An Analysis of B.S.I.E. Degree Completion Time at Morgan State University

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Abstract *- A study was initiated to examine and assess the matriculation of industrial engineering students in an accredited program. Degree completion time is analyzed in this paper based on transcript data of undergraduate students in the Department of Industrial, Manufacturing and Information Engineering at Morgan State University. Degree completion time is considered as a measure of academic performance whereby if this time can be reduced, students will look more favorable on the program and their a cademic success. The considered factors affecting degree completion time included SAT scores, GPA, attempted and earned credit hours. This paper examines these factors as a department, by classification, individually, or in combination with another factor to find how they affect the time students take to complete their undergraduate degree in industrial engineering with the Bachelor of Science. An analysis of these factors using statistical method suggested that reduction in degree completion time variabili ty can be achieved with students not repeating courses, using the "Incomplete" grade policy, and early academic intervention.*

Key Words *- Degree completion time, educational performance, statistical method*

INTRODUCTION

The United States Department of Education reports that the percentage of college graduates who finish college within four years after completing high school has decreased from 45.6 percent in 1977 to 34.5 percent in 1986 to 31.1 percent in 1990 [1]. There are trends to encourage universities to adopt four-year graduation plans [2]. For all general students, three types of reasons (in academic, non-academic and institutional reasons) why many students are taking longer than the traditional four years to graduate have been analyzed [3-6]. Some academic reasons are inadequate preparation for college-level studies, change of and /or delay in selecting a major, transfer between schools, dropping/repeating courses, and participation in cooperative education programs. Non-academic reasons are: taking time out from school (dropping out), participation in extracurricular activities and employment, student's lower expectations of themselves, and financial problems. Institutional reasons reported are: unavailability of required courses due to closure or infrequent offerings, student-advising problems, and increased graduation requirements. In comparison of engineering students with general students, engineering students tend to take longer to graduate than the general student population [7]. The present paper attempts to explore Bachelor of Science in Industrial Engineering (B.S.I.E.) completion time of students at Morgan State University. The results of the study can examine whether or not the semester–by-semester sequencing of courses are best fitted to students who anticipates a four-year graduation, course alignment, tutoring needs, and academic policies. The information reported here may be also helpful to engineering educators participated in curricular reviews and redesign projects.

METHODOLOGY

Morgan State University utilizes a semester system in the School of Engineering. The four-year curricula are designed to be completed in 8 semesters. Generally one credit hour is awarded for one hour of class per week for the fall or spring semesters. At the time of the study, the B.S.I.E. curriculum for all students required a minimum of 134 academic credit hours or equivalent, to complete of the program of study in the Industrial, Manufacturing and Information Engineering (IMIE) Department. The minimum required credit-hour breakdown is as follows: 49 credits for general education requirements; 30 credits for science and mathematics requirements; 46 credits for industrial engineering core requirements and 9 credits for concentration requirements. Students are required to take 35 credits for the first year, 33 credits for the second year, 35 credits for the third year and 31 credits for the fourth year. Required Non-IE courses are offered in the fall and spring semesters. Some of industrial engineering courses are offered every fall and spring semester, the others are offered only in the fall or spring semester. Academic departments now have discretion to add students to course that have reached seat limits through the "override" practice. Classes may be dropped without academic penalty according to the deadline published in the academic calendar. Discontinued attendance does not constitute dropping a class and such action will result in a grade of "F" which is computed in the average. Also, students will be held accountable for the cost of the class. Students who wish to

withdraw completely from the University for the semester, in which they are registered, have to report to their academic dean to begin the withdrawal process. Students transferring from other colleges or veterans must present to the Veterans Administration certifying official of Morgan State University a copy of their official transcript from all other institutions for which educational benefits were paid. Veterans are not eligible to receive educational benefits for courses in which a grade of "NC" has been assigned. A "NC" grade in a course will reduce the veteran's total number of credit hours pursued for any given semester. "I" grade policy states that a student who receives an Incomplete (I) grade for any course must complete the work for the course by the end of the next semester of enrollment or the "I" grade is changed to an "F". This means that students may miss one or more semesters of school without incurring the "F" grade [8-9].

In this study, data was collected from the first B.S.I.E. graduate in 1991 to 2003. The population for the study consisted of 100 students who completed B.S.I.E. degree requirements from 1991 to 2003. Information on SAT scores, GPA, state, race, starting year, graduation year, attempted hours and earned hours was recorded. The time interval between when each student started college and the year they completed degree requirements was calculated. A student who started in fall of 1999 and graduated in the spring of 2003 is thought of as graduating in four years. The total attempted (AHRS) and earned credit hours (EHRS) of each student were collected and recorded respectively.

RESULTS

The average, median, minimum, maximum, and standard deviation values of time to degree, SAT scores, GPA, AHRS, EHRS, difference between AHRS and EHRS, and differences between EHRS and minimum credit hours (134 credits) are listed in Table 1 and 2.

	Time (Yrs)	SAT	GPA	AHRS	EHRS
Average	5.035	1001.80	3.00	158.88	143.88
Median	5.00	1020.00	2.98	154.00	143.00
Min	2.00	460.00	2.15	128.00	128.00
Max	11.00	1290.00	4.00	243.00	168.00
St. Dev.	1.28	125.35	0.41	22.29	7.27

TABLE 1
AVERAGE, MEDIAN, MINIMUM, MAXIMUM AND STANDARD DEVIATION VALUES OF TIME, SAT, GPA, AHRS AND EHRS

	Difference between AHRS and EHRS	Difference between EHRS and Min Credit Hours
Average	15.00	9.88
Median	9.00	9.00
Min	0.00	-6.00
Max	84.00	34.00
St. Dev.	18.53	7.27

TABLE 2
AVERAGE, MEDIAN, MINIMUM, MAXIMUM AND STANDARD DEVIATION VALUES OF DIFFERENCES BETWEEN AHRS AND EHRS AND DIFFERENCES BETWEEN EHRS AND MINIMUM CREDIT HOURS

The characteristics of each student such as time to degree, SAT scores, GPA, AHRS, EHRS, the difference between AHRS and EHRS, and difference between EHRS and minimum credit hour requirements vs. student number are also plotted in Figure 1-6. CL, UCL and LCL in these plots denote averages (center lines), upper control limits and low control limits respectively.

Under the conditions of different SAT scores, frequency distribution of SAT, average GPA, average time-to-degree, average AHRS and EHRS, average difference of AHRS and EHRS, average difference of EHRS and 134 credit hour requirements, and their standard deviations are shown in Table 3. Under the conditions of different time to degree, the similar relations are shown in Table 4.

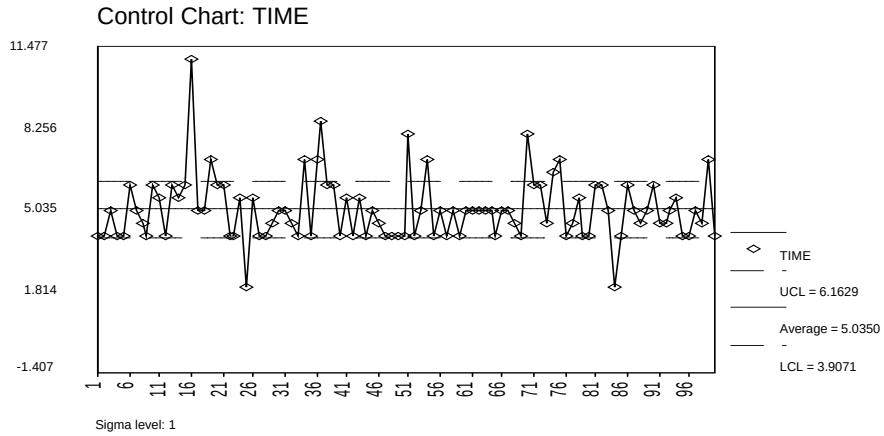


FIGURE 1
TIME TO DEGREE WITH STUDENT NUMBERS

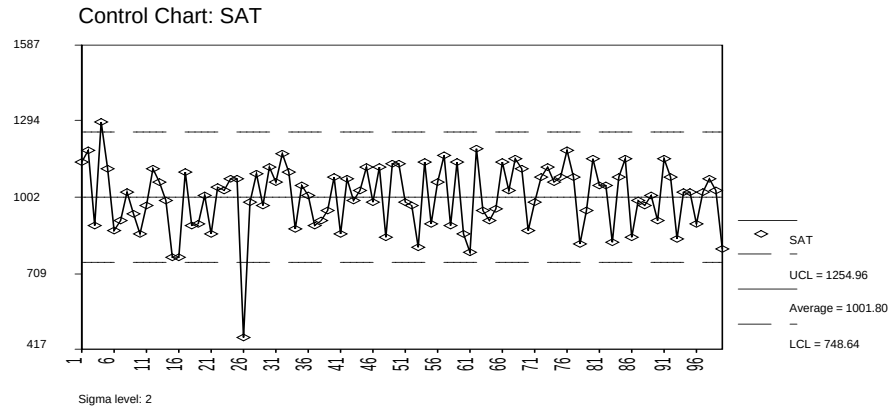


FIGURE 2
SAT SCORES VS. STUDENT NUMBERS

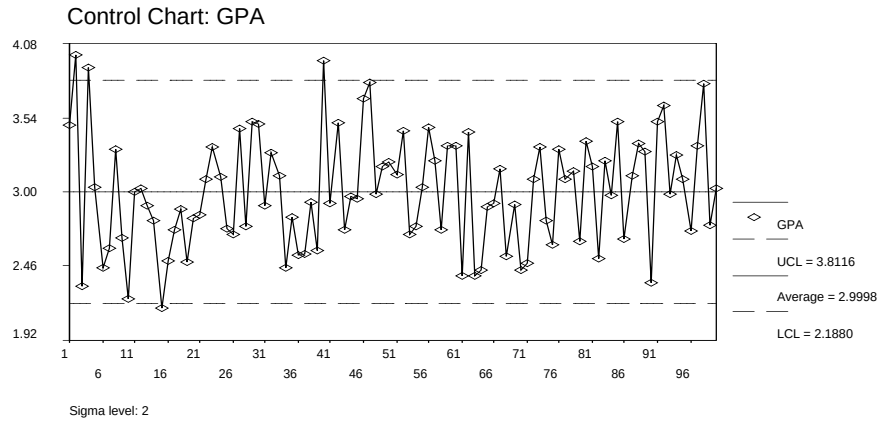


FIGURE 3
GPA VS. STUDENT NUMBERS

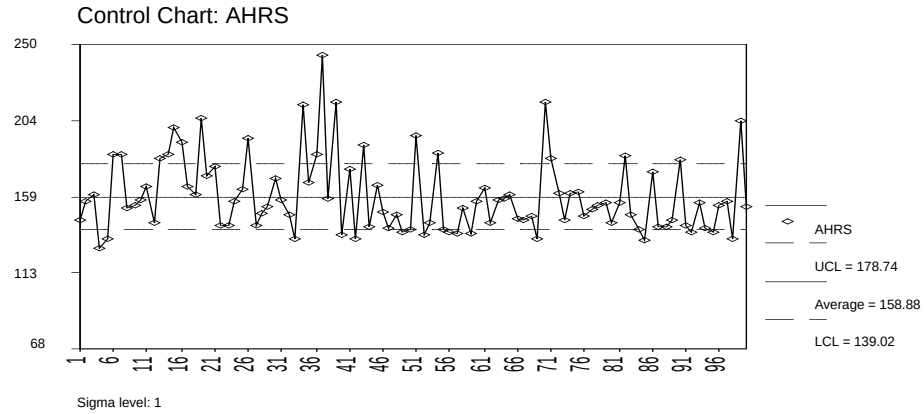


FIGURE 4
AHRS VS. STUDENT NUMBERS

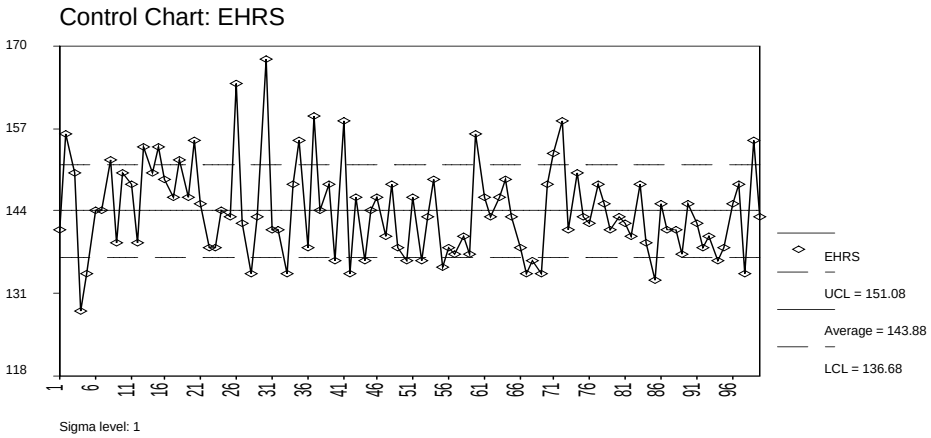
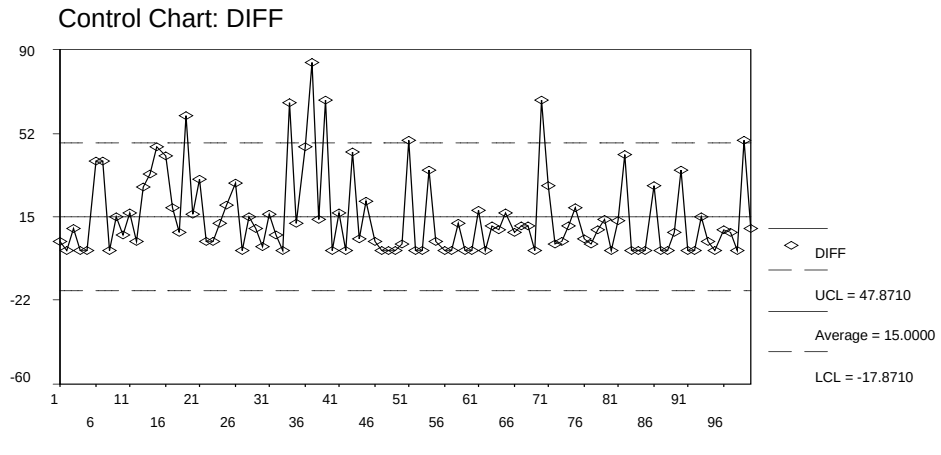


FIGURE 5
EHRS VS. STUDENT NUMBERS



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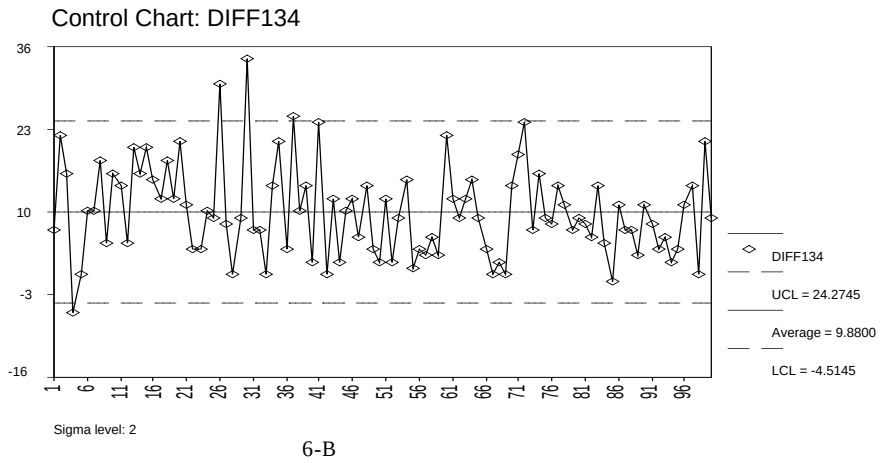

6-B

FIGURE 6

A. DIFFERENCES BETWEEN AHRS AND EHRS VS. STUDENT NUMBERS
B. DIFFERENCES BETWEEN EHRS AND CREDIT HOUR REQUIREMENT VS. STUDENT NUMBERS

	SAT<900	900 SAT<1100	SAT 1100
Frequency	22%	53%	25%
Average GPA	2.71	3.00	3.25
GPA Standard Deviation	0.33	0.38	0.36
Average Time-to- Degree (yr)	5.86	4.99	4.4
Time to Degree Standard Deviation	1.58	1.18	0.68
Average AHRS	173.5	158.98	145.8
AHRS Standard Deviation	26.38	20.27	13.30
Average EHRS	148.9	143.26	140.8
EHRS Standard Deviation	6.21	6.32	8.03
Average Difference of AHRS and EHRS	24.64	15.72	5.0
AHRS vs. EHRS Difference Standard Deviation	24.07	17.21	8.75
Average Difference between EHRS and 134 credit hour Requirement	14.86	9.26	6.8
EHRS vs. 134 Difference Standard Deviation	63.99	6.32	32.34

TABLE 3

STATISTICAL CHARACTERISTICS OF STUDENT UNDER THE CONDITIONS OF DIFFERENT SAT POINTS

	Time to degree<=4	4.0<Time to degree<=5.5	Time to degree>5.5
Frequency	34%	41%	25%
Average SAT	1059.12	984.15	952.79
SAT Standard Deviation	104.86	137.91	101.51
Average GPA	3.19	3.06	2.65
GPA Standard Deviation	0.37	0.38	0.27
Average AHRS	143.53	155.32	185.60
AHRS Standard Deviation	9.41	14.34	22.06
Average EHRS	139.27	145	148.32
EHRS Standard Deviation	5.77	7.34	5.46
Average Difference of AHRS and EHRS	4.27	10.32	37.28
AHRS vs. EHRS Difference Standard Deviation	6.0	11.00	21.15
Average Difference between EHRS and 134 EHRS Requirement	5.27	11.00	14.32
EHRS vs 134 Difference Standard Deviation	5.77	7.34	5.46

TABLE 4

STATISTICAL CHARACTERISTICS OF STUDENTS UNDER THE CONDITIONS OF DIFFERENT TIME TO DEGREE

There are several of factors such as SAT, GPA, differences between AHRS and EHRS and differences between EHRS and minimum credit hours that are related with time to degree. It may be of interest to build a model relating time to degree to SAT scores, GPA, differences between AHRS and EHRS and differences between and minimum credits and then use the model for prediction, time to degree optimization, or improvement of educational performance. In this paper, the relationship between time to degree-y and SAT-x_1, GPA-x_2, differences between AHRS and EHRS-x_3, and differences between EHRS and minimum 134 credit hours -x_4, say $y = \varphi(x_1, x_2, x_3, x_4)$. $\varphi(x_1, x_2, x_3, x_4)$ is assumed as follows:

$$y = a_0 + a_1 x_1 + a_2 x_2 + a_3 x_3 + a_4 x_4 + a_5 x_1 x_2 \quad (1)$$

where a_0-a_5 are constants. Using 100 student data, the constants are calibrated in Table 5

a_0	5.016
a_1	-.00135
a_2	-.1059
a_3	.04518
a_4	.03136
a_5	.00023

TABLE 5

CONSTANTS a_0 - a_5

The effects of four factors - SAT, GPA, difference between AHRS and EHRS and difference between EHRS and 134 credit hour requirements on time to degree are plotted in Figure 7-12. The effects of AHRS and EHRS on time to degree are replaced by the factors: difference between AHRS and EHRS and difference between EHRS and minimum 134 credit hour requirement s. In order to reflect their effects on time to degree in 3D plot, two of the four factors are fixed and the other two factors vary in a range. In Figure 7-12, diff denotes difference between AHRS and EHRS and diff134 stands for difference between EHRS and minimum 134 credit hour requirements.

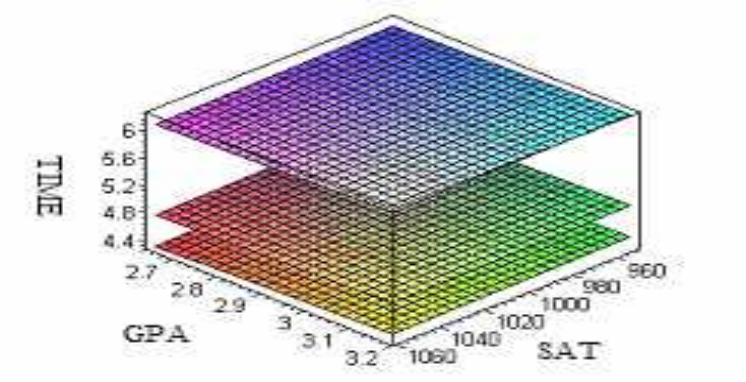

FIGURE 7

TIME TO DEGREE VS. SAT AND GPA (BOTTOM LAYER: DIFF = 4.27; DIFF134 = 5.27. MIDDLE LAYER: DIFF=10.32; DIFF134 = 11.TOP LAYER: DIFF = 37.28; DIFF134 = 14.32)

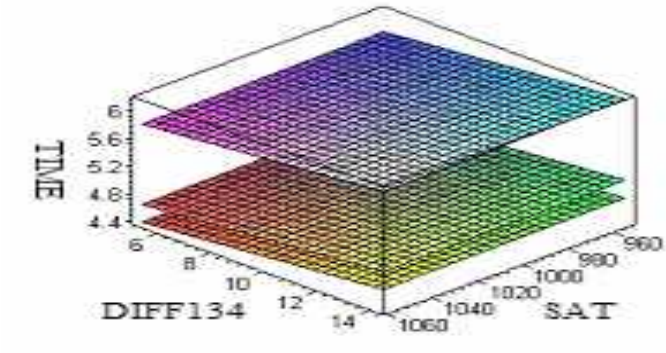

FIGURE 8

TIME TO DEGREE VS. SAT AND DIFF134 (BOTTOM LAYER: DIFF = 4.27; GPA = 3.19. MIDDLE LAYER: DIFF=10.32; GPA = 3.06. TOP LAYER: DIFF = 37.28; GPA = 2.65)

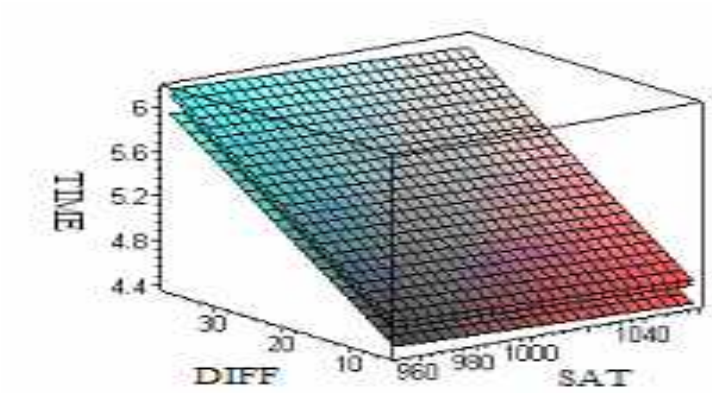

FIGURE 9

TIME TO DEGREE VS. SAT AND DIFF (BOTTOM LAYER: DIFF134 = 5.27; GPA = 3.19. MIDDLE LAYER: DIFF134 =11; GPA = 3.06. TOP LAYER: DIFF134 = 14.32; GPA = 2.65)

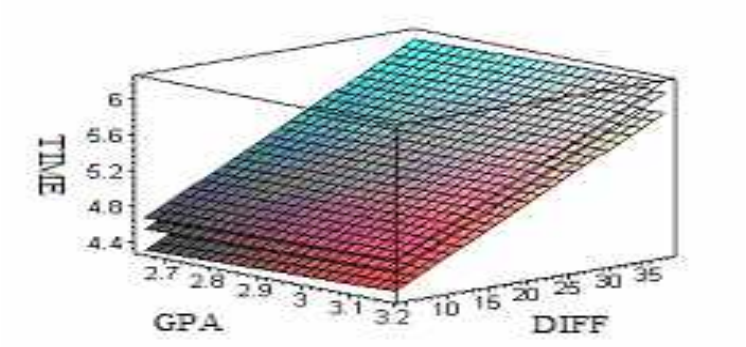

FIGURE 10

TIME TO DEGREE VS. GPA AND DIFF (BOTTOM LAYER: DIFF134 = 5.27; SAT = 1059.12. MIDDLE LAYER: DIFF134 =11; SAT = 984.15. TOP LAYER: DIFF134 = 14.32; SAT = 952.79)

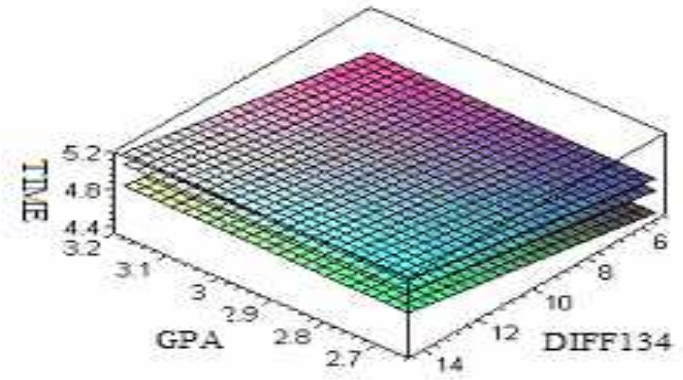

FIGURE 11

TIME TO DEGREE VS. GPA AND DIFF134 (BOTTOM LAYER: DIFF = 4.27; SAT = 1059.12. MIDDLE LAYER: DIFF =10.32; SAT = 984.15. TOP LAYER: DIFF = 37.28; SAT = 952.79)

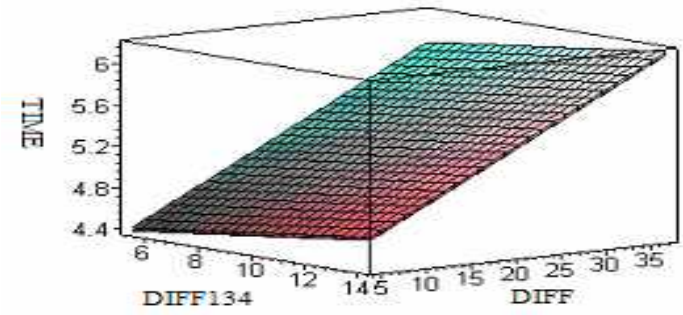

FIGURE 12

TIME TO DEGREE VS. DIFF AND DIFF134 (BOTTOM LAYER: SAT = 1059.12; GPA = 3.19. MIDDLE LAYER: SAT =984.15; GPA = 3.06 TOP LAYER: SAT = 952.79; GPA = 2.65)

DISCUSSION

According to Figure 1, 11% of the students were above the upper control limit; therefore these students took an unusually long time. These aberrations in the graph show the most general trends for the delay of graduation. All the students in this situation had way above normal difference between AHRS and EHRS. For example, the 11 students' average difference between AHRS and EHRS is 48 hours, far higher than the average of all students', which is 15 hours. From this it can be concluded that the difference between AHRS and EHRS is a major factor that contributes to delay of graduation. In order to promote enrollment of students into the university, the lower control limit of acceptance of SAT score would be 748 according to Figure 2. As can be seen from the graph, only 1% of the students will not be able to meet this requirement. According to Figure 3, almost all students' GPA are above the lower control limit of 2.2. Figures 4-6 shows EHRS, AHRS and their relationships (e.g. their differences in figure 6-a). The difference between EHRS and AHRS and the difference between EHRS and the credit requirement can describe the effects of AHRS and EHRS on the delay more clearly, so AHRS and EHRS will not be discussed individually but as a group. Based on Figure 6-a, there are 7 students out of the 100 students that have a difference between EHRS and AHRS of more than the upper control limit of 47.87. These students attempted too many hours without earning credits, which lead to graduation delays. As shown from Figure 6-b, 3% students have abnormal EHRS compared to the required credits.

Based on the data collected and the analysis made, all the factors listed affect the degree completion time on different levels. The most significant cause for the increase in number of years it takes for students to graduate is the difference between AHRS and EHRS. As can be seen from Figures 9, 10, and 12, the effect of DIFF is the greatest out of all of the factors because the graphs have the larger positive slope along the line in the plane of DIFF and TIME than the others, such as the slope on the plane of TIME and DIFF134 in figure 12. This indicates that the more hours students attempt without getting credits, the longer it will take for them to graduate.

The second most significant factor to cause delays is the credits students earn over the required credits (the difference between EHRS and required credits). This can be shown on Figure 8, 11. The slope of the graph on the plane DIFF134 and TIME is greater than both the slopes on the planes of GPA and TIME / SAT and TIME. The influence of SAT scores and GPA are very limited relative to the difference between EHRS and AHRS (DIFF) and the difference between EHRS and the credit requirement (DIFF134). According to Figure 7, the influence of SAT and GPA are barely perceptible.

Finally, by analyzing all figures 7-12, in order to optimize the degree completion time, the difference between EHRS and AHRS and the difference between EHRS and required credits should be kept as small as possible in the current enrollment requirement with a reasonable GPA.

CONCLUSIONS

Because this study was based on limited information, not all factors leading to graduation delays are discussed and analyzed. No one factor can be singled out as the only cause for longer degree completion time and not every factor can be controlled. However, there are some factors that can be controlled and used to improve the completion time.

In this research, four factors were examined and explored in depth: student GPA, SAT scores, difference between EHRS and AHRS, and the difference between EHRS and required credits. The SAT scores of students have little influence on their degree completion time. A lower score may indicate a student less prepared for college than one with a higher score, but given a reasonable amount of time so that the AHRS do not exceed the desired completion time, the student will be able to attain the required credits. The GPA alone also cannot determine the time needed for a student to complete study. For example, one student may have a high GPA and keep up with the credits needed for ideal graduation time while another may graduate at the same time with a lower GPA. It is recommended that student set for reasonable goal for their GPA / academic standard and complete the required credits in the course of four years rather than set for an unreasonable goal and not be able to meet the four-year completion expectation.

What does affect the time significantly are the AHRS and the EHRS. For example, a student may have attempted a credit for numerous times without successfully earning it. As a result of this situation, it will take this student longer to graduate because the time was spent less effectively. In order to lower the difference between the EHRS and the AHRS, Morgan State University has instituted more supportive policies. One example is the "I" policy which enables the student to continue on with a course instead of starting over if they were unable to complete a major portion of a course the first time for various reasons. This would be an effective way because it prevents the students from unnecessarily repeating a course and reduces the students' AHRS.

Other conclusions suggest maybe extending the curriculum for five years, early academic intervention, and more structured tutoring sessions may shorten the degree completion time.

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