THE PROFILE OF ENGINEERING STUDENTS

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ABSTRACT

As engineering plays a fundamental role in today's society, there has been a concomitant increase in the number of students looking for a career in engineering. Nevertheless, engineering has been strongly stereotyped. It is a common belief that to be a good engineering student someone has to enjoy mathematics and similar subjects. Others still try to impose a stereotypical behavior to people working in engineering, as if all of them are introverts, like to work alone and avoid interaction with other people. The result of this investigation can be used to determine the degree of satisfaction and motivation among engineering students, and help others to decide whether a career in engineering is the right path for them to pursue.

Keywords: *Myers-Briggs Type Indicator, MBTI, Engineering Education, Engineering Psychology, Human Factors in Engineering*

الملخص

بما ان الهندسة تلعب دورا" حيويا" في حياة اليوم , لذلك فإن أعداد الطلاب الراغبين في ممارسة هذه المهنة آخذة بالتزايد, ولكن على الرغم من ذلك فما زالت الصورة النمطية عن هذه المهنة قوية , فاالكثيرون ما زالوا يعتقدون بأن المهندس الجيد يجب ان يتمتع بقدارات عالية في الرياضيات و مواد أخرى شبيهة بها, آخرون لديهم فكرة أخرى و هي أن المهندسين انعزاليون لا يحبون الإختلاط بالآخرين و يحبون العمل لوحدهم.

هدف هذه الدراسة هو تحديد مدى رضا طلاب الهندسة و حماستهم لهذه المهنة , و ايضا" مساعدة الطلاب الآخرين في تحديد فيما إذا كانت الهندسة هي التخصص الأمثل لهم أم لا.

1. INTRODUCTION

A great deal of research has recently focused on improving engineering courses in North America and Europe. In the United States, over 85,000 students enter engineering programs as freshmen each year [Lashley, 1997]; unfortunately, fewer than half (47%) graduate as engineers [Astin, 1993]. It is reported in [Thomas *et al*., 2000] that, at Georgia Institute of Technology, the majority of this attrition occurs in the students' first two years, often before they have even begun taking classes in their major discipline. Similarly, Budny *et al*. [1997]

states that 36% of engineering majors at Purdue have left engineering by the third year. These findings support the basic premise that the majority of attrition in engineering education occurs quite early in the courses. Given the social and economic costs to students, parents, faculty, and administrators alike, this high attrition rate is alarming. Some faculties are greatly concerned about this waste of resources; others are more philosophical, seeing it as an inevitable by-product of the search for identity in young adults.

It is widely believed that high school grade point average, admissions test scores, and years of high school mathematics can predict success in engineering. However, many students who could make it on the bases of these criteria drop out or fail because of deficits in attention to detail, absence of systematic thinking or lack of motivation. Although many causes are plausible (e.g. social, financial, or health problem), this disillusionment with the field by the student is thought to be: (1) poor results in specific pre-engineering mathematics and science courses; (2) students see themselves as being incongruent with the prototypical engineers represented by their peers; (3) classroom performance problems due to the student inability to communicate and interact effectively with classmates, professors, or teaching assistant because of personality differences. Therefore psychological type theory can be used in an attempt to predict motivation and persistence in engineering courses. This work aims at establishing a profile of engineering students, which is particularly important in an area that outsiders and even insiders have wrongly stereotyped.

Psychological assessment instruments have been used for over sixty years and have reached a mature stage for job/career selection and for predicting behavior [Blatt, 1986]. The Swiss physician-psychologist Carl Jung had the insight that people could be identified by their different - and equally legitimate – preferences for functioning. Myers *et al*. [1998] had the vision to apply that knowledge, determining how people take in information, make decisions, and communicate thoughts and feelings. The MBTI (Myers-Briggs Type Indicator) is based on the Jung's theory that people with different personality profile organize information and perceive the world in different, but predictable ways. MBTI has been used for more than three decades to determine personality styles. Although neither this scheme nor any other yet developed is considered by all psychologists to be universally accepted, many educators and institutions are employing the MBTI inventory for a variety of purposes, including vocational counseling and career development.

As a starting point, it is useful to quickly introduce the four scales of the MBTI, as summarized below by Morrow [1997]. The Indicator establishes four parameters for assessing personality types. We all have personality qualities of each scale or parameter; we simply prefer some qualities or are more comfortable with some styles than others. In the MBTI, each scale is bimodal with the center point holding a zero value. Each respondent is forced to choose preferences; the higher the score on each preference, the stronger the preference is likely to be.

1.1. Extroversion and Introversion: E and I

The first scale represents complementary attitudes toward the external world. Where the extrovert prefers looking outward, the introvert looks inward. For example, the strong extroverts are sometimes said to "talk to think" whereas the introverts "think to talk". The implications of these terms go beyond the everyday caricatures of sociable versus shy. Extroverts are talkative, initiator of conversation and outgoing, they like action and variety. In contrast, introverts are quiet, respondent to conversation and reserved, they like silence and time to consider things.

1.2. Sensing and Intuition: S and N

The second scale of preference distinguishes the way we take in information from the environment. While a strong S might need to assimilate a whole series of facts in linear fashion, the person who prefers N can absorb the same information through abstraction and concepts that might not seem to be directly related in the first place, but that could establish a pattern. S dislikes new problems unless prior experience shows how to solve them; N likes solving new problems, and dislikes doing the same thing over and over again. The adjectives that describe a sensing person are realistic, practical, and fact-oriented; while the ones appropriate to an intuitive person are speculative, imaginative and principle-oriented. Of course, we all share both sets of qualities to some extent, but one set predominates.

1.3. Thinking and Feeling: T and F

The third mode of orientation in the MBTI classification are thinking and feeling; again these terms are more extensive than everyday usage would indicate. After information is gathered by, some decisions are made about how to process that information. This scale of preferences identifies thinking as the logical way of making a decision, while feeling describes the tendency to rely on values to make a decision. There is a gender difference in the general population regarding this scale, that is, the majority of women prefer F. Thinking people are principle-oriented, cool-headed and firm. Feeling people are emotion-oriented, warm-hearted and gentle.

1.4. Judging and Perceiving: J and P

The fourth scale differentiates between how we orient our lifestyles, and how we organize our world. J identifies the tendency to be super organized. If a deadline is to be met, the J person usually finishes the task well in advance. At the other extreme the person who prefers perceiving (P) appears to be very disorganized and seems to be distracted from completing a task until some little bell goes off at the last minute and tells this individual to get the task done. Often, it is said the easiest way to distinguish between these two preferences is to look at the person's desk. The desk of a J person is immaculately organized; the desk of a P individual appears to be in constant chaos even though the P person claims to know exactly

where everything is located and that there are rules underlying the chaos. The words deadlines, punctual, definite and routine apply to judging types; whereas open-ended, tentative, adaptable and spontaneous apply more to perceiving types.

Summarizing, the MBTI sorts these four sets of preferences (one from each pair) to filter out a person's preferred type. Hence, there are 16 possible configurations, as shown in Table 1, along with the percentage of type distribution of the U.S. adult population (Myers *et al*., 1998]. If the MBTI results show that a person is ISTP, then the terminology is to suggest that the person *prefers* ISTP, not that the person *is* an ISTP. No type is better than any other; the various types are gift differing. Of course, people can and do use all eight preferences in each of the four pairs; however, we all have one preference that is stronger than the other, one that works better for us than its complement.

Table 1. The 16 MBTI Types and their Distribution among the U.S. Adult Population

ISTJ	**ISFJ**	**INFJ**	**INTJ**
11.6%	**13.8%**	**1.5%**	**2.1%**
ISTP	**ISFP**	**INFP**	**INTP**
5.4%	**8.8%**	**4.4%**	**3.3%**
ESTP	**ESFP**	**ENFP**	**ENTP**
4.3%	**8.5%**	**8.1%**	**3.2%**
ESTJ	**ESFJ**	**ENFJ**	**ENTJ**
8.7%	**12.3%**	**2.5%**	**1.8%**

2. THE ENGINEERS

Many people outside the engineering area seem to have ideas and stereotypes about what engineers are like and what attract them to the engineering field. This research aims at comparing the type distribution of a sample of 1,252 engineering students to the general adult population. The type distribution for that engineering group, summarized in Table 2, is based on the type distribution of Canadian students successful in their first-year in engineering at the University of Western Ontario [Rosati, 1997]. The sample distribution is similar to other samples found for engineering majors at different universities across the United States and Canada.

Table 2. Type Distribution of Engineering Students
and SRTT Comparison with an Adult Population Sample
(N = 1252, += 1%, I=Selection Ratio Index "p<.05 #p<.01 *p<.001)

ISTJ **N=244** **19.5%** **I=1.69*** ++++++++++ ++++++++++	**ISFJ** **N=41** **3.3%** **I=0.24*** +++	**INFJ** **N=38** **3.0%** **I=2.08*** +++	**INTJ** **N=126** **10.1%** **I=4.88*** +++++++
ISTP **N=102** **8.2%** **I=1.51*** ++++++++	**ISFP** **N=36** **2.9%** **I=0.33*** +++	**INFP** **N=54** **4.3%** **I=0.98** ++++	**INTP** **N=124** **9.9%** **I=3.04*** +++++++++
ESTP **N=68** **5.4%** **I=1.27** +++++	**ESFP** **N=30** **2.4%** **I=0.28*** ++	**ENFP** **N=45** **3.6%** **I=0.45*** ++++	**ENTP** **N=85** **6.8%** **I=2.13*** +++++++
ESTJ **N=136** **10.9%** **I=1.25"** ++++++++++ +	**ESFJ** **N=31** **2.5%** **I=0.20*** +++	**ENFJ** **N=29** **2.3%** **I=0.94*** ++	**ENTJ** **N=63** **5.0%** **I=2.80*** +++++

In Table 2, the letter *I* refers to the ratio known as the self-selection index in the Selection Rate Type Table (SRTT). The ratio is computed based on the percentage of the observed frequency to the expected frequency. When the ratio is greater than 1.00, there are more people in that cell of the table than we expected from their numbers in the general population. If the ratio is less than 1.00, there are fewer people in that cell than expected in the general population. SRTT also indicates the statistical significance (p) of the results represented by a chi-square calculation whenever possible. A quick inspection of the sixteen types shows that all four NT types and all four ST types have indices greater than 1.00 showing the trend that NT and ST are over-represented among engineering students. On the other hand, all four SF

types have index much smaller than 1.00 confirming that SFs are under-represented among engineers.

Table 2 shows that ISTJ, ESTJ, INTJ and INTP compose over 50% of the sample, thus significantly over-represented; whereas ESFP, ESFJ and ENFJ are all particularly under-represented in that group. The study found more introverts (I=61%) than extroverts (E=39%) types; slightly more sensing (S=55%) than intuitive (S=45%); significantly more thinking (T=75%) than feeling (F=25%); and less perceiving (P=43%) compared to judgment (J=57%) type. It can be clearly seen that the sample contains more sensing (S), thinking (T) and judging (J) types than estimated to be in the general population.

It is worth noticing that there are more ISTJ (19%) and ESTJ (11%) than any other type (I ratio greater than 1.00), but most importantly, it can be clearly seen that the sample contains much more INTJ and INTP types than estimated to be present in the general population (I ratio greater than 3.00). It can also be noted that STs comprise almost 45% of the sample, and so do TJs, but SFs compose only 11% of the subjects. STs and TJs are abundant among engineering students, whereas SFs are scarce.

These findings will have profound implications on the work preferences for engineers. NTs are heavily represented in R&D organizations. In most companies NTs will be attracted to areas engaged in major design activities. Once all the conceptual work on a project has been done, however, many NTs prefer to start working on something new. They will usually try to avoid work that is similar to what they have already done. NTs always seem to be looking for new challenges, whereas STs are comfortable with applying previous experience in order to solve new problems, they are realistic, investigative, but conventional.

This is generally congruent with the type theory, as NTs are ingenious and logical people, they like using their abilities in abstract conceptualization. Power fascinates them, power to explain, to understand. Additionally, the combination of sensing and thinking (ST) makes up practical people who like using technical skills in applied sciences, production and construction. *Scratch a NT or a ST, you may find an engineer*.

In summary, the preferences and type distribution in Table 2 demonstrates that the type distribution of engineering students is different from the type distribution found in a general population, which confirms that the engineers form a particular group of professionals. It is clear that attraction to engineering courses and psychological types are clearly related, as suggested by this investigation.

3. DISCUSSION

Many people outside the engineering field seem to have ideas and stereotypes about what engineers are like and what attracts them to the field. It is generally accepted that individuals with similar interests and abilities tend to gravitate toward certain professions. Obviously, this may be the result of many factors. These factors may include, but are not limited to, such things as similar interests leading to similar choices of major, high school counselors' advising students to go into engineering only if they are of an "engineering type", or a relationship between interests and abilities such that students choose engineering because they perform well in mathematics in high school. Nonetheless, the current study demonstrates that, for whatever reasons, students attracted to engineering programs are a unique group of individuals.

The implications here are that the counselors steering non-prototypical types away from engineering may be providing a valuable service to some students. It seems that if individuals decide to enter engineering despite their lack of fit, they may be at risk for failure in one or more courses necessary for successful completion of their degree. However, it is also important to note that the field of engineering may benefit from diversity if counselors continue to send qualified non-prototypical types to engineering programs. The point is that counselors should recognize the fact that these non-prototypical individuals face a unique set of challenges and advise their students accordingly. With appropriate counseling, students make better career choices; they would be more motivated and productive in their professions, and engineering will gain by a better use of the wide diversity of people. A critical, but unanswered questions, is whether those who leave would or would not have been an asset to the complex profession of engineering.

A major assumption of the type theory is that when there is good match between a person's type preference and choice of a career, the work of that career will continue to be interesting and rewarding. Therefore, it becomes more critical and more complex for students entering university to know which career best fit them. Although it is true that engineering programs attract students of different psychological profiles. By assessing the aspect of personal satisfaction, MBTI can help students cope with possible frustration when they enter a university. As it has been known that all 16 types enter engineering, we can assume that somewhere in the complex activities of engineering, members of each type can find a niche for the best use of their gifts.

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