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CHANGING MAJORS: HOW GRADES AND MBTI TYPE INTERACT

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1. Education
2. Major- Changing
3. MBTI

Professor John M. Wilkes, Advisor

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ABSTRACT

Based on data from WPI Classes of 2002 and 2003, students' choice of major and dynamics of changing majors are studied through the lens of MBTI types. Certain majors are found to attract students of certain MBTI types. For example, Computer Science attracts Introverts, Management Extraverts and Electrical & Computer Engineering Judging students. Significantly more Extraverts than Introverts are found to switch from technical fields to various forms of management. For Intuitive and Perceiving students, changing majors is associated with lower average Math and Science grades in the freshman year. These and other findings have possible implications for research and policy in higher education.

1. Introduction

Choosing major is generally considered to be an important aspect of a student's undergraduate education. Worcester Polytechnic Institute (WPI) provides extensive advising support to students to help them select their majors in the form of personal academic advisor/s, internal departmental information sessions, and a 7- week non- credit course called Major Selection Program (MSP). The MSP program is fairly well attended (30-40 students/ year in 1998-99) demonstrating the importance placed by WPI undergraduates in general on their choice of major.

As such, choice of major and any related issue is of importance to students and educators. The central theme of this IQP is to examine academic preferences of college students and related issues through the lens of their cognitive types. Academic performance, psychological type and gender are used to investigate the pattern of major choices, major changes and certain related issues in a cohort of students at WPI.

In this context, the following need to be first clarified:

1. How is academic performance measured?
2. How is "psychological type" measured?

1. Four measures of academic performance are available: a) the time taken to graduate, b) honors (whether someone graduated with high distinction, distinction or no honors), c) the overall academic GPA, and d) the GPA in Math and Science courses.

The choice of the specific measure to be used depends on the specific question to be answered, my related hypothesis and available data.

2. Psychological type is measured by the psychometric instrument MBTI (specifically, MBTI Form G) that is based upon Jung's personality theory, and that helps to classify individuals into four dichotomies: i) Extraversion vs. Introversion, ii) Sensing vs. Intuition, iii) Thinking vs. Feeling and iv) Judging vs. Perceiving. The MBTI is a widely used personality instrument with about 2 million people a year taking it (Jackson, Parker & Dipboye, 1996; Quenk, 2000). The four MBTI dimensions have been described in Chapter 2.

This study focuses on two cohorts of students for whom the necessary data is available: the WPI Class of 2002 and the WPI Class of 2003[1]. For each of these two classes, the archive contains freshman student grades (transcript data), gender, MBTI type, major at the time of orientation and graduating major. The Class of 2002 dataset is described in detail in Chapter 3 and the Class of 2003 dataset in Chapter 3.

Specifically, the study seeks to answer the following questions:

1. What is the MBTI profile of the students at WPI? How does it compare to that of the general population of USA and that of the engineering professionals of USA? This comparison allows one to place the results of this IQP in a bigger context.

[1] WPI Class of 2002 means freshman students entering WPI in the Class of 2002. They may or may not have graduated in the year 2002. It is likewise for the WPI Class of 2003.

Moreover, how do the MBTI profiles of the males and females at WPI compare? This is a pertinent research question in itself, and also tells me whether to use gender as a control variable to answer the other questions in this IQP. This is reported in Chapters 3 and 4.

2. Can one label the majors at WPI by MBTI type? i.e, are there majors at WPI that tend to receive a percentage of a certain MBTI type that is significantly greater than the percentage of that type in WPI's undergraduate population? This is reported in Chapter 5.
3. How do students who change major compare to those who do not in terms of academic performance? This issue is examined through the lens of MBTI type and gender, and the findings reported in Chapters 6 and 7.
4. As compared to other fields, a significant ($p=0.042$) proportion of the students starting out in Computer Science are found to have left the field, whereas Management gained a significant percentage of students ($p<0.001$) for the Class of 2002. This led me to perform a case study on Computer Science and Management majors, which is reported in Chapter 8.

Changing major is a fact of academic life in USA. A large percentage of undergraduates change major at least once. Universities have recognized this fact and spend substantial resources towards providing students with counseling about this decision. Identifying possible problems/ issues related to this ubiquitous academic phenomenon will eventually help universities devise ways to tackle such problems and allocate resources accordingly. Moreover, identifying issues specific to students of certain psychological types will help

universities set up appropriate and adequate support structure for such students. This would be a positive step towards a fair and just educational system- a system that respects different types of learning styles, and that provides adequate support for these different types of students.

This study is also intended to contribute to the bigger picture of higher education research. College students study and perform under a number of different sociological conditions and forces such as parental expectations, pressure to perform well academically and find a suitable job after graduation, attitude towards studies in the family, peer influence etc. Much of higher education research is aimed towards identifying these forces and understanding their influence on students. However, people of different psychological types would be expected to react differently to the same sociological forces. As such, it is important to investigate how psychological differences manifest themselves in the arena of education. Drawing a loose analogy with the natural world, the behavior of a material in magnetic field would depend on whether it is paramagnetic, ferromagnetic or exclusively diamagnetic. As such, accounting for the different types of materials is essential for a complete and correct understanding of how materials behave in magnetic field.

2. Psychological Types and the MBTI

This study is based on the use of psychological types. It uses the Jungian personality theory and the MBTI.

$2.1 Jungian Personality Theory and the MBTI Typology

The Jungian theory of personality used three variables to classify individuals into different psychological types. Carl Jung used several long interviews with clients to ascertain their “type”. The Jungian theory- based psychological type of a given individual is nowadays determined using a psychometric instrument called the MBTI, developed by Isabel Myers and Katharine Briggs.

First of all, the Jungian theory of psychological type is based on four aspects of the conscious mind. For each aspect or dimension, a mind can be exclusively classified into one of two types. These four dimensions are discussed below.

A. Extravert (E) vs. Introvert (I)

Does the mind of a person get energized by interacting with the external world (external objects, other people etc), or the internal world (introspection, solitary reflection etc)? If the conscious mind of a person gets energized when he deals with other people, external objects etc, he is classified as an Extravert (E) while a person with an introspective mind is called Introvert (I). This aspect is called the attitude of the mind.

An extravert would, therefore, prefer such conditions that allow him to interact more with the outer world, and the introvert conditions that would allow him to interact more with the internal world. For example, it is reasonable to suppose that Extraverts would be attracted to managerial duties such as negotiating, coordinating between different groups of people etc. whereas an Introvert may prefer to work alone on a mathematics problem or a piece of computer code.

According to Jung, the mind consists of both conscious and unconscious layers. The conscious layer is what a person uses to make choices and decisions. The E/I distinction deals with the conscious level, as do the other three aspects in this part of the theory. In this study, I am primarily interested in a person's *choice* of majors and related issues (as opposed to, for example, his dreams and nightmares). As such, it is the type of the conscious mind that I am interested in.

B. Sensing vs. Intuition

There are two modes of perception. Jung's question was: How does a person become aware of new information about people and things, and how does he process it? If he prefers to use his senses to focus on gathering the concrete details and specifics in a situation, then he is classified as Sensing. On the other hand, if he prefers to focus on the interrelationships between objects and the bigger picture, then he is classified as an Intuitive. It is to be noted that every person can use and does use both these ways of becoming aware, but one or the other is a dominant function of his conscious mind, and as such his *preferred* way of becoming aware.

C. Thinking vs. Feeling

Does a person prefer to base his decisions on impersonal logic (Thinking), or does he prefer to subjectively empathize with the different people concerned (Feeling)? Both are rational forms of decision- making, and everyone uses both forms. However, for every individual, one of the two ways is preferred, depending on whether he relies more on subjective information or want to be objective and dispassionate so as to avoid “bias”.

D. Judging vs. Perceiving

Does one prefer to predominantly use his decision- making facet (Thinking or Feeling) or prefer to become as much aware of the situation before making decisions? The former is a Judging type. A person of Judging type prefers a structured task environment and also takes a planned approach in his choices. The latter is called Perceiving and is more prone to delaying a serious decision and changing minds as he gathers more and more information about the situation.

$2.2 Reliability of the MBTI

This section is based on Chapter 8 of MBTI Manual, 3rd Edition, Copyright 1998 by Consulting Psychologists Press, Inc.

The internal consistency of the four MBTI scales is quite high in all the samples available till date. For the MBTI Form G used in this study, the correlations based on logical split-half procedure along the four dimensions are 0.82 for E/I, 0.84 for S/N, 0.83 for T/F and 0.86 for J/P; this is based on the 32,671 people in the Form G databank of the Center for Applications of Psychological Type (CAPT).

The MBTI type is also found to be fairly stable over time. Test- retest percentage agreement of the dichotomies for Form G (based on all the Form G data from the 1985 Manual) exceeds 80% for all four dichotomies for retest within 9 months (N=356) , and exceeds 75% for all four dichotomies for retest after 9 months (N=1133). Also, a study of the effect of moods on reliabilities conducted by Howes and Carskadon (1979) found mood changes do not significantly affect test- retest MBTI percentage of agreement on the preference scales.

3. Class of 2002 Dataset

This chapter contains basic information about the dataset for the Class of 2002, and describes certain basic features about its MBTI type profile, the distribution of majors and the academic performance of the class.

$3.1 Sample Representiveness

Based on the number of students to have received freshman grades, the entering Class of 2002 has 650 students. The archive contains the MBTI profiles for 562 (86% approx.) of these 650 students. These 562 students, who filled out MBTI forms during the freshman orientation, comprise my sample. Please note that the study group excludes transfer students. According to a previous IQP "WPI Transfer Students Study: An MBTI Perspective" by Dheri and Qirko, the MBTI type profile of transfer students differs significantly from that of the rest of the student body. As such, my results will generalize to the original class of entering freshmen students excluding the transfer students, and not to the entire class.

All the 650 students had equal probability, practically speaking, to be at the freshman orientation and to take the MBTI. Therefore, my study group of the 562 students can be considered to be a simple probability sample.

The sample is representative of the population in terms of academic performance. Of the 650 students in the population, the grades of 612 students are known for the courses they passed in their first- year. For these 612 students, the mean first- year GPA in math and

science courses on a 0 to 3.0 scale **(artificial scale, A=3.0, B=2.0, C=1.0, NR=0.0)** is 1.87 with a standard deviation of 0.59. Of the 562 students in our sample, the archive contains the first- year grades for 527 students. For these 527 students in the sample, it is 1.85 with a standard deviation of 0.57. As such, in terms of academic performance as represented by math and science GPA obtained in freshman year, the sample is representative of the entering Class of 2002.

The sample is also found to satisfy the Kolmogorov- Smirnov test for normality of the distribution of GPA of math & science courses passed in freshman year, with p=0.002.

$3.2 MBTI Profile of Class of 2002

Tables 3.1 to 3.4 presents the MBTI profile of the sample students along the four dimensions I/E, S/N, T/F and J/P respectively. Gender being a sociological variable of interest and possibly an important variable, the MBTI profile of the sample students has also been looked at by gender. The key findings are discussed in detail in $3.3. Apropos, the MBTI profile of the national population of USA along the four dimensions, obtained from the MBTI literature, is presented in Appendix A.

Table 3.1 Percentage of Extraversion (E) vs. Introversion (I) preference of the sample of the entering Class of 2002, WPI

	Male (n=434)	***Female (n=128)***	***Overall Sample (n=562)***
E	38.2	45.3	39.9
I	61.8	54.7	60.1
Total	100.0	100.0	100.0

p=0.15 (Chi- square test)

Table 3.2 Percentage of Sensing (S) vs. Intuition (N) preference of the sample of the entering Class of 2002, WPI

	Male	***Female***	***Overall Sample***
S	38.2	46.9	40.3
N	61.8	53.1	59.7
Total	100.0	100.0	100.0

p=0.08

Table 3.3 Percentage of Thinking (T) vs. Feeling (F) preference of the sample of the entering Class of 2002, WPI

	Male	***Female***	***Overall Sample***
T	68.9	48.4	64.3
F	31.1	51.6	35.7
Total	100.0	100.0	100.0

p<0.001

Table 3.4 Percentage of Judging (J) vs. Perceptive (P) preference of the sample of the entering Class of 2002, WPI

	Male	***Female***	***Overall Sample***
J	34.1	52.3	38.3
P	65.9	47.7	61.7
Total	100.0	100.0	100.0

p<0.001

The distribution over the 16 MBTI psychological types, for the entering Class of 2002, is presented in Table 3.5, and compared to that of the engineers and the general population of USA[2]. Table 3.6 does the same for the students in the entering Class of 2002 who eventually graduate in 6 years or less.

[2] Source: CAPT- MBTI Atlas, Copyright 1986 Center for Applications of Psychological Type (CAPT)

Table 3.5 MBTI profile of the sample of the entering Class of 2002

MBTI Type	*WPI Males (n=434)*	*WPI Females (n=128)*	*WPI Overall Sample (n=562)*	*Sample of Engineers[2] (n=986)*	*CAPT Databank Total Population[2] (n=232557)*
INTP	**17.3**	5.5	**14.6**	6.19	3.97
ENTP	12.0	7.0	10.9	5.98	4.34
ISTJ	10.9	7.8	10.2	**15.52**	**9.35**
ENFP	7.9	**11.7**	8.7	6.8	10.52
INFP	9.0	6.3	8.4	6.19	7.60
INTJ	8.1	7.8	8.0	7.71	4.24
ISTP	8.1	5.5	7.5	4.97	3.19
ESTP	5.8	3.9	5.3	3.75	3.08
ESTJ	3.9	7.0	4.6	11.97	9.16
ISFJ	2.5	8.6	3.9	6.09	9.28
INFJ	2.8	7.0	3.7	3.14	4.30
ISFP	3.0	6.3	3.7	2.54	4.84
ENTJ	3.0	3.9	3.2	7.51	5.01
ESFP	2.8	1.6	2.5	3.14	5.47
ESFJ	1.4	6.3	2.5	4.67	9.75
ENFJ	1.6	3.9	2.1	3.85	5.90
Total	100.0	100.0	100.0	100.0	100.0

Table 3.6 MBTI profile of the sample of the Class of 2002 to have eventually graduated from WPI

MBTI Type	*WPI Males (n=336)*	*WPI Females (n=110)*	*WPI Overall Sample (n=446)*	*Sample of Engineers[2] (n=986)*	*CAPT Databank Total Population[2] (n=232557)*
INTP	**15.5**	5.5	**13.0**	6.19	3.97
ISTJ	11.6	7.3	10.6	**15.52**	4.34
ENTP	11.6	4.5	9.9	5.98	**9.35**
ENFP	8.4	**13.6**	9.7	6.8	10.52
INTJ	8.7	8.2	8.5	7.71	7.60

INFP	9.0	6.4	8.3	6.19	4.24
ISTP	6.9	6.4	6.7	4.97	3.19
ESTP	6.3	3.6	5.6	3.75	3.08
ESTJ	4.5	6.4	4.9	11.97	9.16
ISFJ	**3.0**	9.1	4.5	6.09	9.28
INFJ	3.0	8.2	4.3	3.14	4.30
ISFP	3.0	6.4	3.8	2.54	4.84
ENTJ	2.1	4.5	2.7	7.51	5.01
ESFJ	1.8	5.5	2.7	4.67	5.47
ESFP	2.7	1.8	2.5	3.14	9.75
ENFJ	2.1	2.7	2.2	3.85	5.90
Total	100.0	100.0	100.0	100.0	100.0

$3.3 Striking Difference by Gender

Tables 3.1 to 3.6 show striking dissimilarity between the MBTI profiles of males and females. For males, the I,N,T and P dimensions respectively are overrepresented, but for females the distribution of students between each dichotomy is more balanced. The dimensions I, N, T and P are the overrepresented dimensions in the overall WPI Class of 2002 sample, mainly due to their overrepresentation in the male population. In fact, the disproportionate number of the INTP type students among the males is evident from Table 3.5 that presents the MBTI profile of the males in the sample, the females in the sample and the overall sample of the entering Class of 2002 (not segregated into separate dimensions.) Interestingly, this is a relatively rare MBTI type in the general population, and appears among the female students at the same percentage as in the general population. Table 3.6 presents MBTI profile of the sample of the Class of 2002 to have eventually graduated from WPI. The male vs. female difference persists till graduation.

The male and female students differ in terms of their academic performance too. The mean first- year GPA in math and science courses on the 0 to 3.0 scale for the males in our sample is 1.84 with a standard deviation of 0.59 while that for females is 1.90 with a standard deviation of 0.52. However, this difference is not statistically significant for the Class of 2002 (p=0.23) though it is for the Class of 2003 as we will see later. In the case of male students, 336 of the total 433 students graduate (by 2004, i.e., in 6 years or less), while for female students 110 of the 128 do. Therefore, the male graduation rate for our sample is 77.4% whereas it is 85.9% for females.

Therefore, gender emerges as a key variable from the perspective of both MBTI profile and academic performance. As such, gender is to be used as a control variable for all analysis, i.e, the sample is segregated into male- only and female- only samples. Some analyses of females will run into sample size difficulties, but the male dataset is large enough to support all the analysis anticipated thus far.

$3.4 Major Distribution

Next, I will look at how the students in my sample were distributed between the different available majors at the beginning of the freshman year (Table 3.7) and at graduation (Table 3.8).[3] I have final majors on record for 446 (79.3%) of the 562 students in my sample; presumably, these 446 students were the ones who graduated from WPI by the year 2004.

[3] The final major was coded from the Commencement Program for students who graduated in 2001 to 2004. About 63.5% of the sample graduated 'on time' in 4 years. Less than 1% graduated early.

Table 3.7 Freshman Major Distribution in the sample of the entering Class of 2002, WPI. The majors are presented in descending order of frequency percentage in the overall sample.

	Male (n=434)	***Female (n=128)***	***Overall Sample (n=562)***
Computer Science	28.4	5.5	23.2
Mechanical Engg. (incl. AE, MFE)	21.2	10.2	18.7
Electrical & Computer Engg.	20.8	5.5	17.3
Biology/Biotechnology	4.4	37.5	11.9
Chemical Engg.	5.8	7.8	6.2
Civil Engg.	5.8	7.0	6.1
Biomedical Engg.	2.5	9.4	4.1
Other/Undecided (incl. humanities, Social Sciences, IGSD)	3.5	4.7	3.7
Chemistry/ Biochemistry	1.6	8.6	3.2
Physics	3.9	0.0	3.0
Mathematics	0.9	2.3	1.2
Management (incl. MGE, MIS, IE)	1.2	1.6	1.2
Total	100.0	100.0	100.0

Table 3.8 Final Major Distribution[4] in the sample of the entering Class of 2002, WPI. The majors are presented in descending order of frequency percentage in the overall sample.

	Male (n=336)	***Female (n=110)***	***Overall Sample (n=446)***
Electrical & Computer Engg.	23.6	5.5	19.1
Mechanical Engg. (incl. AE, MFE)	22.1	9.1	18.9
Computer Science (CS)	18.8	1.8	14.6
Biology/Biotechnology	5.7	38.2	13.7
Management (incl. MGE, MIS, IE)	9.9	4.5	8.5
Civil Engg.	6.3	8.2	6.7
Chemical Engg.	4.8	6.4	5.2
Biomedical Engg.	2.1	9.1	3.8
Biochemistry/ Chemistry	1.5	7.3	2.9
Physics	2.7	0.0	2.0
Others	0.6	6.4	2.0
Mathematics	1.5	2.7	1.8
Actuarial	0.6	0.9	.7
Total	100.0	100.0	100.0

Certain facts emerge. First, for the overall sample, the ranks of the majors in terms of how 'attractive' they are relative to one another change from the freshman year to graduation. Note in particular that CS and ECE swap relative rankings; Management climbs up from the 12th (last position) to the 5th position. This indicates much major change between freshman and final year. Secondly, a large percentage (28.4%) of the males starts out with CS major, but only 18.8% graduate with CS major. On the other

[4] The final major was coded from the Commencement Program for students who graduated in 2001 to 2004.

hand, a large percentage (37.5%) of the females starts out with biology or biotechnology, and 38% end up there as well. Thirdly, at time of graduation, Electrical Engineering and Mechanical Engineering are the most ‘attractive’ majors while Computer Science which was most popular in the case of freshmen has gone down substantially from 23.2% to 14.6% overall. This indicates an exodus of students from the CS major in course of their undergraduate careers. Fourthly, the management- related majors have gained a substantial number of students. While it accounted for only 1.6% of the freshmen of Class of 2002, management accounts for 8.5% of the graduating students. These last two issues have been dealt with later in Chapter 8 through a case study of the students to start out with CS major and a case study of students to graduate with Management major.

4. CLASS OF 2003 DATASET AND REPLICATION OF TRENDS

This chapter presents the basic information about the dataset for the Class of 2003, and describes certain basic features about the MBTI type profile, the distribution of majors and the academic performance of the class, and compares these with those of the Class of 2002 (Chapter 3.)

$4.1 Sample Representativeness

Based on the number of students to have received freshman grades, the entering Class of 2003 has 690 students. My archive contains the MBTI profiles for 605 (87.68%) of these 690 students. These 605 students, who filled out MBTI forms during the freshman orientation, comprise our sample. Just like the Class of 2002 sample, my Class of 2003 sample excludes transfer students.

All 690 students in the entering freshman class had equal probability, practically speaking, to be present at the freshman orientation and take the MBTI. Therefore, theass of 2003 sample of 605 students can be considered to be a simple probability sample.

Of the 690 students in the population, my archive contains the grades of 642 students for courses they passed in their first year. For these 642 students, the mean first- year GPA in math and science courses on a 0 to 3.0 scale **(artificial scale, A=3.0, B=2.0, C=1.0, NR=0.0)** is 1.899 with a standard deviation of 0.56. Of the 605 students in the sample, the first- year grades for 587 students are known. For these 587 students, it is 1.894 with

a standard deviation of 0.55. As such, in terms of academic performance as measured by math and science GPA obtained in freshman year[5], the sample is representative of the entering Class of 2003.

The sample satisfies the Kolmogorov-Smirnov test for normality of the distribution of GPA of math & science courses passed in freshman year (p=0.001)

$4.2 MBTI Profile of the Class of 2003 and Similarities with the Class of 2002 MBTI Profile

Tables 4.1 to 4.4 presents the MBTI profile of the sample students along the four dimensions I/E, S/N, T/F and J/P respectively, overall and by gender.

Table 4.1 Percentage of Extraversion (E) vs. Introversion (I) preference of the sample of the entering Class of 2003, WPI

	Male (n=456)	***Female (n=149)***	***Overall Sample (n=605)***
E	37.1	47.0	39.5
I	62.9	53.0	60.5
Total	100.0	100.0	100.0

p=0.032 (Chi- square tests for cross tabulation of gender and E/I.)

Table 4.2 Percentage of Sensing (S) vs. Intuition(N) preference of the sample of the entering Class of 2003, WPI

	Male	***Female***	***Overall Sample***
S	38.2	43.0	39.3
N	61.8	57.0	60.7
Total	100.0	100.0	100.0

p=0.298

Table 4.3 Percentage of Thinking (T) vs. Feeling (F) preference of the sample of the entering Class of 2003, WPI

	Male	***Female***	***Overall Sample***
T	70.4	53.0	66.1
F	29.6	47.0	33.9
Total	100.0	100.0	100.0

p<0.001

[5] Note that Math and Science courses dominate the course schedule of a typical WPI student, and provide a common ground for comparing students from different majors.

Table 4.4 Percentage of Judging (J) vs. Perceptive (P) preference of the sample of the entering Class of 2003, WPI

	Male	***Female***	***Overall Sample***
J	35.7	51.0	39.5
P	64.3	49.0	60.5
Total	100.0	100.0	100.0

p=0.001

Tables 4.1 to 4.4 show striking replication of trends observed in the MBTI profile of the Class of 2002. In males, the I,N,T and P dimensions are overrepresented, but for females the distribution of students between each dichotomy is more balanced. (possibly excepting the S-N dimension) Moreover, both Class of 2003 and Class of 2002 have nearly equal ratios for Extraverts:Introverts, Sensing:Intuitives, Thinking:Feeling and Judging:Perceiving. Table 4.5 depicts this.

Table 4.5 Replication of Class of 2002 MBTI distribution in Class of 2003

	Class	**Males**	**Females**
E	2002	38%	45%
	2003	37%	47%
S	2002	38%	47%
	2003	38%	43%
T	2002	67%	48%
	2003	70%	53%
J	2002	34%	52%
	2003	36%	51%

Please note that x % E means x% E, (100-x)% I. Similarly, x% S means x% S, (100-x)% N and so on.

Table 4.6 presents the MBTI profile of the entering Class of 2003 for the complete MBTI type.

Table 4.6 MBTI profile of the sample of the entering Class of 2003

MBTI Type	*WPI Males (n=456)*	*WPI Females (n= 149)*	*Overall WPI Sample (n=605)*	*Sample of Engineers (n=986)*[6]	*CAPT Databank Total Population*[2] *(n=232557)*
INTP	**17.3**	10.1	**15.5**	6.19	3.97
ENTP	11.0	5.4	9.6	5.98	4.34
ISTJ	14.3	9.4	13.1	**15.52**	**9.35**
ENFP	7.9	**13.4**	9.3	6.8	10.52
INFP	10.3	5.4	9.1	6.19	7.60
INTJ	7.7	7.4	7.6	7.71	4.24
ISTP	8.1	3.4	6.9	4.97	3.19
ESTP	5.0	4.0	4.8	3.75	3.08
ESTJ	3.9	9.4	5.3	11.97	9.16
ISFJ	1.1	6.0	2.3	6.09	9.28
INFJ	2.6	7.4	3.8	3.14	4.30
ISFP	1.5	4.0	2.1	2.54	4.84
ENTJ	3.1	4.0	3.3	7.51	5.01
ESFP	3.1	3.4	3.1	3.14	5.47
ESFJ	1.1	3.4	1.7	4.67	9.75
ENFJ	2.0	4.0	2.5	3.85	5.90
Total	100	100	100	100	100

Table 4.6 too shows that the Class of 2003 MBTI profile replicates that of the Class of 2002. For males, the INTP has the highest frequency as was the case in the Class of 2002 (a frequency that is, in fact, approximately equal to that in the Class of 2002.) For females, the ENFP has the highest frequency (13.4%) as again was the case in the Class of 2002 (frequency 13.6%). For males and females taken together, INTP has the highest frequency in both Class of 2003 (frequency 15.5%) and Class of 2002 (frequency 14.6%).

[6] Source: CAPT- MBTI Atlas, Copyright 1986 Center for Applications of Psychological Type (CAPT)

Also, note that INTP has relatively low frequency in both the general population and the national sample of engineers. ESTJ, by contrast, is underrepresented at WPI.

Tables 4.1 to 4.6 taken together with corresponding tables for the Class of 2002 (Tables 3.1 to 3.5) strongly indicates that MBTI is a reliable variable and that WPI attracts a distinctive MBTI profile of students. Appendix B presents MBTI distributions at some other colleges- this information is obtained from the MBTI literature (Provost et al.).

Table 4.7 presents MBTI profile of the sample of the Class of 2003 to have eventually graduated from WPI. The male vs. female difference persists till graduation.

Table 4.7 MBTI profile of the Class of 2003 sample students to graduate from WPI by 2004

MBTI Type	*Male (n=326)*	*Female (n=120)*	*Overall Sample (n=446)*	*Sample of Engineers[5] (n=986)*	*CAPT Databank Total Population[5] (n=232557)*
INTP	15.5	6.7	13.1	6.19	3.97
ISTJ	**16.8**	10.0	**14.9**	**15.52**	4.34
ENTP	9.5	5.0	8.3	5.98	**9.35**
ENFP	7.3	**12.5**	8.7	6.8	10.52
INTJ	9.2	9.2	9.2	7.71	7.60
INFP	9.2	5.0	8.0	6.19	4.24
ISTP	8.2	4.2	7.1	4.97	3.19
ESTP	6.3	3.3	5.5	3.75	3.08
ESTJ	4.7	10.8	6.4	11.97	9.16
ISFJ	1.3	5.8	2.5	6.09	9.28
INFJ	2.2	7.5	3.7	3.14	4.30
ISFP	1.9	4.2	2.5	2.54	4.84
ENTJ	2.8	5.0	3.4	7.51	5.01
ESFJ	1.3	3.3	1.8	4.67	5.47
ESFP	2.5	4.2	3.0	3.14	9.75
ENFJ	1.3	3.3	1.8	3.85	5.90
Total	100.0	100.0	100.0	100.0	100.0

$4.3 Gender Difference in Academic Performance

The male and female students differ in terms of their academic performance too, just like they did in Class of 2002. The mean first- year GPA in math and science courses on the 0 to 3.0 scale for males in the Class of 2003 sample is 1.87 with a standard deviation of 0.56 (n=441), while that for females is 1.96 with a standard deviation of 0.53. (n=146) A T- test for equality of means is performed between the males and the females. Females are found to have scored better than the males by 0.09 at p=0.07. In the case of male students, 316 of the 456 students in the sample graduate from WPI by 2004 (i.e., in 5 years or less), while for female students 120 of 149 students do. Therefore, the male graduation rate for our sample is 69.3% as opposed to 80.5% for females.

Therefore, the difference between males and females in terms of MBTI profile and academic performance that was observed in the Class of 2002 is replicated in the Class of 2003.

$4.4 Major Distribution Trends

Next, I will look at how the students in the sample were distributed between the different available majors at the beginning of the freshman year (Table 4.8) and at graduation (Table 4.9). I have final majors on record for 436 (72.1%) of the 605 students in the sample. Presumably, these were the students who graduated (in 5 years or less.) Please note once more that I know the final majors for students who graduated till 2004. Therefore, for the Class of 2002, I know the students who graduated in 6 years or less, but for Class of 2003 I know the students who graduated in 5 years or less.

Table 4.8 Freshman Major Distribution in the sample of the entering Class of 2003, WPI. The majors are presented in descending order of frequency percentage in the overall sample.

	Males (n=456)	*Females (n=149)*	*Overall (n=605)*
Computer Science	30.0	12.1	25.6
Mechanical Engg. (incl. AE, MFE)	21.3	7.4	17.9
Electrical & Computer Engg.	18.9	9.4	16.5
Biology/ Biotechnology	4.4	22.1	8.8
Others/ Undecided	6.8	12.1	8.1
Biomedical Engg.	3.9	10.7	5.6
Civil Engg.	3.9	4.7	4.1
Chemical Engg.	3.1	5.4	3.6
Chemistry/ Biochemistry	1.8	8.7	3.5
Physics	2.2	2.7	2.3
Mathematics	2.0	2.7	2.1
Management (incl. MIS, IE, MGE)	1.8	2.0	1.8
Total	100.0	100.0	100.0

Table 4.9 Final Major Distribution in the sample of the entering Class of 2003, WPI. The majors are presented in descending order of frequency percentage in the overall sample.

	Males (n=316)	*Females (n=120)*	*Overall (n=436)*
Mechanical Engg. (incl. AE, MFE)	23.1	15.0	20.9
Electrical & Computer Engg.	23.7	10.0	20.0
Computer Science	20.9	8.3	17.4
Management (incl. MIS, IE, MGE)	9.2	6.7	8.5
Biology/ Biotech	2.5	21.7	7.8
Civil Engg.	7.0	7.5	7.1
Chemical Engg.	5.4	5.8	5.5
Biomedical Engg	1.6	9.2	3.7
Biochemistry/ Chemistry	1.6	6.7	3.0
Others	1.6	5.8	2.8
Mathematics	2.2	3.3	2.5
Physics	1.3	0.0	0.9
Total	100.0	100.0	100.0

From choosing major as entering freshmen to their final major choice, the Class of 2003 replicates the dynamic pattern of change found for Class of 2002 ($3.3 Striking Difference by Gender).

Class of 2002 Trends

- CS moves down from #1 to #3 spot.
- Management climbs up several spots (from the last spot the 5th spot)
- EE and ME emerge as the two most popular majors at WPI
- 37.5% of females start out with biology or biotechnology, and 38% graduate with this major as well. This indicates the stability of biology/ biotechnology which remains most popular among females.

Class of 2003 Trends

- CS moves down from #1 to #3 spot.
- Management climbs up several spots (from the last spot to the 4rth spot.)
- EE and ME emerge as the two most popular majors at WPI.
- 22.1% females start out with biology or biotechnology, and 21.7% graduate with this major as well. This indicates the stability of biology/ biotech which remains most popular among females.

$4.5 Summary

To summarize:

- Class of 2003 sample is representative of the Class of 2003 population in terms of mean GPA in math and science courses passed in freshman year.
- Class of 2003 is found to replicate the gender- based differences of academics and MBTI profile found in the Class of 2002.
- Class of 2003 is found to have a MBTI profile similar to that of Class of 2002 for both males and females.
- From choosing their major as entering freshmen to final major choice, Class of 2003 replicates the major trends found for the Class of 2002.

5. Labeling Majors by MBTI Type

This chapter examines if the **final major** choice of **male** students is related to their MBTI types. The results are summarized in section $5.3 (p. 38-39) of this chapter.

$5.1 Class of 2002

For the 336 male students of the Class of 2002 sample to have graduated from WPI by 2004, the final major is cross tabulated against their E/I preference, S/N preference, T/F preference and J/P preference respectively. These results are presented in Tables 5.1 to 5.4

Table 5.1 Percentage of Extravert (E) vs. percentage of Introverts (I) within each major in the graduating males of the Class of 2002

Major	*No. of Male Students in the major*	*Extraverts (E) %*	*Introverts (I) %*
Actuarial	2	100.0	0.0
Biochemistry/ Chemistry	5	20.0	80.0
Biology/ Biotechnology	19	31.6	68.4
Biomedical Engg.	7	42.9	57.1
Chemical Engg.	16	50.0	50.0
Civil Engg.	21	52.4	47.6
Computer Science	63	30.2	69.8
Electrical & Computer Engg.	80	32.5	67.5
Mathematics	5	40.0	60.0
Management (incl. MGE, MIS, IE)	33	54.5	45.5
Mechanical Engg. (incl. AE, MFE)	74	47.3	52.7
Physics	9	11.1	88.9
Others (incl. Humanities, Social Sciences, IGSD)	2	0.0	100.0
Total	336	39.4	60.6

Note that the sample comprises 39.4% Extraverts vs. 60.6% Introverts (I). However, 54.5% of the 33 Management students are Extraverts, 47.3% of the 74 ME students are extraverts and 53.4% of the 21 Civil Engineering students are Extraverts. As such, the

population for these three majors contains a much higher percentage of extraverts than the overall WPI population. A group of majors favored by the Introverts (I) also emerge: 88.9% of the 9 Physics majors are Introverts, 69.8% of the 63 CS majors are Introverts, 67.1% of the 79 ECE majors are Introverts, 68.4% of the 19 Biology/ Biotech majors are Introverts.

I had hypothesized that groups of majors will emerge, each group being attractive to certain MBTI type of students. These results support this hypothesis. Based on the Extravert/Introvert dimension of MBTI, three groups of majors seem to emerge:

1. Favored more by the Extraverts: Management (and related majors like MIS…), Mechanical Engineering (and related majors), Civil Engineering
2. Favored more by Introverts: Physics, Computer Sciences, Electrical and Computer Engineering, Biology/ Biotech, Chemical Engineering
3. Favored equally by either type/ Not clear: Mathematics, Biomedical Engineering, Biochemistry/ Chemistry

Table 5.2 Percentage of Sensing students (S) vs. Percentage of Intuitives (N) within each major in the graduating males of the Class of 2002

Major	*No. of Students in the major*	*Sensing (S) %*	*Intuitive (N) %*
Actuarial	2	50.0	50.0
Biochemistry/ Chemistry	5	40.0	60.0
Biology/ Biotechnology	19	26.3	73.7
Biomedical Engg.	7	57.1	42.9
Chemical Engineering	16	56.3	43.8
Civil Engg.	21	52.4	47.6
Computer Science	63	31.7	68.3
Electrical & Computer Engg.	80	36.3	63.8
Mathematics	5	0	100.0
Management	33	36.4	63.6
Mechanical Engineering	74	51.4	48.6
Physics/ Engg. Physics	9	22.2	77.8
Others (Humanities, Social Sciences, IGSD)	2	0	100.0
Total	336	39.6	60.4

Based on the S/N dichotomy, the majors can be apparently grouped into three categories:

1. Favored more by the Sensing students: Mechanical Engineering, Civil Engineering, Chemical Engineering
2. Favored more by Intuitive students: Computer Science, Biology/ Biotech, Physics
3. Favored equally by either type/ Not Clear: Management, Mathematics, ECE, Biochemistry, Biomedical Engineering

Table 5.3 Percentage of Thinking (T) students vs. Percentage of Feeling(F) students within each major in the graduating males of the Class of 2002

Major	*No. of Students in the major*	*Thinking (T) %*	*Feeling (F) %*
Actuarial	2	50.0	50.0
Biochemistry/ Chemistry	5	40.0	60.0
Biology/ Biotechnology	19	63.2	36.8
Biomedical Engg.	7	57.1	42.9
Chemical Engineering	16	81.3	18.8
Civil Engg.	21	52.4	47.6
Computer Science	63	74.6	25.4
Electrical & Computer Engg.	80	67.5	32.5
Mathematics	5	60.0	40.0
Management	33	60.6	39.4
Mechanical Engineering	74	67.6	32.4
Physics/ Engg. Physics	9	66.7	33.3
Others (Humanities, Social Sciences, IGSD)	2	100.0	0.0
Total	336	67.0	33.0

Based on the T/F dichotomy, the following three groups of majors seem to emerge:

1. Favored more by Thinking students: Computer Science, Chemical Engineering
2. Favored more by Feeling students: Civil Engineering
3. Favored equally by either type/ Not clear: the rest of the majors

Table 5.4 Percentage of Judging (J) students vs. Percentage of Perceiving (P) students within each major in the graduating males of the Class of 2002

Major	*No. of Students in the major*	*Judging (J) %*	*Perceiving (P) %*
Actuarial	2	0.0	100.0
Biochemistry/ Chemistry	5	60.0	40.0
Biology/ Biotechnology	19	42.1	57.9
Biomedical Engg.	7	14.3	85.7
Chemical Engineering	16	25.0	75.0
Civil Engg.	21	4.8	95.2
Computer Science	63	44.4	55.6
Electrical & Computer Engg.	80	43.8	56.3
Mathematics	5	20	80
Management	33	33.3	66.7
Mechanical Engineering	74	35.1	64.9
Physics/ Engg. Physics	9	55.6	44.4
Others (Humanities, Social Sciences, IGSD)	2	0.0	100.0
Total	336	36.6	63.4

Based on the J/P dichotomy, the following three groups of majors seem to emerge:

1. Favored more by Judging students: Physics, Electrical & Computer Engineering, Chemistry , Biology/ Biotech, Computer Science
2. Favored more by Perceiving students: Civil, Chemical Engineering., Biomedical Engineering
3. Favored equally by either type/ Not clear: the rest

Table 5.5 Labeling Major by MBTI Type for the Class of 2002 (p- values specified in brackets)

Major	*E/I dimension*	*S/N dimension*	*T/F dimension*	*J/P dimension*
Chemical Engg.	I (0.37)	S (0.17)	X	P (0.32)
Civil Engg.	E (0.21)	S (0.22)	F (0.14)	**P** (0.002)**
Computer Science	**I* (0.096)**	N (0.15)	T (0.16)	J (0.15)
Electrical & Computer Engg.	I (0.17)	X	X	J (0.11)
Management	**E* (0.06)**	X	X	X
Mechanical Engg.	**E* (0.12)**	**S** (0.02)**	X	X
Physics	**I* (0.08)**	N (0.28)	X	J (0.24)

**Significant at the level of p<0.05

* Significant at the level of p<0.1

$5.2 Class of 2003

For the 316 male students of the Class of 2003 to have graduated, the final major is similarly cross tabulated against their E/I preference, S/N preference, T/F preference and J/P preference respectively. These results are presented in Tables 5.6 to 5.9

Table 5.6 Percentage of Extravert (E) vs. percentage of Introverts (I) within each major in the graduating males of the Class of 2003

Major	*No. of Students in the major*	*Extraverts (E) %*	*Introverts (I) %*
Biochemistry/ Chemistry	5	40.0	60.0
Biology/ Biotechnology	8	50.0	50.0
Biomedical Engg.	5	60	40
Chemical Engineering	17	23.5	76.5
Civil Engg.	22	31.8	68.2
Computer Science	66	24.2	75.8
Electrical & Computer Engg.	75	33.3	66.7
Mathematics	7	42.9	57.1
Management	29	65.5	34.5
Mechanical Engineering	73	39.7	60.3
Physics/ Engg. Physics	4	0	100.0
Others (Humanities, Social Sciences, IGSD)	5	20.0	80.0
Total	316	35.8	64.2

Based on the I-E dichotomy, the following groups seem to emerge in the Class of 2003 sample:

1. Favored more by the Extroverts: Management, Mechanical Engineering
2. Favored more by the Introverts: Computer Science, Physics, Chemical Engineering
3. Favored equally by either type/ Not Clear: the rest

Table 5.7 Percentage of Sensing (S) vs. Percentage of Intuitive (N) students within each major in the graduating males of the Class of 2003

Major	*No. of Students in the major*	*Sensing (S) %*	*Intuitive (N) %*
Biochemistry/ Chemistry	5	22.2	77.8
Biology/ Biotechnology	8	25.0	75.0
Biomedical Engg.	5	80.0	20.0
Chemical Engineering	17	58.8	41.2
Civil Engg.	22	40.9	59.1
Computer Science	66	31.8	68.2
Electrical & Computer Engg.	75	48.0	52.0
Mathematics	7	42.9	57.1
Management	29	58.6	41.4
Mechanical Engineering	73	42.5	57.5
Physics/ Engg. Physics	4	0	100.0
Others (Humanities, Social Sciences, IGSD)	5	20.0	80.0
Total	316	43.0	57.0

Based on the S/N dichotomy, the following groups emerge in the Class of 2003 sample:

1. Favored more by the Sensing students: Management, Chemical Engineering, Biomedical Engineering

2. Favored more by the Intuitives (N): Computer Science, Physics

3. Favored equally by either type/ Not Clear: the rest

Table 5.8 Percentage of Thinking (T) vs. Percentage of Feeling (F) students within each major in the graduating males of the Class of 2003

Major	*No. of Students in the major*	*Thinking (T) %*	*Feeling (F) %*
Biochemistry/ Chemistry	5	80.0	20.0
Biology/ Biotechnology	8	75.0	25.0
Biomedical Engg.	5	40.0	60.0
Chemical Engineering	17	70.6	29.4
Civil Engg.	22	81.8	18.2
Computer Science	66	78.8	21.2
Electrical & Computer Engg.	75	70.7	29.3
Mathematics	7	57.1	42.9
Management	29	75.9	24.1
Mechanical Engineering	73	71.2	28.8
Physics/ Engg. Physics	4	75.0	25.0
Others (Humanities, Social Sciences, IGSD)	5	60.0	40.0
Total	316	73.1	26.9

Based on the T/F dichotomy, the following groups emerge in the Class of 2003 sample:

1. Favored more by Thinking Students: Civil Engg., Computer Science

Table 5.9 Percentage of Judging (J) vs. Percentage of Perceiving (P) students within each major in the graduating males of the Class of 2003

Major	*No. of Students in the major*	*Judging (J) %*	*Perceiving (P) %*
Biochemistry/ Chemistry	5	40.0	60.0
Biology/ Biotechnology	8	12.5	87.5
Biomedical Engg.	5	40.0	60.0
Chemical Engineering	17	58.8	41.2
Civil Engg.	22	45.5	54.5
Computer Science	66	36.4	63.6
Electrical & Computer Engg.	75	52.0	48
Mathematics	7	42.9	57.1
Management	29	44.8	55.2
Mechanical Engineering	73	28.8	71.2
Physics/ Engg. Physics	4	0	100.0
Others (Humanities, Social Sciences, IGSD)	5	0	100.0
Total	316	39.6	60.4

Based on the J/P dichotomy, the following groups seem to emerge from the Class of 2003 sample:

1. Favored more by Judging students: Chemical Engg., Civil Engg., ECE
2. Favored more by Perceiving students: Biology/ Biotechnology, Mechanical Engg.
3. Favored equally by either/ not clear: the rest

$5.3 Replication of the Trends of the Class of 2002 in the Class of 2003 and Labeling Majors by MBTI Type

Table 5.10 presents the connection between different majors and MBTI type for the two class years studied, along with the statistical significance for each connection. For example, consider the CS major in the Class of 2003. CS receives a much higher percentage of Introvert (I) students than there are in the WPI sample (table 5.6), and as such is labeled “I”. A cross- tabulation of students who graduate with CS/ students who graduate with some other major vs. the E/I MBTI type yields a p- value of 0.02 (chi-square test).

Table 5.10 Labeling Major by MBTI Type (p- value specified in brackets)

Major	*'02*	*'03*	*'02*	*'03*	*'02*	*'03*	*'02*	*'03*
Chemical Engineering	**I** (0.37)	**I** (0.24)	**S** (0.17)	**S*** (0.07)	X	X	P (0.32)	J** (0.04)
Civil Engg.	E (0.21)	X	S (0.22)	X	F (0.14)	T (0.22)	P** (0.002)	J (0.33)
Computer Science	**I*** (0.096)	**I**** (0.02)	**N** (0.15)	**N** (0.25)	**T** (0.16)	**T** (0.11)	J (0.15)	X
Electrical & Computer Engg.	I (0.17)	X	X	S* (0.06)	X	X	**J** (0.11)	**J**** (0.001)
Management	**E*** (0.06)	**E**** (0.001)	X	S** (0.019)	X	X	X	X
Mechanical Engineering	**E*** (0.12)	X	S** (0.02)	X	X	X	X	P (0.175)
Physics	**I*** (0.08)	**I** (0.12)	**N** (0.28)	**N** (0.12)	X	X	J (0.24)	X

**Significant at the level of p<0.05

* Significant at the level of p<0.1

Based on the replication and p- values in Table 5.10, the following relations between major and MBTI type can be proposed:

- Management- Extravert.
- Computer Science- Introvert
- Physics-Introvert
- Electrical and Computer Engineering- Judging
- Chemical Engineering- Sensing (needs to be replicated in further class years)

$5.4 Future Directions

It is to be noted that certain majors are not attracting the same MBTI type in Class of 2002 and in Class of 2003. This could be because there is no relationship between these majors and MBTI type, and a random pattern emerges over time. It could also be a case that most years, there is a relationship but one of the years there was an exception. The WPI archive contains 6 years of MBTI data; therefore, the next logical step is to repeat this analysis for the rest of the years to clarify this matter. Final major data from the WPI

archives would be needed. Further study into the time order of major changes by type would also be of value whereby one can identify flows of given types between majors by academic terms, and see if particular “stumbling block” courses in a given major set the migration in motion. To answer this, transcript data for all years and a semester- by- semester or term- by- term listing of academic majors is required.

6. Studying Major Changes for Male Students

I hypothesized that major change, freshman academic performance and MBTI types are linked. This chapter examines the presence and nature of these links for the males of Class of 2002, and if these are replicated in the Class of 2003 or not.

$6.1 Major Change, Freshman Academic Performance and MBTI Type for Males of the Class of 2002

Analysis of the data of the Class of 2002 sample for males reveals major change and freshman academic performance to be related. For students who graduated, those who changed major are found to have performed less well in the freshman year than those who did not.

GPA of math and science (biology, chemistry and physics) courses passed in the freshman year has been used as the indicator of "freshman academic performance." Engineering courses have been ignored so as to compare academic performance of students on a common ground, and not confound performance with affinity of students to respective engineering disciplines or raise questions about the relative difficulty of different engineering majors. Also, different students have started out with different levels of math and science courses, depending on their academic background coming to college. By equally weighting these different levels of courses, I have largely eliminated the effect of level of academic background on freshman academic performance. Social Science and Humanities courses were not considered in this analysis because, while a problem in this area might delay graduation, it is unlikely that this is related to choice of majors or changing majors.

In this section, the term "GPA" or "academic performance" refers to the GPA in the math and science courses passed in the first year. Note that science and math courses dominate the course schedule of a typical WPI freshman student. This GPA is calculated using a 3.0 scale with A=3.0, B=2.0, C=1.0, NR=0.0.

The students have been grouped into three categories:

Group 1: Students who graduate with the same major that they started out with

Group 2: Students who graduate with a different major than they started out with

Group 3: Students who do not graduate (at least from WPI) by the year 2004.

These three groups are drawn from a simple probability sample. As such, these three groups can be assumed to be independent random samples.

If we compare the mean of freshman math and science GPA μ for the three groups, we find $\mu_{group1} > \mu_{group2} > \mu_{group3}$ .Table 6.1 presents the details. Please note that the grade data coverage for the sample is excellent but not quite 100% (407 out of 434 for males.)

Table 6.1 Mean GPA of math and science courses passed in the first year for the Class of 2002

	N	*Mean GPA*	*Standard Deviation*
Group 1	**222**	**1.96**	**0.602**
Group 2	**99**	**1.81**	**0.522**
Group 3	**86**	**1.56**	**0.538**
Total	**407**	**1.84**	**0.590**

Please note that the freshman academic performance for group 2 is close to that of the overall class. As such, it is the segregation of the students who eventually do not graduate into a separate group 3 that elucidates the difference in academic performance of students

who change major and those who do not. Specifically, a T- test for equality of the mean GPA of Groups 1 and 2 reveals that Group 1 and Group 2 differ at the significance level of $p=0.033$ (2- tailed). The mean difference is 0.14 and the corresponding 95% interval is [0.012,0.27].

Apropos, the Group 3 students who do not graduate from WPI in 6 years already differ significantly ($p<0.0001$) from Group $1 \cup$ Group 2. The mean GPA difference is 0.352 and is [0.22, 0.483] at the 95% confidence interval.

Now, it has been shown in this section that collectively students who graduate without changing major outperform those who do. Can MBTI type be used to elucidate this further?

Does the freshman academic performance of Group 1 and Group 2 differ for any particular MBTI dimension/s? For each MBTI type, the T- test for equality of mean GPA (μ) is performed between Group 1 and Group 2. Two key results are obtained:

1. For every single MBTI dimension, students who graduate without changing major academically outperform those who change major and graduate.

   $\mu_{Group1} - \mu_{Group2} > 0$ for every MBTI dimension

2. This difference in academic performance is statistically significant ($p<0.05$) along three MBTI dimensions: Extravert, Intuitive and Perceiving.

Table 6.2 Comparing Freshman Academic Performance of Group 1 and Group 2 along the 8 MBTI dimensions

MBTI Type	$\mu_{Group\ 1} - \mu_{Group2}$ *for GPA*	*Significance (2- tailed)*
Extravert	**0.25**	**0.01**
Introvert	0.065	0.5
Sensing	0.107	0.328
Intuitive	**0.168**	**0.057**
Thinking	0.13	0.14
Feeling	0.180	0.08
Judging	0.05	0.66
Perceiving	**0.209**	**0.018**

$6.2 Major Change, Freshman Academic Performance and MBTI Type for Males of the Class of 2003

The analysis of $6.1 is repeated for the Class of 2003. It is to be noted that Group 3 for the Class of 2003 comprises students who graduated from WPI in 5 years or less (as opposed to 6 years or less for the Class of 2002). For Class of 2003, it is found that $\mu_{group1} > \mu_{group2} > \mu_{group3}$, thus replicating the trend observed in the Class of 2002. Table 6.3 presents the details. Please note that coverage of grade data for the sample is excellent but not quite 100% (441 out of 456 for males.)

Table 6.3 Mean GPA of math and science courses passed in the first year for the Class of 2003 Males

	N	***Mean GPA***	***Standard Deviation***
Group 1	**184**	**2.01**	**0.56**
Group 2	**127**	**1.89**	**0.55**
Group 3	**130**	**1.65**	**0.52**
Total	**441**	**1.87**	**0.56**

A T- test for equality of the mean GPA of Groups 1 and 2 show that $\mu_{group1} - \mu_{group2} = 0.12$ at p= 0.055. For the Class of 2002, this difference was 0.14 at p=0.033.

For each MBTI type, the T- test for equality of mean GPA (μ) is performed between Group 1 and Group 2. Table 6.4 presents the results.

Table 6.4 Comparing Freshman Academic Performance of Group 1 and Group 2 along the 8 MBTI dimensions for Class of 2003

MBTI Type	$\mu_{Group\ 1} - \mu_{Group2}$ *for GPA*	*Significance (2- tailed)*
Extravert	0.12	0.175
Introvert	0.095	0.27
Sensing	0.068	0.49
Intuitive	**0.169**	**0.046**
Thinking	0.12	0.125
Feeling	0.12	0.27
Judging	0.107	0.3
Perceiving	**0.139**	**0.085**

For the Class of 2003 just like for the Class of 2002, $\mu_{group1} > \mu_{group2}$ for every MBTI type. **Moreover, this difference between Group 1 and Group 2 is found to be significant at the p<0.05 level for the Intuitive type (N) and at the p<0.1 level for the Perceiving type for both Class of 2002 and the Class of 2003.**

$6.3 MBTI Type Distribution of Students to Change Major

This section provides the MBTI type distribution for the Group 2 males (who graduated with a different major than they had started out with.)

$6.1 to $6.3 have shown that for Intuitives (N) and Perceiving (P) types, the Group 2 students are outperformed by the Group 1 students at a statistically significant level. From policy- making point of view, this finding puts the Group 2 N and the Group 2 P under the radar. However, what percentage of the Group 2 students is N? What

percentage is P? This section answers such questions. It *does not* answer the question of which MBTI type is more likely to change major.

Table 6.5 MBTI Distribution of Group 2 students along the E/I dimension

	Class of 2002 (N=105)	Class of 2003 (N=128)
Extravert	48.6	41.4
Introvert	51.4	58.6
Total	100.0	100.0

Table 6.6 MBTI Distribution of Group 2 students along the S/N dimension

	Class of 2002 (N=105)	Class of 2003 (N=128)
Sensing	39.0	46.9
Intuitive	61.0	53.1
Total	100.0	100.0

Table 6.7 MBTI Distribution of Group 2 students along the T/F dimension

	Class of 2002 (N=105)	Class of 2003 (N=128)
Thinking	59.0	70.3
Feeling	41.0	29.7
Total	100.0	100.0

Table 6.8 MBTI Distribution of Group 2 students along the J/P dimension

	Class of 2002 (N=105)	Class of 2003 (N=128)
Judging	37.1	43.0
Perceiving	62.9	57.0
Total	100.0	100.0

Please note that both Intuitive and Perceiving form the majority in Group 2 ('major-changers') in both Class of 2002 and Class of 2003. This result means that this issue of Group 2 being outperformed by Group 1 for the N and the P concerns a fairly large percentage of the students to change major.

This finding should not be misinterpreted as implying that the N and the P are more likely to change majors because I have not compared these findings to the MBTI distribution of the entire sample here. In fact, these MBTI types happen to be overrepresented at WPI.

$6.4 Post- Hoc Hypothesis

I propose Hypothesis 1 below to explain why Group 2 Intuitive (N) students do not perform as well as Group 1 Intuitive (N) students in math and science courses passed in their freshman year. Hypothesis 2 (proposed by Prof. Wilkes) is presented as a possible explanation for this trend among the Perceiving students.

Hypothesis 1: Inability to understand how the basic mathematics and science courses fit into the bigger picture causes students who eventually change major to also perform relatively poorly in the math and science courses that they passed in freshman year. This lack of connection of the basic courses to the 'bigger picture' hurts the Intuitives (N) the most.

I have below explained how I came up with Hypothesis 1.

Observation 1: $\mu_{group1} > \mu_{group3}$, $\mu_{group2} > \mu_{group3}$, $\mu_{group1 \cup group2} > \mu_{group3}$ **All three inequalities are statistically significant, and as such assumed to represent fact.**

Observation 1 is consistent with our intuition that the students who ultimately do not graduate from WPI in 6 years or less would academically underperform as a group as compared to students who do graduate. This is a positive evidence for the sensitivity of the GPA of mathematics and science courses passed in the freshman year as an indicator of freshman academic performance.

Observation 2: $\mu_{group1} > \mu_{group2}$. **This trend is consistent in both class years for every MBTI variable, though the difference between Group 1 and Group 2 is not statistically significant for every MBTI variable.**

Assumption 1: There exists psycho- sociological force/s such that students who eventually change major also academically underperform, at least in freshman math and science courses.

To identify possible psycho- sociological forces, I would first like to answer: Why do Group 2 students start out with a "wrong" major to begin with? Possible reasons may be (in no particular order):

1. They are not serious about their academics, and choose casually or whimsically.
2. They are not confident and/or clear about their goals at the onset.
3. That major seems 'fashionable' from the point of view of job prospects, though not necessarily a good fit for them as individuals.
4. They have AP credits in courses pertinent to that major, and either want to use those AP credits or feel more confident with the major because of prior success in the field where they received the AP credits.

Next, I would like to answer: What possibly triggers them to change major? A few possible answers are:

1. They perform below their expectations in their academics overall, and decide to change, due to doubts about being able to succeed, especially if classmates that they are comparing themselves with are performing better.
2. They become clearer and confident about their goals, and switch to a major that they believe to be more suited towards achieving their goals.
3. They find the course requirements for the major unsuitable to their tastes and/or abilities.
4. They perform below their expectations in their major courses, take that as a warning of future trouble, and decide to switch major.

I base my hypothesis on the possibilities listed above. The hypothesis will be aimed towards finding one dominant force at play in the dynamics of major changing. By considering what type is affected the most by this unknown force, I will gather information about the nature and identity of this force.

Observation 3: The difference in the academic performance of Group 1 and Group 2 is statistically significant and most pronounced for the Intuitives

By definition, the Intuitives prefer to accept and process information by placing it in context of the bigger picture. They are said to live in the future, not the present, and focus on possibilities and implications. How a basic science or mathematics course fits into the bigger picture, and how these courses relate to courses taken in the major would possibly be more important to the Intuitives than to the Sensing students. If an Intuitive does not have a clear picture of his goals (pt.#2), and does not any bigger picture to begin with or has doubts about it, he would not be able to place the freshman math and science courses

in context as means to his end. These courses would just tend to become busy work in his eyes, and a motivation and application lapse may arise. This may explain Observation 3, and leads to my hypothesis 1 (stated at the beginning of this section.)

Test for hypothesis 1: **If hypothesis 1 is true, then the Intuitives should recover in terms of their academic performance once they choose their final major.** *Do* they?

However, to perform this test, the following data is required:

1. Periodic listing (every term) of academic majors, in order to determine when (if at all) students of Group 2 become settled as to their choice of academic majors.
2. Transcript data for the all undergraduate years to see whether or not the Intuitives of Group 2 recover, after they settle into a major.

It is to be emphasized that recovery of the Group 2 Intuitives would not *prove* Hypothesis 1, while failure to recover would be grounds for rejecting the hypothesis1.

Hypothesis 2 (attributable to Prof. Wilkes): "The Perceiving (P) type students have certain recognized weaknesses in the context of time management and self- discipline, i.e. they have difficulty completing things in a timely manner and sticking to the plan. Following directions is disproportionately likely to be an issue for the NPs. On the other hand, P's (and especially NP's) have a reputation for creativity and being able to read between the lines. They go off on tangents and do not put "first things first" but this sometimes results in extraordinary contributions. Since they typically lack a personal

preference for closure, they view major choices as tentative, rather than a firm commitment, and subject to change based on later information. Some majors are more tolerant of the kind of "dithering" involved in keeping one's options open and not fully connecting to a plan on career than others. Some parts of a field such as design and R & D, as opposed to management and production, are also more open to insight driven innovation than on schedule deliverables. So, in terms of freshman classes, one manifestation of this more distracted pattern of the P versus the J is to be less likely to complete and submit things on time, edit thoroughly and so forth- things that affect their math and science grades. They may also take some courses without first taking the appropriate pre- requisites."

Caveat: Group 1 students in this current study represent those who graduated with the same major that they started out with. It is possible that some Group 1 students did change their major, but reverted back to their original major. However, in developing the hypothesis, the number of such Group 1 students has been assumed to be negligible.

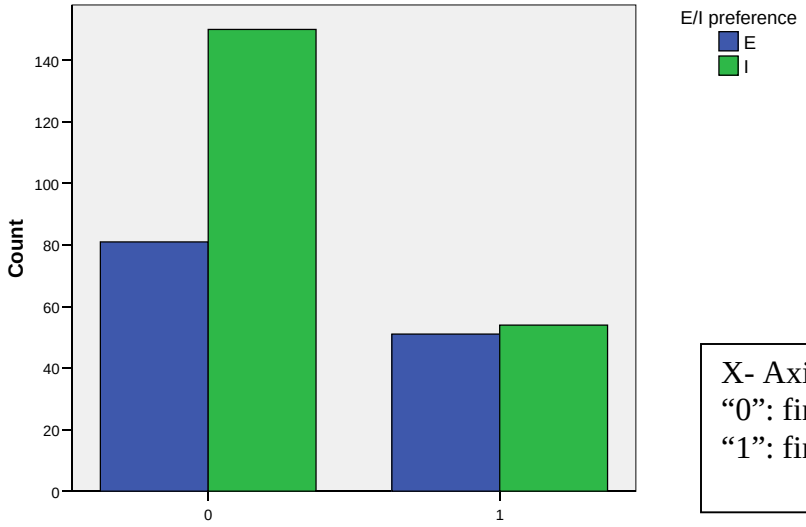
$6.5 Which MBTI Type/s Are More Likely To Change Major?

This section looks at the Class of 2002 and Class of 2003 male students who graduated from WPI by the year 2004, and compares the MBTI profile of the Group 2 students with that of the Group 1 students. Figures 6.1 to 6.4 show the results of the comparison for each dimension.

The E/I dimension is found to be statistically significant (at alpha=0.1 level) in both the Class of 2002 and the Class of 2003, with significantly more Extraverts changing

major. In the Class of 2002, the T/F dimension is also found to be statistically significant. However, this finding does not replicate in the Class of 2003.

E/I Dimension



X- Axis:
"0": final and initial majors are the same
"1": final major differs from initial major

Fig. 6.1a Class of 2002 males (N=336). Chi- square test gives p=0.019

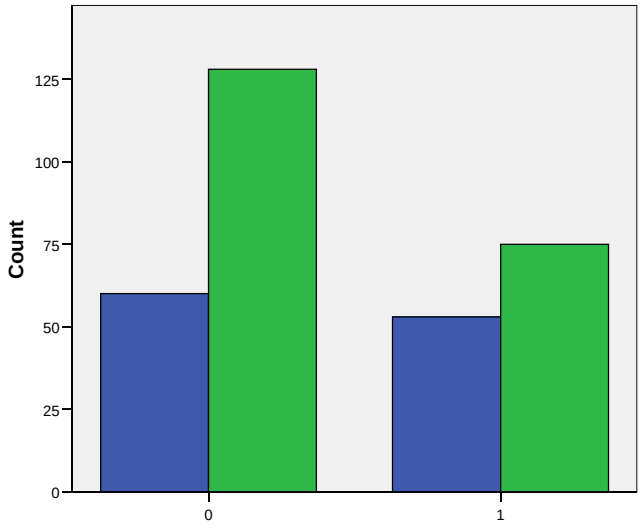
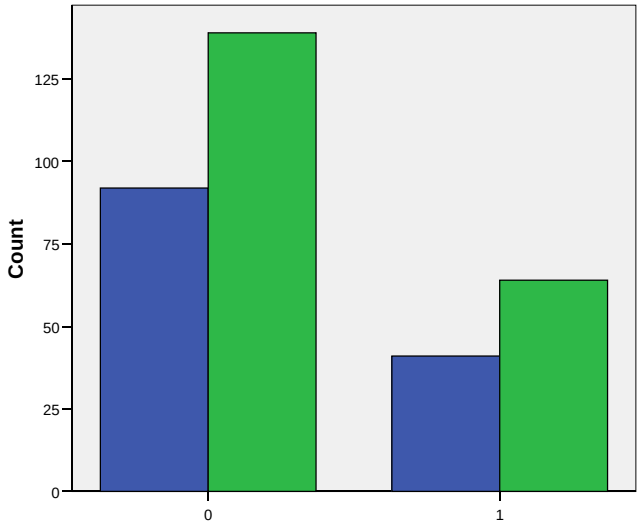


Fig. 6.1b Class of 2003 males (N=316). Chi- square test gives p= 0.084

S/N Dimension



X- Axis:
"0": final and initial majors are the same
"1": final major differs from initial major

Fig. 6.2a Class of 2002 males.

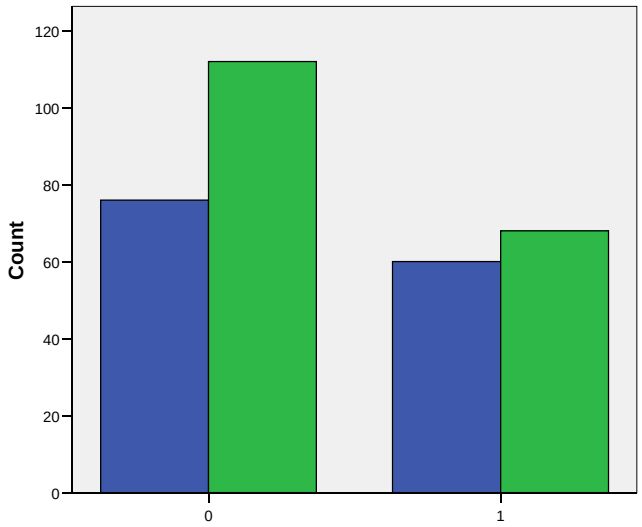
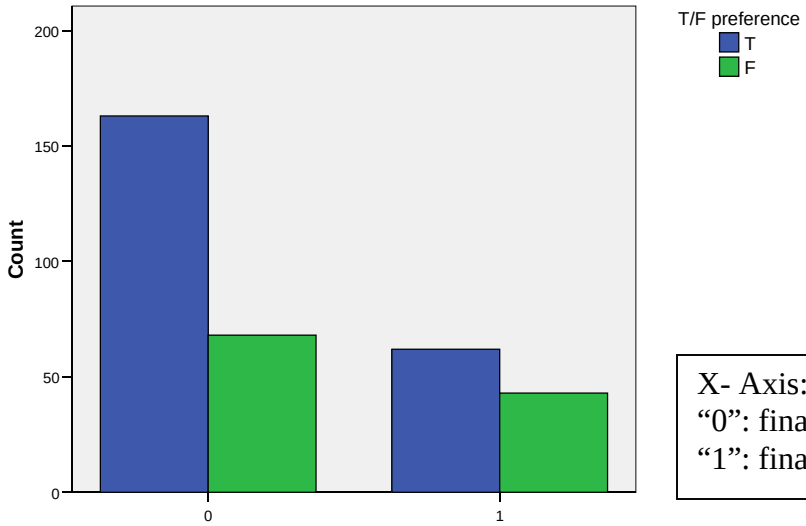


Fig. 6.2b Class of 2003 males.

T/F Dimension



X- Axis:
"0": final and initial majors are the same
"1": final major differs from initial major

Fig. 6.3a Class of 2002 males. Disproportionately fewer T appears to change majors. Chi- square test yields p=0.038.

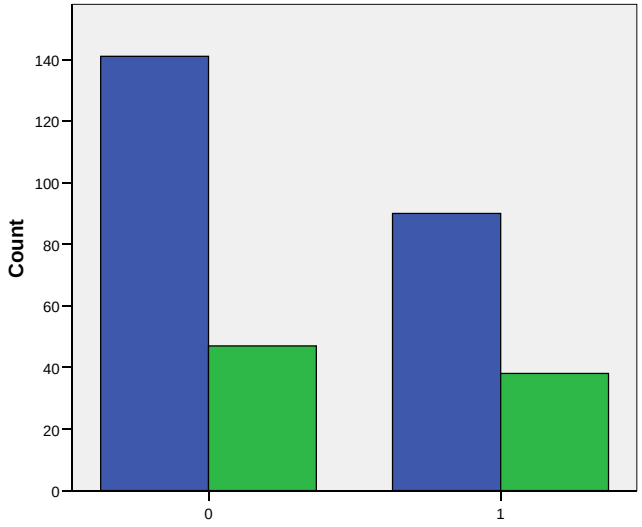
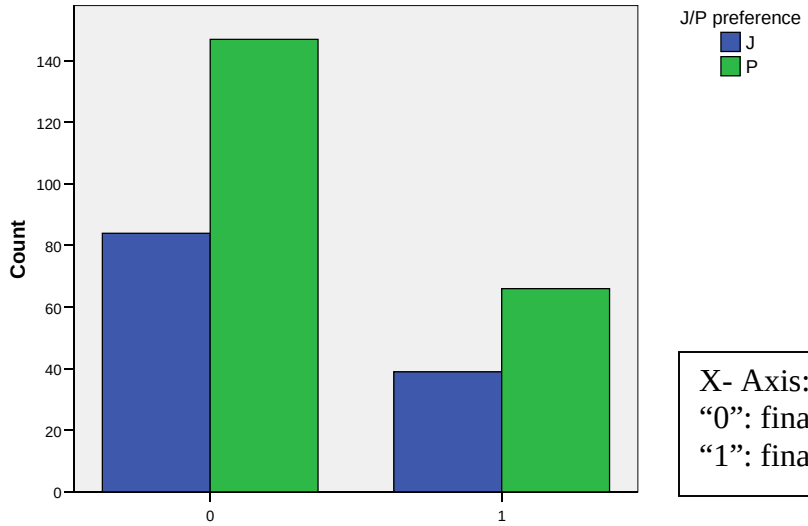


Fig. 6.3b Class of 2003 males. Disproportionately fewer T's appear to change majors in Class of 2003 too. However, this is not statistically significant at the alpha=0.1 level

J/P Dimension



X- Axis:
"0": final and initial majors are the same
"1": final major differs from initial major

Fig. 6.4a Class of 2002 males.

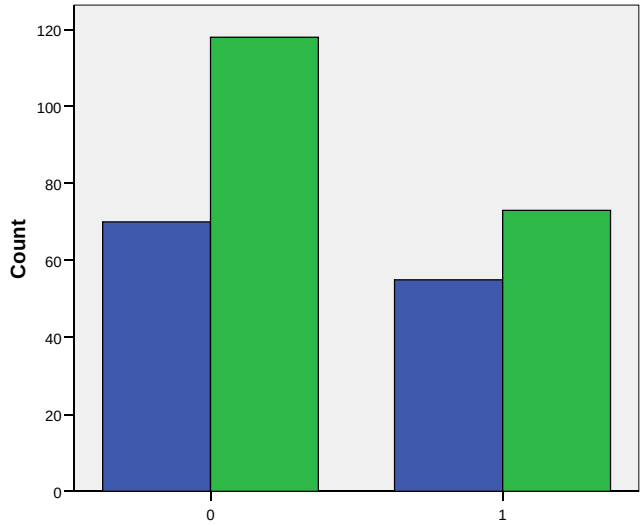


Fig. 6.4b Class of 2003 males.

The key result from this section that switching out of technical majors is related to Extraversion (and possibly Feeling) is consistent with that of a study by Thomas et al.[7]

[7] Thomas, A., Benne, M.R., Marr, M.J., Thomas, E.W., Hume, R.M. (2000) "The evidence remains stable: The MBTI predicts attraction and attrition in an engineering program." J. of Psychological Type, 55, 35-42

$6.6 Future Directions & Policy Recommendation

1. Group 3 students need to be segregated into two further groups: Group 3A students who change major at least once and Group 3B students who never change major. Periodic major listing of the students is required in order to do this.
2. Hypothesis 1 needs to be tested in the manner described on p. 39 in $6.3.
3. The analysis should be made more robust by defining Group 1 students as students who never change major and Group 2 students as students who change major at least once. This is possible only after obtaining periodic listing of majors for the students of Class of 2002 and the Class of 2003.

Policy Recommendation: First of all, I have shown that changing of majors is associated with a relatively low freshman math and science GPA. Furthermore, I have theorized about one dominant factor that accounts for this is students' not being able to understand how these courses relate to their bigger goals (assuming my hypothesis 1 is true). Therefore, every effort should me made to test hypothesis 1, and if it cannot be rejected, then WPI administration and faculty should consider implementing teaching strategies that relate basic math and science courses to different majors/ applications.

7. Studying Major Changes for Female Students

The analysis performed for the males in Chapter 6 is repeated for the females. I would like to mention at the outset that the trends observed for the Class of 2002 females are not found to be replicated for the Class of 2003 females. The analysis for females needs to be repeated for several other class years before any attempts to formulate a hypothesis, due to sample size restrictions related to the sex ratio in the WPI student body.

$7.1 Females of the Class of 2002

The freshman students have been grouped into three categories:
Group 1: Students who graduate with same major as they started out with.

Group 2: Students who graduate with a different major than the one they had started out with.

Group 3: Students who do not graduate (at least, from WPI and in 6 years or less).

The mean of freshman math and science GPA μ for the three groups are compared. We find for females too $\mu_{group1} > \mu_{group2} > \mu_{group3}$. Table 7.1 presents the details.

Table 7.1 Mean GPA of math and science courses passed in the first year for Class of 2002, WPI

	N	*Mean GPA*	*Standard Deviation*
Group 1	**71**	**2.00**	**0.534**
Group 2	**33**	**1.79**	**0.413**
Group 3	**16**	**1.72**	**0.582**
Total	**120**	**1.90**	**0.518**

In the case of females too, the students who eventually graduate without changing majors (Group 1) significantly outperform those who do (Group 2). A T- test for equality of μ of Groups 1 and 2 reveals that Groups 1 and 2 differ at the significance level of p=0.039. The mean difference is approx. 0.21 and corresponding 95% interval is [0.01, 0.39].

Table 7.2 presents the difference between the academic performance of the Groups 1 and 2 by MBTI type.

Table 7.2 Comparing Freshman Academic Performance of Group 1 and Group 2 along the 8 MBTI dimensions, Class of 2002 Females

MBTI Type	$\mu_{Group\ 1} - \mu_{Group2}$ *for GPA*	*Significance (2- tailed)*
Extravert	0.23	0.107
Introvert	0.16	0.225
Sensing	0.07	0.66
Intuitive	**0.31**	**0.016**
Thinking	- 0.15	0.329
Feeling	**0.54**	**<0.0001**
Judging	0.25	0.13
Perceiving	0.11	0.405

The following interesting results come up for females, especially as compared to males:

1. There is a MBTI dimension (Thinking type) along which Group 2 is *not* academically outperformed by Group 1. In the case of males, along no MBTI dimension for which this happened.
2. The Intuitive and the Feeling dimensions are significant at the $p<0.05$ level. In the case of males, the **Intuitive** and Perceiving dimensions turned out to be the significant ones.

$7.2 Females of the Class of 2003

The analysis is repeated for the females of the Class of 2003. Table 7.3 presents the results for the mean GPA of math and science courses passed in the first year.

Table 7.3 Mean GPA of math and science courses passed in the first year for Class of 2003, WPI

	N	*Mean GPA*	*Standard Deviation*
Group 1	**59**	**2.05**	**0.46**
Group 2	**60**	**2.04**	**0.52**
Group 3	**27**	**1.62**	**0.56**
Total	**146**	**1.96**	**0.53**

The difference between the GPA of Groups 1 and 2 is not found to be significant for any MBTI dimension.

$7.3 Future Directions

This analysis needs to be repeated in an analysis encompassing all 6 years of female MBTI data in the WPI archive. To get approximately the number of cases in the male analysis of graduates, the Class of 2001- 2003 data sets for females should be pooled and compared to the Class of 2004- 2006 data. At this point of time the major data has not been incorporated into the 2001 dataset and the 2004-2006 datasets do not have the WPI academic performance data.

8. Case Study: Computer Science and Management Majors (Males)

In both Class of 2002 and Class of 2003, it was found that CS was the most popular major among the entering freshmen, but dropped down to the third position in terms of final choice of major. Freshman major distribution of the students who change major (fig. 8.1) reveals that Computer Science contributes more students to the pool of major-changers than any other initially declared major.

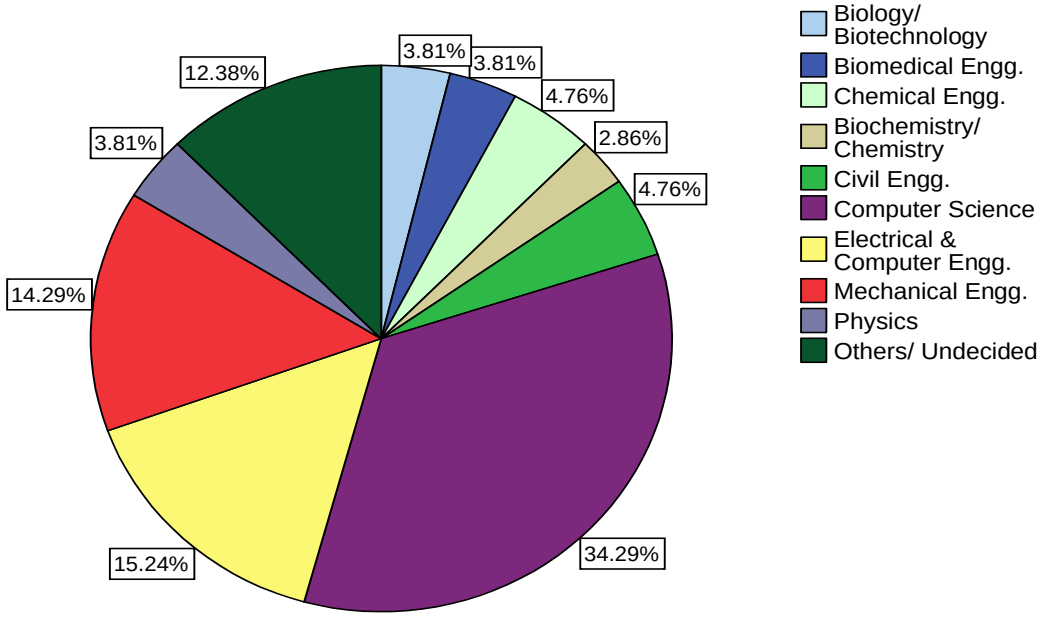


Fig. 8.1a Freshman Major Distribution of the 105 Males to change major in the Class of 2002 sample

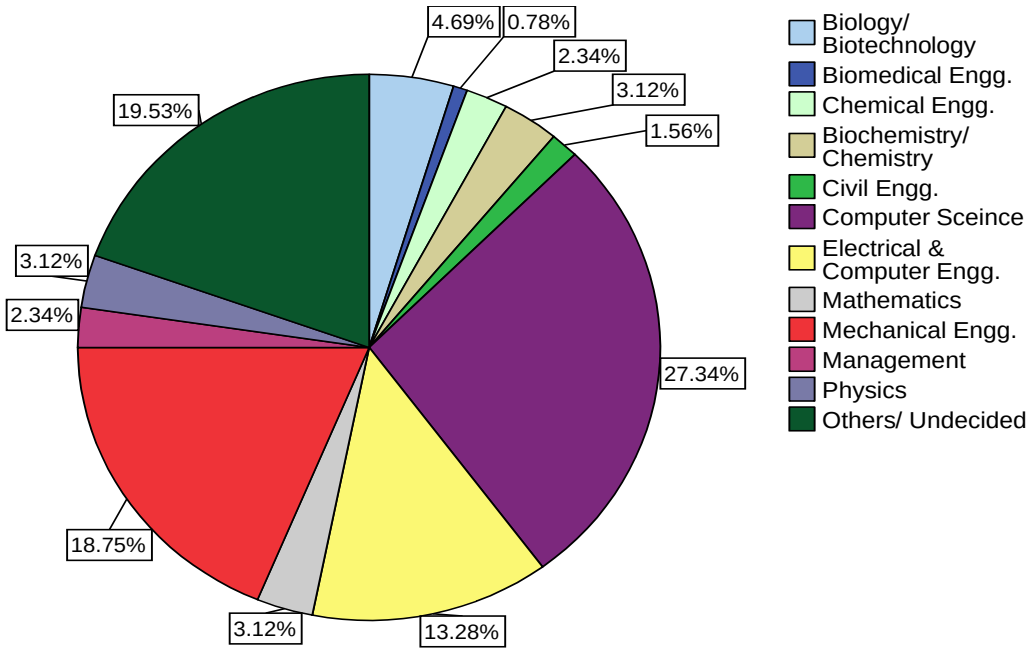


Fig.8.1b Freshman Major Distribution of the 128 Males to change major in the Class of 2003 sample

Management, on the other hand, started out as the least popular major among the entering freshmen in both Class of 2002 and Class of 2003, but climbed up several spots by the time of graduation.

In this chapter, I study the students who start out with Computer Science major, and students who end with Management major.

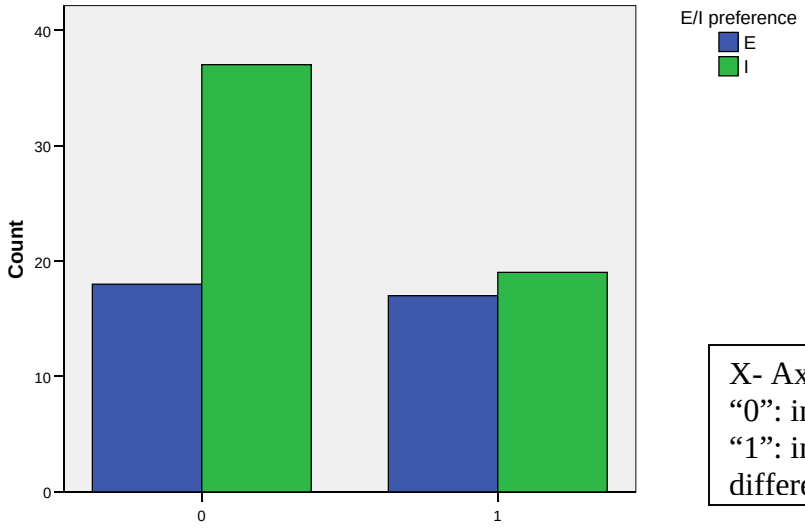
$8.1 Students starting out as Computer Science major

In our sample for the entering freshmen of the Class of 2002, 123 male students start out as Computer Science majors. 32 (26%) of these 123 students do not graduate from WPI by the year 2004. 36 (39.6 %) of the rest 91 students who graduate did so with a different major than the CS they had started out with. Incidentally, the bulk of these 36 students switch to Management (17) and to Electrical & Computer Engineering (9).

In the sample for the entering Class of 2003, 137 male students start out as Computer Science majors. 46 students (33.6%) do not graduate by the year 2004 (i.e, in 5 years or less.) Of the 91 students to graduate, 35 (38.5%) do so with a different major than the CS they had started out with. As in the case of Class of 2002, the bulk of these 35 students switch to Management (11) and to Electrical & Computer Engineering (14).

Do students of any particular MBTI type/s switch major out of Computer Science? Figures 8.2 through 8.5 present bar charts that answer this question.

E/I Dimension



X- Axis:
"0": initial and final majors are both CS
"1": initial major is CS, but final major is different from CS

Fig.8.2a Class of 2002 Major change along E/I dimension Chi- square test yields p=0.165.

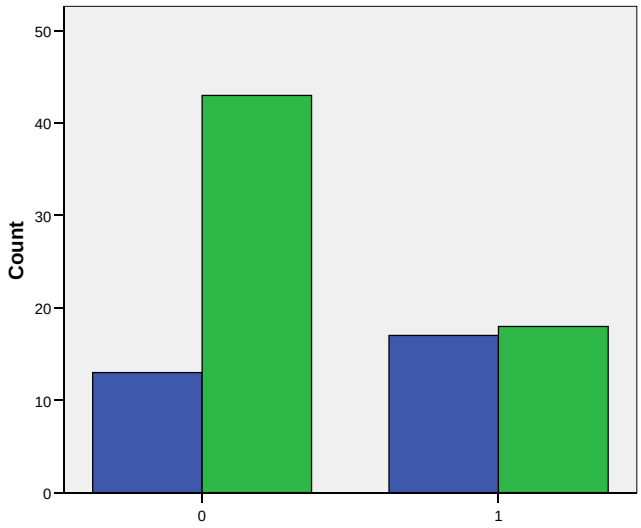
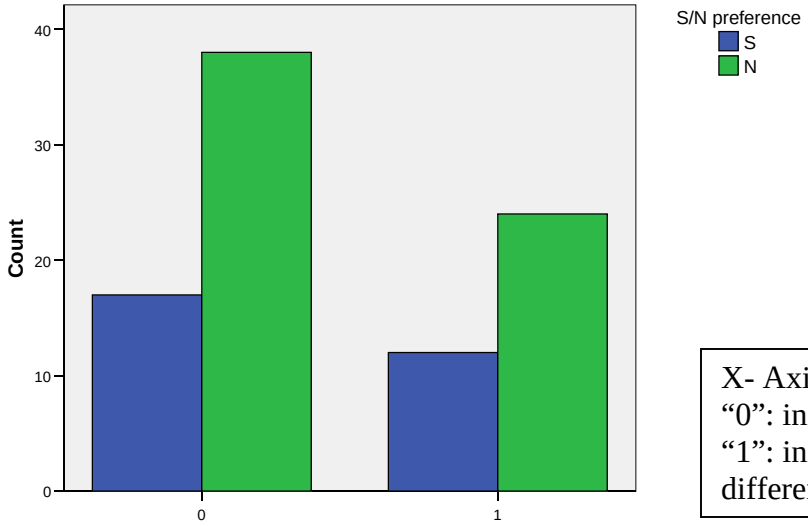


Fig. 8.2b Class of 2003 Major Change along E/ I dimension (p=0.012)
Note that disproportionately large numbers of Extraverts appear to leave Computer Science in both Class of 2002 and Class of 2003. Although, this was not statistically significant in the Class of 2002, the results are consistent between Class of 2002 and Class of 2003 and with CS being an Introverted major (Chapter 5).

S/N Dimension



X- Axis:
"0": initial and final majors are both CS
"1": initial major is CS, but final major is different from CS

Fig. 8.3a Class of 2002 Major Change along the S/N dimension, p=0.8

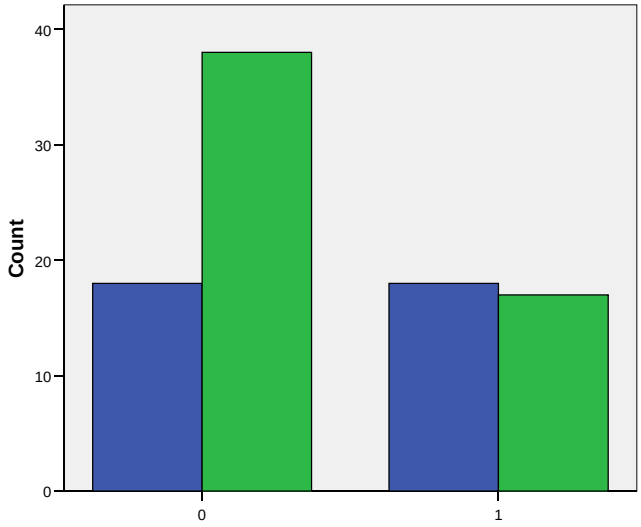
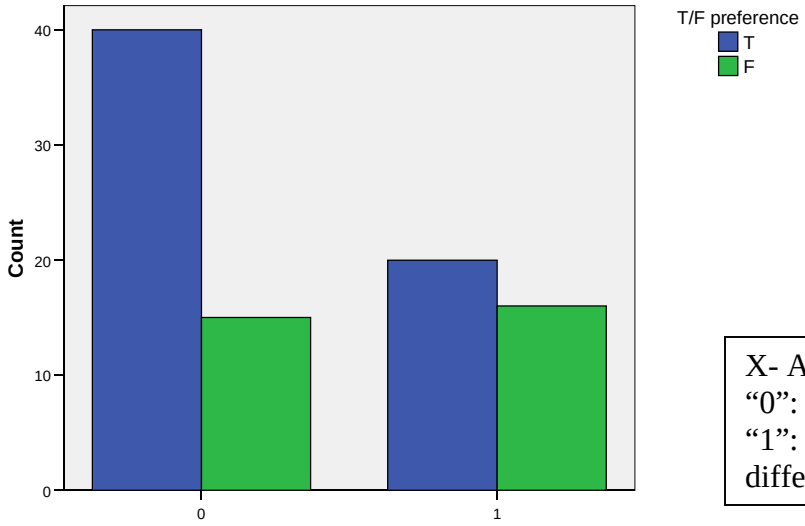


Fig. 8.3b Class of 2003 Major Change along the S/N dimension, p=0.067

Note that disproportionately large number of Sensing students changes major in the Class of 2003. However, this is not observed in the Class of 2002.

T/F Dimension



X- Axis:
"0": initial and final majors are both CS
"1": initial major is CS, but final major is different from CS

Fig. 8.4a Class of 2002 Major Change along the T/F dimension. Students with a Feeling preference appear to disproportionately move out of the CS major. Chi- square test yields p=0.09

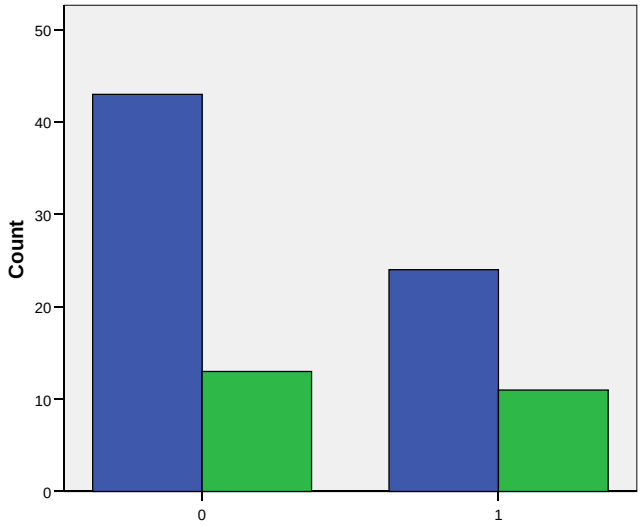
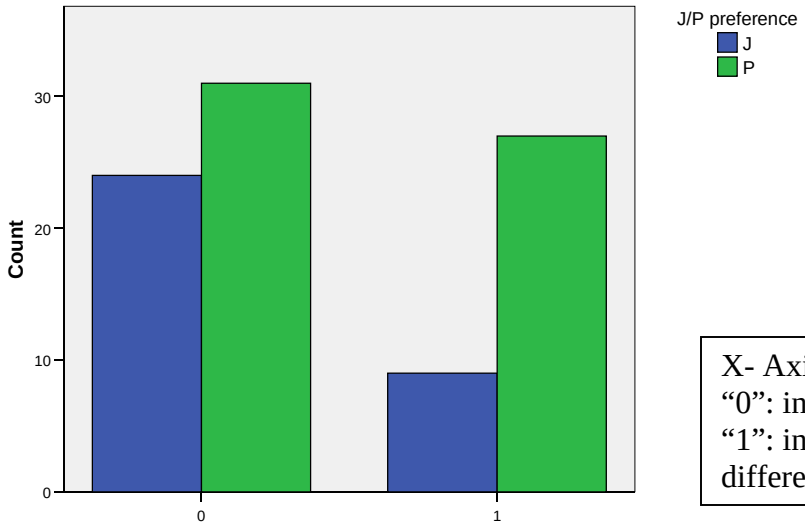


Fig. 8.4b Class of 2003 Major Change along the T/F dimension, p= 0.39

J/P Dimension



X- Axis:
"0": initial and final majors are both CS
"1": initial major is CS, but final major is different from CS

Fig. 8.5a Class of 2002 Major Change along the J/P dimension Disproportionately large number of Perceiving students appear to move out of the CS major. **(**p=0.071)

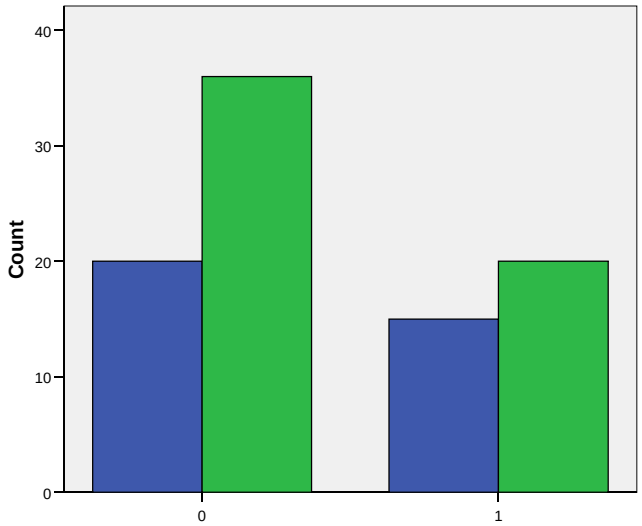


Fig. 8.5b Class of 2002 Major Change along the J/P dimension, p=0.5

In both class years, the Group 1 students (same major[8]) are found to have outperformed the Group 2 students (major changers). In Class of 2002, the difference between the Group 1 and Group 2 in terms of mean freshman math and science GPA is 0.13 (p= 0.3). In the Class of 2003, the difference between the Group 1 and Group 2 in terms of mean freshman math and science GPA is 0.32 (p=0.005). Therefore, the finding Group 1 students outperform Group 2 students (Ch 4) replicates for the subsection comprising students starting out with Computer Science majors. The students were not further broken down into groups by MBTI type as in Chapter 4 because the sample sizes become too small to obtain statistically significant results. Moreover, the issue of central importance in this chapter is whether any particular MBTI types are disproportionately likely to be switching out of the CS major.

$8.2 Students graduating with Management

This section studies the students who switched majors to Management (includes MIS, IE).

What is the MBTI profile of students who switch to Management, and how does this profile compare to the MBTI profile of Group 2 students (major changers) in general? Note that the question I ask here is different from what I asked in $8.1

In the Class of 2002, a total of 105 male students 'change major', and 29 (27.6%) of these 105 students end up with Management. In the Class of 2003, a total of 128 male students

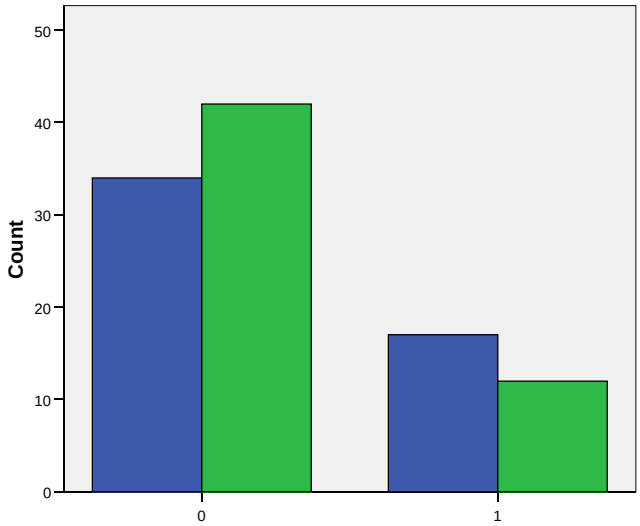
[8] If someone changed major, but eventually graduated with the original major, then he is treated as not having changed major. This is due to limitation of currently available data.

‘change major’, and 25 (19.5%) of them end up with Management. As such, Management receives a large portion of the students who change major.

Figures 8.6 to 8.9 (p. 67-70) indicate that the E/I dimension is important. Management appears to attract Extraverts. Although there are fewer Extraverts than Introverts in the overall pool of major- changers, more Extraverts than Introverts switch to Management. This is consistent with the finding in Ch 5 that Management is attractive to Extraverts.

For figures 8.5 to 8.8, along X- axis: “0” represents students who change major but *not* to Management, while “1” represents the students who change major to Management.

E/I dimension



X- axis:
"0": students who change major but ***not*** to Management
"1": students who change major to Management

Fig. 8.6a Class of 2002 Males. Chi- square test yields p=0.2

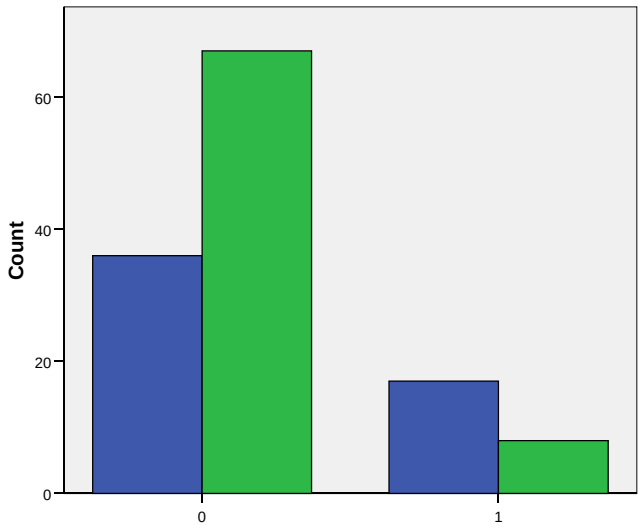
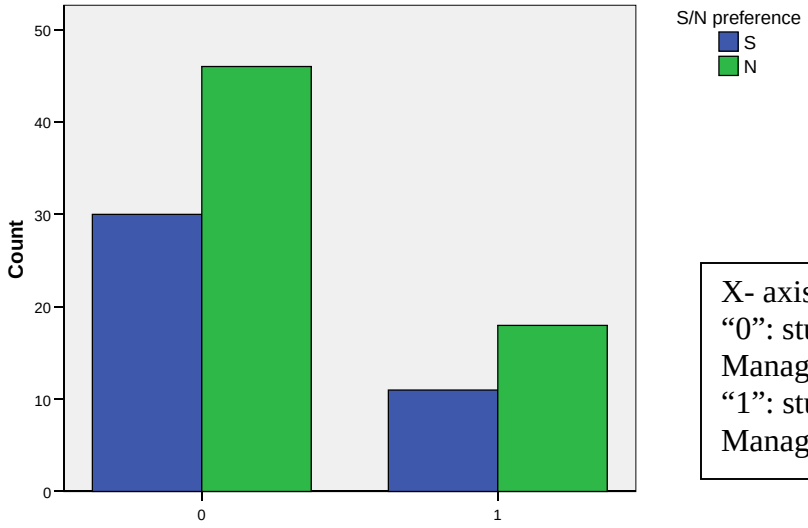


Fig. 8.6b Class of 2003 Males, p=0.003

S/N dimension



X- axis:
"0": students who change major but ***not*** to Management
"1": students who change major to Management

Fig. 8.7a Class of 2002 Males

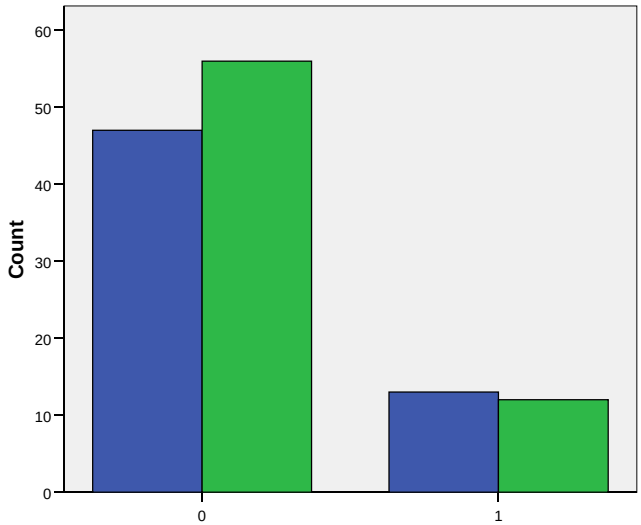
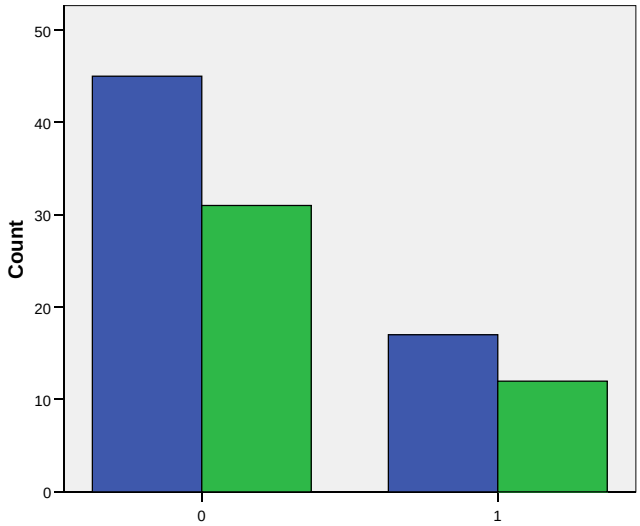


Fig. 8.7b Class of 2003 Males

T/F dimension



X- axis:
"0": students who change major but ***not*** to Management
"1": students who change major to Management

Fig. 8.8a Class of 2002 Males

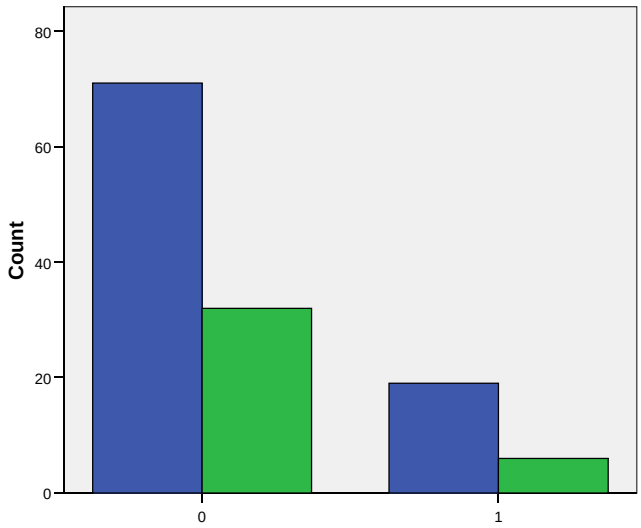
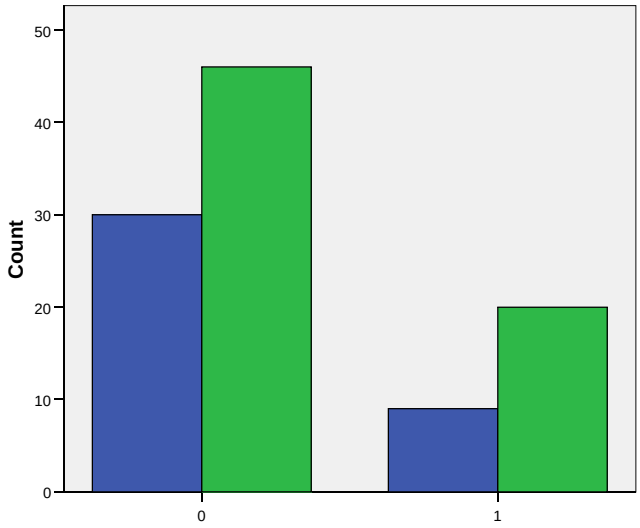


Fig. 8.8b Class of 2003 Males

J/P dimension



X- axis:
"0": students who change major but ***not*** to Management
"1": students who change major to Management

Fig. 8.9a Class of 2002 Males

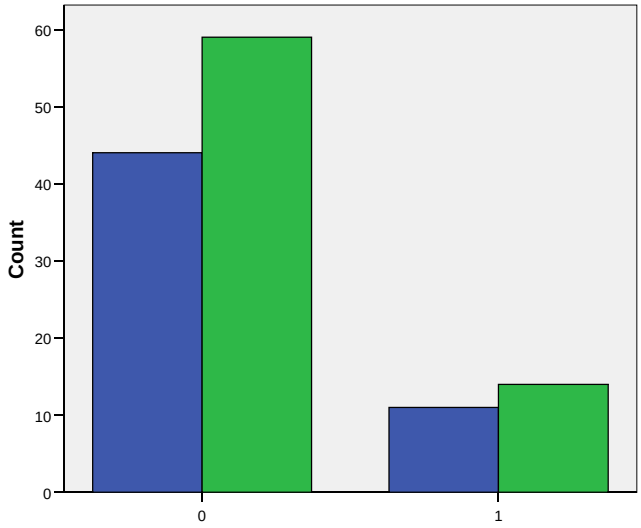


Fig. 8.9b Class of 2003 Males

I conclude this section by looking at the (initial) freshman major distribution of the students who change major to Management and graduate as Management major (fig.

8.10a and 8.10b). This analysis reveals that most of these students started out at WPI as Computer Science majors.

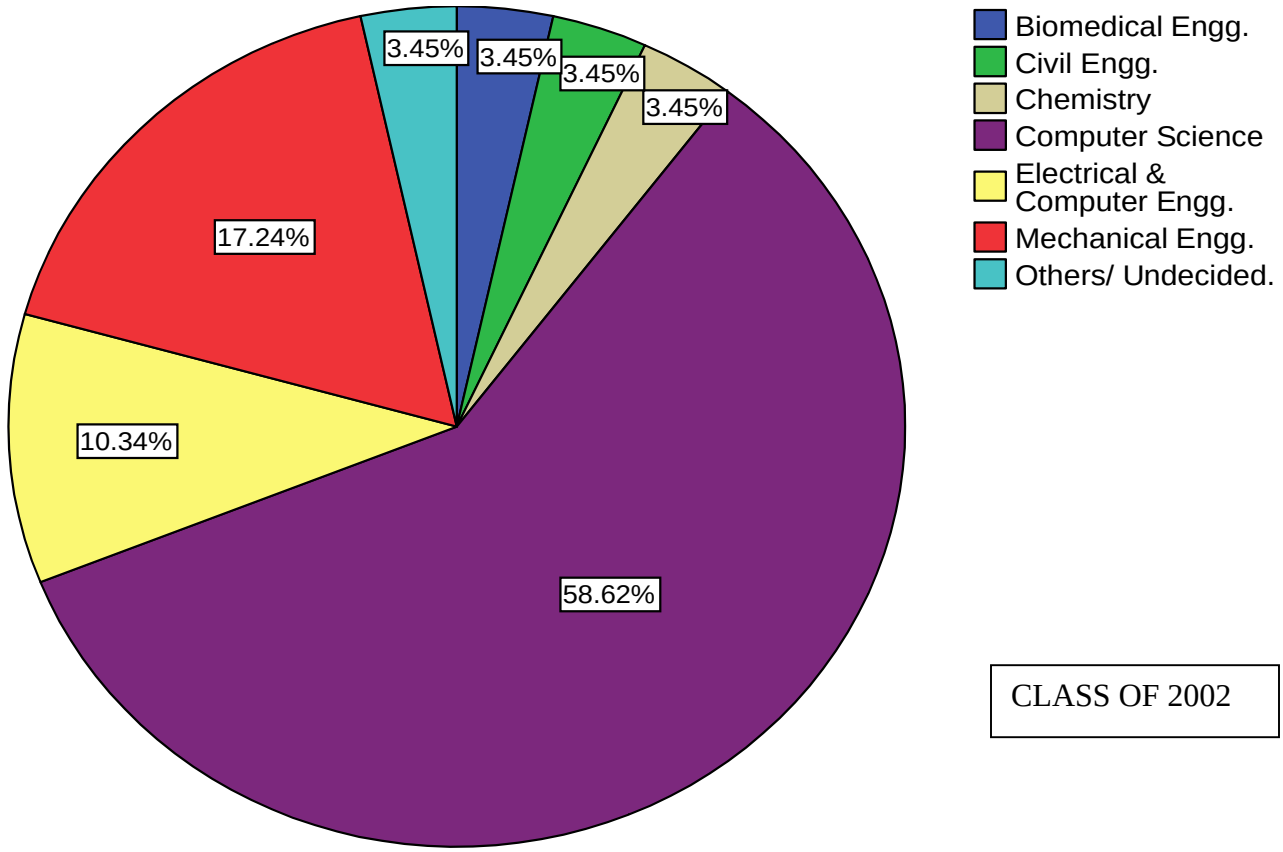


Fig.8.9a Freshman Major Distribution of the 29 male students in the entering Class of 2002 who change major to Management. The number of students (29) is too low to obtain results of statistical significance. However, it is suggestive that 17 (58.6%) of these 29 students had CS as their initial major at WPI.

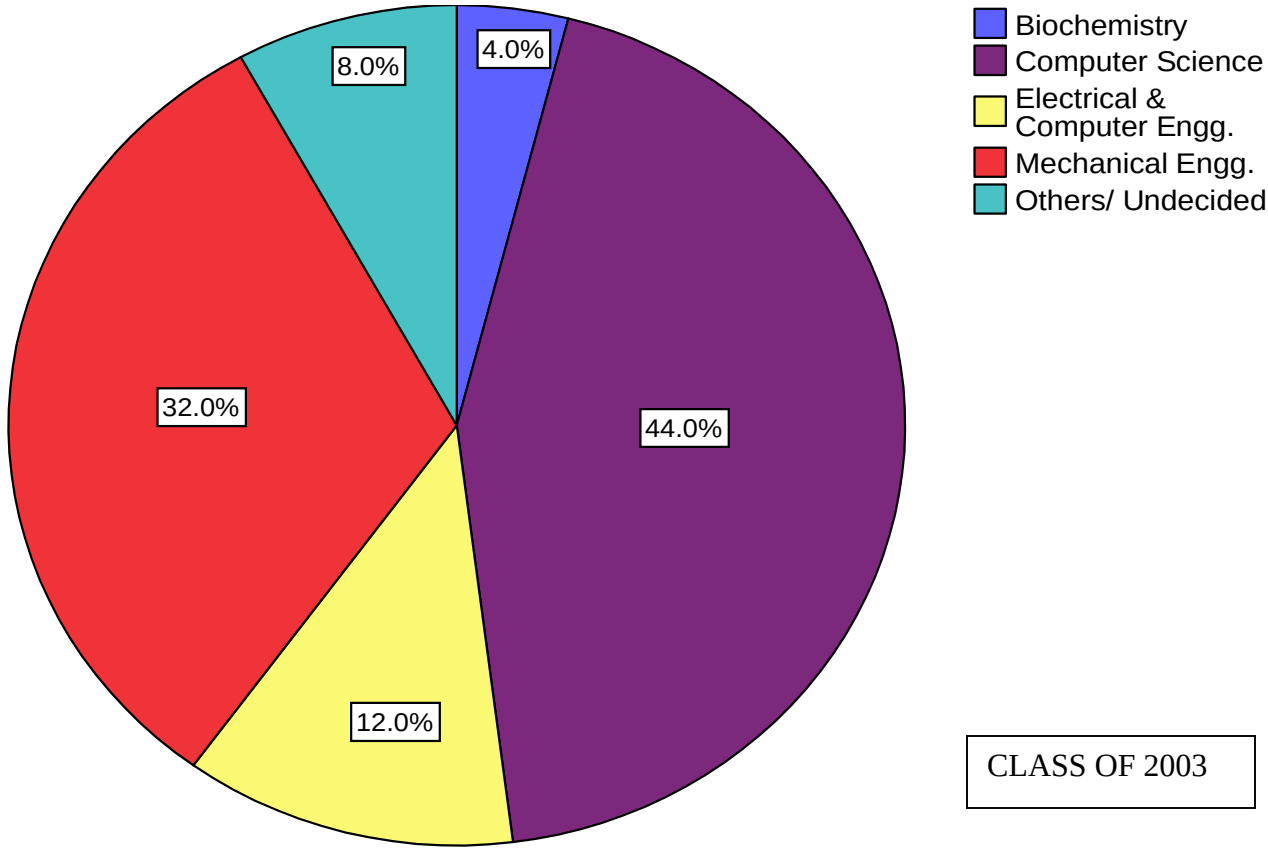


Fig.8.9b Freshman Major Distribution of the 25 male students in the entering Class of 2003 who change major to Management. As in the case of Class of 2002 (fig. 8.9a), a large number 11 (44%) of these 25 students start out as Computer Science major.

9. Conclusions, Limitations and Future Directions

This project yielded several striking findings and some interesting trends and inconclusive patterns. These findings provide insights into questions in higher education-insights that are interesting in their own right and that can potentially influence policy in higher education. Moreover, these findings should result in further research in this area.

This chapter summarizes the findings from this project, states some caveats and recommends future lines of research based on the findings of this 2 year comparative study.

$9.1 Conclusions

All findings reported in this section are found in *both* the entering Class of 2002 and the entering Class of 2003, unless otherwise indicated.

Distinctive MBTI Profile

- The male student population and the female student populations at WPI have distinctive MBTI profiles. [Chapter 4] For purpose of comparison, Appendix A2 presents the MBTI distribution at some other colleges, that of the general US population and that of the professional engineers from the Atlas of Type tables produced by the Center for Applications of Psychological Types, the mainstay source in the MBTI literature.

Gender Difference

- MBTI profile- Along each of the four MBTI dimensions, the male distribution is skewed but the female distribution is not. For example, for males, the number of Extraverts: the number of Introverts is about 4:6 in both Class of 2002 and Class of 2003, but it is about1:1 for females. [Chapter 4]
- Academic Performance- Females outperform males academically at WPI- both in terms of grade point performance and in terms of graduation rates. This was already well known at WPI, but the possible connection to learning style distribution may be worth exploring. [Chapters 3 & 4]
- Major Choice- Certain majors appear to attract males while some attract females. This too is well known at WPI. [Chapters 3 & 4]

All results below are for males only.

Labeling Major by MBTI Type:

- Certain majors appear to attract certain MBTI types: [Chapter 5]
    - Management- Extravert.
    - Computer Science- Introvert
    - Physics-Introvert
    - Electrical and Computer Engineering- Judging
    - Chemical Engineering- Sensing

Dynamics in the Choice of Major:

- More than 30% of the graduating male students do so with a different major than what they had started out with. Much major changing occurs at WPI. [Chapter 6]
- Computer Science starts out as the most popular major among WPI's entering freshmen, but ultimately loses a large percentage of students to slip to the third position. On other hand, Management receives 20-30% of the students who

change major at WPI, and climbs up to be among the 5 most popular majors at WPI. [Chapters 3,4 & 9]

MBTI and Changing Majors:

- The E/I dimension is important. A much larger proportion of Extraverts appear to change major as compared to the proportion of Introverts changing majors. (However, the *number* of Introverts changing major is slightly more; there are many more Introverts at WPI than there are Extraverts.) [Chapter 6]
- A significantly large proportion of the Extraverts (E) who start out with Computer Science leave Computer Science. This is consistent with my finding that CS can be called an Introverted field. [Chapter 9]
- Management attracts a significantly large proportion of the Extraverts who do change major. [Chapter 9]

Changing Majors and Academic Performance through the lens of MBTI:

- Students who do not change major outperform those who do change major *in math and science courses taken their freshman year*. [Chapter 6]
- This is found to be true for the Intuitive (N) and the Perceiving (P) types at statistically significant level (alpha=0.1). This is true for the Extraverts at statistically significant level for the Class of 2002 but not for the Class of 2003. [Chapter 6]

I have formulated post- hoc hypothesis to explain this phenomenon for the Intuitive type, one of which is: Inability to understand how the basic mathematics and science courses fit into the bigger picture cause students who eventually change major to also perform inferiorly in math and science courses passed in freshman year. This lack of connection of the basic courses to the 'bigger picture' hurts the Intuitives (N) the most. [Chapter 6]

$9.2 Limitations

For each entering freshman, we know the major at the time of his entry into WPI and at the time of his graduation. Therefore, when I say that someone did not change major, I mean he/ she had the same major at these two times. However, the pool of such students may include a few who changed major but then switched back to their original major. I have noted this at several relevant places in this report, and have carefully considered it while drawing my conclusions.

I had grade data for only the freshman year. Therefore, I could not test my hypothesis concerning changing majors and academic performance through the lens of MBTI (Chapter 6).

For the Class of 2003, 2 students were coded as females in the data received from the WPI registrar, but coded as males in the MBTI data. I have treated them as females in my analysis. The registrar has agreed to classify their sex code before future analysis is done on the dataset.

$9.3 Future Directions

A couple of majors did not attract the same MBTI type in both Class of 2002 and in Class of 2003. An effort to try to isolate the cause for this should be undertaken. Did the students of a particular type perform poorly in a certain required course in a certain year, and thereafter switch to another major? To answer this, transcript data for all years and a term by term listing of academic majors would be required.

From this project, we know that MBTI type and major choice are related at WPI. What is the current scenario? Do we have the same major labels today as we did for the Class of 2002 and the Class of 2003? The analysis in Chapter 5 for labeling major by MBTI type should be repeated for the Classes of 2011, 2012 and 2013. This study would require collecting MBTI data from students entering in these classes at a cost of about $3000 ($ 5000 if the students receive feedback) per class year.

The dynamics of changing majors for the students who did not graduate from WPI should be studied. This requires data for all class years and periodic listing of majors.

The hypothesis proposed to explain the relation between major changing, academic performance and MBTI type should be tested, as per step outlined in Chapter 6. To do so, transcript data for all years and a periodic listing of academic majors is required. A study parallel to that of the males in Chapter 6 should also be performed for the females but using a pooled dataset of several years from the MBTI archive.

This project has demonstrated the connection between MBTI, academic performance and major changing for the first time. Moreover, it has demonstrated the nature of this connection, and how this connection is to be studied. I **strongly recommend** collecting MBTI data for the next three entering class years: the Class of 2011, the Class of 2012 and the Class of 2013, and following their academic progress and major changing over their undergraduate career. This study has the potential to be very revealing.

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APPENDICES

A1 MBTI Type of the National Population of USA[9]

Table A1.1 presents the MBTI type distribution of the national population of USA based on data collected by Brooke Warrick of SRI International during the summer of 1983. Subjects were 55% of 2000 in a random national sample of households with telephones in 300 counties across the United States. Half the sample was drawn from ten metropolitan areas.

Table A1.1 MBTI Type Distribution of the national population of USA

MBTI Type	Males (n=446)	Females (n=659)
E	36.32 %	43.25 %
S	72.87 %	78.00 %
T	74.66 %	33.99 %
J	69.73 %	63.73 %

Please note that x% E means x% E, (100-x)% I; x% S means x% S, (100-x)% S, and so on.

[9] This Appendix is based on CAPT-MBTI Atlas: Copyright 1986 Center for Applications of Psychological Type, Gainesville, Florida.

A2 MBTI Distribution (along N/S dimension) at Some Other Colleges and Universities

This appendix quotes the MBTI distribution along the S/N dimension in some other universities from the MBTI literature (Provost and Anchors; Myers). Please note that the distribution is found to be skewed towards the N at WPI.

Table A2.1 MBTI Distribution (along N/S dimension) at Some Other Colleges and Universities

University	Year	N	% S
Cal Tech	1958-1961	498	20%
Amherst	1963	242	27%
Cal Tech	1962	198	31%
Wesleyan	1963	232	33%
Stanford	1963	698	39%
Amherst	1962	242	40%
Brown	1962	575	42%
Dartmouth	1963	796	43%
Cornell (Engineering)	1964	483	44%
U. of Florida	1972	2514	45%
Hope College	1973-1975	1505	47%
Rollins College	1983	395	48%
Dartmouth	1961	653	52%
St. Louis University	1982-1985	1760	52%
Concordia College	1975-1981	1699	54%
U. of Maine	1981-1982	4035	55%
U. of Wisconsin at Stevens Point	1983	1195	56%
U. Of North Carolina at Greensboro	1976-1979	2492	57%
Auburn University	1975	10347	57%

Mercer University	1978-1981	1506	59%
Parks College (Aeronautics)	1982	405	59%
Adrian College	1978	198	64%
Berkshire Christian College	1974-1982	403	67%
St. Clair Community College	1977	1979	68%
Nicholls State University	1979-1980	4150	72%

A3 Summary of the Class of 2002 and 2003 datasets

Class of 2002

Total number of students= 650

Total number of students for whom freshman grades are available= 612

Sample Size= Total number of students whose MBTI types are known= 562 (86% of total students in the class) = 434 males + 128 females.

For the 562 students in the sample, freshman grades are known for 527 students= 407 males + 120 females.

Of the 562 students in the sample, number of students to graduate from WPI by the year 2004 is 446= 336 males + 110 females. I know the final major for these 446 students.

Class of 2003

Total number of students= 690

Total number of students for whom freshman grades are available=642

Sample Size= Total number of students whose MBTI types are known= 605 (87.7% of total number of students in the class).

For the 605 students in the sample, freshman grades are known for 587 students= 441 males + 146 females.

Of the 605 students in the sample, number of students to graduate from WPI by the year 2004 is 436 = 316 males +120 females. I know the final major for these 436 students.

A4 Definitions of Some Commonly Used Terms in this Report

Academic Performance: GPA of math and science courses passed in the freshman year at WPI

Class of 2002: Students who enter WPI as freshmen in the year 1998

Class of 2003: Students who enter WPI as freshmen in the year 1999

Freshman Major: The major at the *beginning* of the freshman year.

GPA: Grade Point Average computed using the artificial 0 to 3.0 scale (A=3.0, B= 2.0, C= 1.0, NR=0.0)

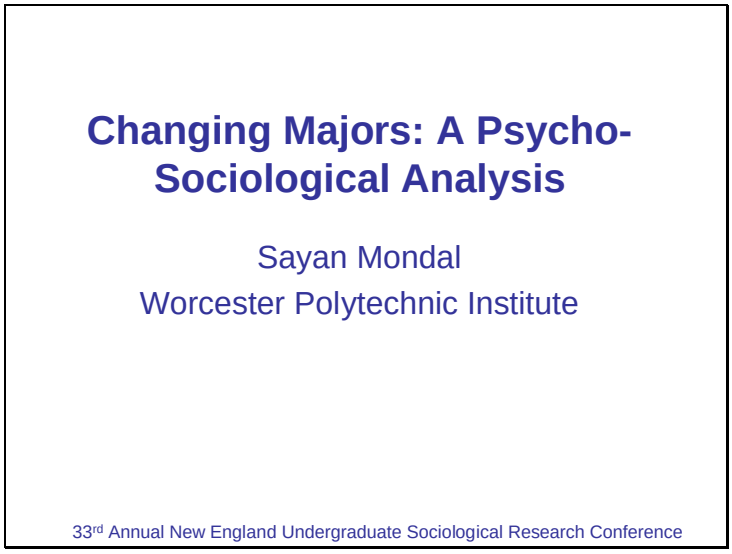
Group 1: Students who graduate with the same major as the one they had at the time of freshman orientation.

Group 2: Students who graduate with a different major than the one they had at the time of freshman orientation

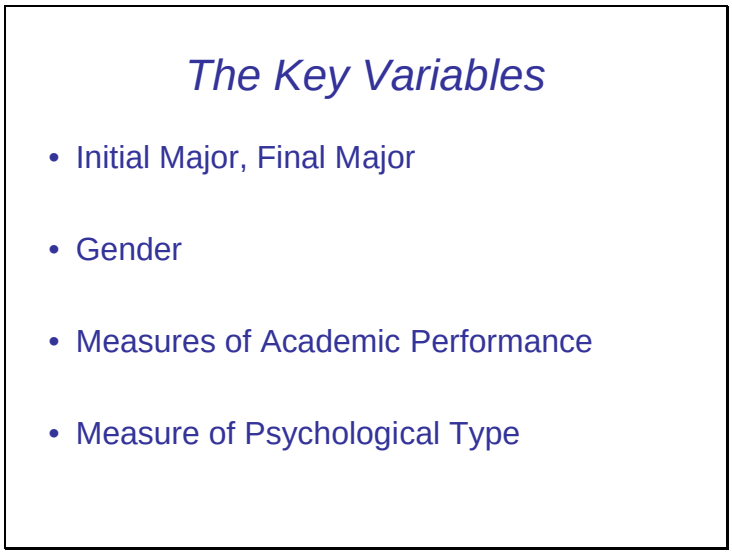
Group 3: Students who do not graduate from WPI by the year 2004.

A5 PowerPoint Slides of My Presentation at the 33rd Annual New England Undergraduate Sociological Research Conference

Slide 1



Slide 2



Slide 3

MBTI Type: Measure of Psychological Type*

- **Extravert (E) vs. Introvert (I)**

  Does the mind of a person get energized by interacting with the external world or the internal world?

- **Sensing (S) vs. Intuitive (N)**

  Prefer concrete details and specifics or interrelationships between objects and the bigger picture ?

- **Thinking (T) vs. Feeling (F)**

  Prefer to use impersonal logic or subjectively empathize with the different people concerned?

- **Judging (J) vs. Perceiving (P)**

  Prefer structured task- environment & planned approach or not?

* MBTI was authored in 1942 by Isabel Myers and Katherine Briggs, based on Jungian theory of typology

Slide 4

Datasets

WPI Class of 2002

Total Number of Students= 650

Sample= 562 (86%)

Sample is representative in terms of academic performance as measured by mean GPA of math and science courses passed in freshman year

Population: 1.87 (N=612), standard deviation= 0.59

Sample: 1.85 (N=527), standard deviation= 0.57

(Artificial scale: A= 3.0, B=2.0, C=1.0, NR=0.0)

Sample satisfies the K-S test for normality of the distribution of GPA of math & science courses passed in freshman year (p=0.002)

Slide 5

Datasets

WPI Class of 2003

Total Number of Students= 690

Sample= 605 (87.7%)

Sample is representative in terms of academic performance as measured by mean GPA of math and science courses passed in freshman year

Population: 1.90 (N=642), standard deviation= 0.56

Sample: 1.89 (N=587), standard deviation= 0.55

(Artificial scale: A= 3.0, B=2.0, C=1.0, NR=0.0)

Sample satisfies the K-S test for normality of the distribution of GPA of math & science courses passed in freshman year (p=0.001)

Slide 6

Findings

Slide 7

Striking Difference by Gender

Academic Performance

	Males	Females
GPA	1.84	1.90
Graduation Rate (%)*	77.4	85.9

Class of 2002

* In 6 years or less

	Males	Females
GPA	1.87	1.96
Graduation Rate (%)**	69.3	80.5

Class of 2003

** In 5 years or less

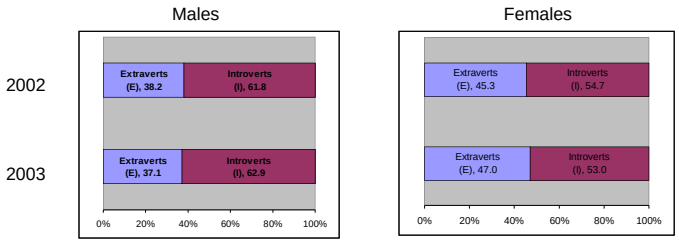
MBTI Type Distribution

In the Class of 2002, Introverts: Extraverts, Intuitives: Sensing, Thinking:Feeling, Judging:Perceiving =6:4 to 7:3 for males but 1:1 for females

This is found to be replicated in the Class of 2003

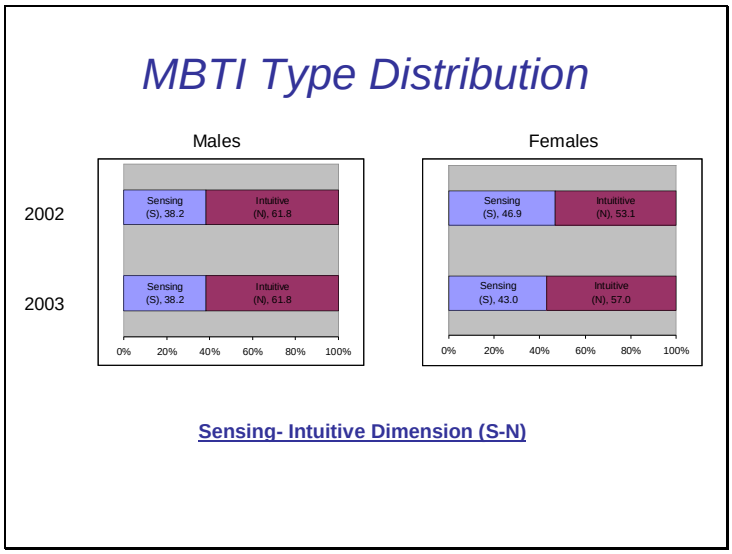
Slide 8

MBTI Type Distribution

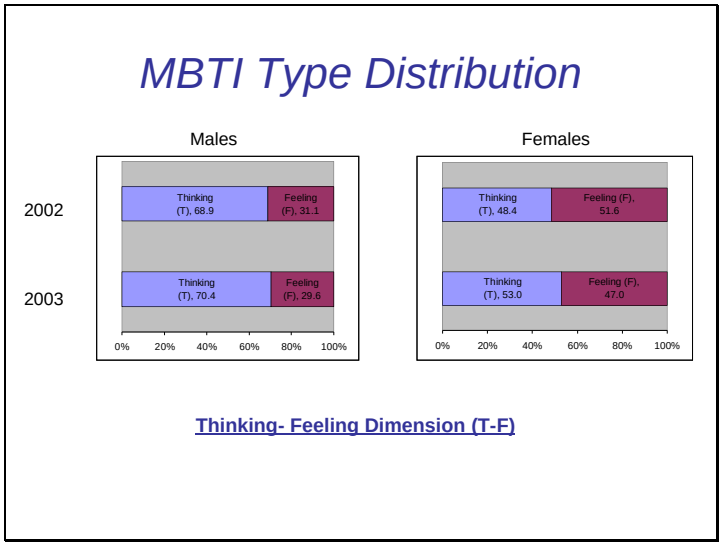


Extravert- Introvert Dimension (E- I)

Slide 9

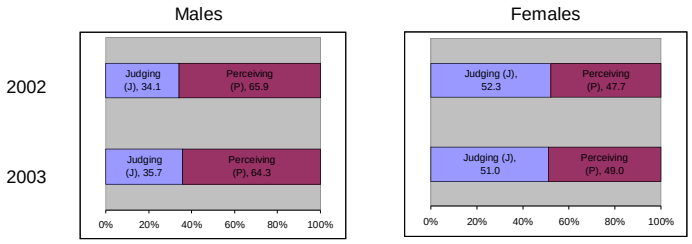


Slide 10



Slide 11

MBTI Type Distribution



Judging- Perceiving Dimension (J-P)

Slide 12

Conclusion I

- WPI appears to attract a certain MBTI Type distribution
- MBTI Type Distribution for Males vs. MBTI Type Distribution for Females
- Need to segregate the sample into male-only and female- only samples

Slide 13

The Next Question...

Do certain majors at WPI receive a percentage of students of a certain MBTI type that is significantly greater than the percentage of that type in WPI's undergraduate population?

Slide 14

Labeling Majors by MBTI Type

Table 5.5 Percentage of Extraverts (E) vs. percentage of Introverts (I) within each major in the graduating Males of the Class of 2003

Major	*No. of Students in the major*	*Extraverts (E)* %	*Introverts (I)* %
Biochemistry/ Chemistry	5	40.0	60.0
Biology/ Biotechnology	8	50.0	50.0
Biomedical Engg.	5	60	40
Chemical Engineering	17	23.5	76.5
Civil Engg.	22	31.8	68.2
Computer Science	**66**	**24.2**	**75.8**
Electrical & Computer Engg.	75	33.3	66.7
Mathematics	7	42.9	57.1
Management	29	65.5	34.5
Mechanical Engineering	73	39.7	60.3
Physics/ Engg. Physics	4	0	100.0
Others (Humanities, Social Sciences, IGSD)	5	20.0	80.0
Total	**316**	**35.8**	**64.2**

Slide 15

Labeling Majors by MBTI Type

- Computer Science- Introvert (I)

For each MBTI dimension, I cross- tabulated major with MBTI type: major vs. E/I, major vs. S/N, major vs. T/F, major vs. J/P for the Class of 2002 and the Class of 2003.
Based on that and chi- square tests, certain major- MBT type associations emerge.

Slide 16

Labeling Majors by MBTI Type

- Computer Science- Introvert (I)
- Chemical Engg.- Sensing (S)

Slide 17

Labeling Majors by MBTI Type

- Computer Science- Introvert (I)
- Chemical Engg.- Sensing (S)
- Electrical & Computer Engg.- Intuitive (N)

Slide 18

Labeling Majors by MBTI Type

- Computer Science- Introvert (I)
- Chemical Engg.- Sensing (S)
- Electrical & Computer Engg.- Intuitive (N)
- Management- Extravert (E)

Slide 19

Labeling Majors by MBTI Type

- Computer Science- Introvert (I)
- Chemical Engg.- Sensing (S)
- Electrical & Computer Engg.- Intuitive (N)
- Management- Extravert (E)
- Physics- Introvert (I)

Slide 20

Dynamics of Changing Majors

Slide 21

Class of 2002 Males

Freshman Major

Major	*Males (n=434)*
Computer Science	**28.4**
Mechanical Engineering	21.2
Electrical Engineering	20.8
Biology/Biotech	4.4
Chemical Engineering	5.8
Civil Engineering	5.8
Biomedical Engineering	2.5
Other/Und.	3.5
Biochemistry/ Chemistry	1.6
Physics	3.9
Mathematics/ Actuarial	0.9
Management	**1.2**
Total	100.0

Final Major

Major	*Males (n=336)*
Electrical Engineering	23.6
Mechanical Engineering	22.1
Computer Science	**18.8**
Biology/Biotech	5.7
Management	**9.9**
Civil Engineering	6.3
Chemical Engineering	4.8
Biomedical Engineering	2.1
Biochemistry/ Chemistry	1.5
Physics	2.7
Others	0.6
Mathematics	1.5
Actuarial	0.6
Total	100.0

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Class of 2003 Males

Freshman Major

Major	*Males (n=456)*
Computer Science	**30.0**
Mechanical Engineering	21.3
Electrical Engineering	18.9
Biology/ Biotech	4.4
Others/ Undecided	6.8
BME	3.9
Civil Engg.	3.9
Chemical Engg.	3.1
Chemistry/ Biochemistry	1.8
Physics	2.2
Mathematics	2.0
Management	**1.8**
Total	100.0

Final Major

Major	*Males (n=316)*
Mechanical Engineering	23.1
Electrical Engineering	23.7
Computer Science	**20.9**
Management	**9.2**
Biology/ Biotech	2.5
Civil Engineering	7.0
Chemical Engineering	5.4
Biomedical Engineering	1.6
Biochemistry/ Chemistry	1.6
Others (Humanities, SS etc)	1.6
Mathematics	2.2
Physics	1.3
Total	100.0

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Changing Majors: Major Trends

- Computer Science moves down from #1 to #3 spot.
- Management climbs up several spots
- EE and ME emerge as the two most popular majors at WPI

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The Message…

There is much changing of majors

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Changing Majors and Academic Performance

Group 1: Students who graduate with the same major that they started out with

Group 2: Students who graduate with a different major than they started out with

Group 3: Students who do not graduate (at least, from WPI and in 6 years or less)

These three groups are assumed to be simple probability samples, and independent

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Changing Majors and Academic Performance

Group 1: Students who graduate with the same major that they started out with

Group 2: Students who graduate with a different major than they started out with

Group 3: Students who do not graduate (at least, from WPI and by 2004)

	Mean GPA	*Standard Deviation*
Group 1 (N= 222)	1.96	0.602
Group 2 (N= 99)	1.81	0.522
Group 3 (N=86)	1.56	0.538
Total	1.84	0.590

2002 Males

	Mean GPA	*Standard Deviation*
Group 1 (N=184)	2.01	0.56
Group 2 (N=127)	1.89	0.55
Group 3 (N=130)	1.65	0.52
Total	1.87	0.56

2003 Males

Mean freshman science & math *GPA*:

group1>group2>group3

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Changing Majors and Academic Performance

T- test for equality of the mean GPA of Groups 1 and 2 shows statistically significant difference between Group 1 and Group 2 at alpha=0.05 level

2002: p=0.033 (2- tailed)

2003: p=0.055(2- tailed)

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Can MBTI Type help to understand this?

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Can MBTI Type help to understand this?

Is the freshman academic performance of Group 1 vs. Group 2 more marked for any particular MBTI type/s?

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Can MBTI Type help to understand this?

Is the freshman academic performance of Group 1 vs. Group 2 more marked for any particular MBTI type/s?

For each MBTI type, the T- test for equality of mean GPA (μ) is performed between Group 1 and Group 2

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Changing Majors, Academic Performance and MBTI Type

Comparing Freshman Academic Performance of Group 1 and Group 2 along the MBTI dimensions, Class of 2002 Males

MBTI Type	$\mu_{Group\ 1} - \mu_{Group2}$ *for GPA*	*P- value (2- tailed)*
Extravert	0.25	0.01
Introvert	0.065	0.5
Sensing	0.107	0.328
Intuitive	**0.168**	**0.057**
Thinking	0.13	0.14
Feeling	0.180	0.08
Judging	0.05	0.66
Perceiving	**0.209**	**0.018**

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Changing Majors, Academic Performance and MBTI Type

Comparing Freshman Academic Performance of Group 1 and Group 2 along the MBTI dimensions, Class of 2003 Males

MBTI Type	$\mu_{Group\ 1} - \mu_{Group2}$ *for GPA*	*P- value (2- tailed)*
Extravert	0.12	0.175
Introvert	0.095	0.27
Sensing	0.068	0.49
Intuitive	**0.169**	**0.046**
Thinking	0.12	0.125
Feeling	0.12	0.27
Judging	0.107	0.3
Perceiving	**0.139**	**0.085**

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Results

- Mean GPA: Group 1, Group 2 >> Group 3. Both inequalities are statistically significant.

- Mean GPA: Group1>Group2 and this is true for every MBTI type, and is statistically significant for the Intuitive (N) and the Perceiving (P) types.

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Suggested Post- Hoc Hypothesis

Students who eventually change major do not yet understand the "big picture".

Inability to understand how the basic mathematics and science courses fit into the bigger picture is responsible for students who eventually change major to also perform inferiorly in math and science courses they pass in their freshman year.

Not understanding the "big picture" hurts the Intuitives in particular, and therefore Group 2 intuitives perform much inferior as compared to the Group 1 Intuitives

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Prediction:

The Group 2 Intuitives will recover in academic performance after they change major for the final time.

Data Required:

Therefore, we need to track their major changes and academic performance in course of their undergraduate career, for which we need their periodic major listings and grade data for sophomore, junior and senior years.

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