved by roughly 10%. However, after the initial jump in retention, there has been little change in overall retention to date. See, for example, Figure 1 and the data in Table 1 pertaining to the class of 1999 and subsequent classes. Note, again, that the data pertaining to the Class of 2002 are anomalous (as discussed and explained earlier). However, the data in Table 6 clearly show that 55-60% of the total number of students lost over four years are lost at the end of the freshman year in spite of our adding the introduction to engineering courses to the freshman year and in spite of virtually everything we tried to do to increase retention, at least up to our recent experiment involving Chemistry and Physics tutoring.

As a result of our (currently) ongoing (and admittedly limited) tutoring experiment for students taking Chemistry and Physics, we believe that retention in the Engineering School can be affected significantly by complementing instruction in the Sciences with tutoring by Engineering faculty. To support this assertion, we note that the data in Tables 1 – 3 and plotted in Figures 1 and 2 seem to suggest a significant decrease in migration for the freshmen student members of the class of 2006. While our tutoring experiment described above was only able to involve a relatively small portion of the class of 2006 and involves a small set of data, it appears to already have a measurable impact upon the retention of the students in that class. Unfortunately, a collaborative, intensive effort involving the faculty in Chemistry and Physics in both Science and Engineering Schools and Departments is not always a viable solution given demands on faculty time or the nature of the different schools in an institution. However, if retention of students in an engineering program is a desired outcome, it seems clear that such a co-operative approach, acknowledging and utilizing the strengths in each area, is the effective method. Unfortunately, academic cultural differences, as well as resource and local priority issues often make such co-operative endeavors difficult to initiate in spite of the strong possibility that the outcomes of such collaborative efforts are of significant value to the Institution.

Finally, we remark that it is quite possible that we have achieved our maximum level of retention unless opportunities outside the School are developed. Manhattan College has and will continue to accept students with lower than suggested MSAT scores in order to fulfill the Mission of the College. In spite of these and other mitigating issues, the average graduation rate in the SOE over the last five years is roughly 60% - essentially the same as the national graduation rate.

Biographical Information

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