CHAPTER 13

PSYCHOLOGICAL TYPE AND LEARNING

How do individuals learn? What can teachers do to aid learning? Why do different teaching methods have different effects on individuals (or why doesn't everyone learn the same way I do?). Complete answers to these and related questions are not known despite years of intensive research; however, what is known can be helpful to professors in understanding the learning and teaching processes. Chapters 13 through 15 explore these questions and suggest ways of incorporating them in engineering education. Chapter 14 examines two theories of cognitive development, Piaget's and Perry's, and offers implications for engineering education. Piaget's theory leads to the learning theory known as constructivism, which is dealt with in Chapter 15, along with Kolb's learning cycle and, finally, motivation.

This chapter focuses on the natural differences among students that need to be considered in the planning of instruction and for handling interpersonal relationships. By accounting for such differences we can not only retain the students we have, but also attract the nontraditional groups that are underrepresented in engineering. As Sections 13.2 through 13.4 show, the personality instrument discussed in this chapter, the Myers-Briggs Type Indicator (MBTI), has proven to be a successful tool in engineering education for recognizing and accommodating these differences.

The essence of the theory behind the MBTI is that "much seemingly random variation in behavior is actually quite orderly and consistent, being due to basic differences in the way individuals prefer to use their perception and judgment" (Myers and McCaulley, 1985, p. 1). "Perception" refers to the ways that we process information or become aware of the world around us. "Judgment" has to do with the ways we make decisions on the basis of what has been perceived. These ideas are based on the theories of the Swiss psychologist Carl Jung (1971) and their application and extension by Katherine Briggs and Isabel Briggs Myers. The MBTI has been used in education and industry as well as career and marriage counseling to help identify personality types in order to improve communication and open the possibilities for learning. Such knowledge is very important for professors and beneficial for students.

An indicator, not a test, the MBTI is a self-reporting instrument which offers a forced-choice format between equally valuable alternatives. In answering the questions or responding to certain word-pairs, we can discover our preferred way of dealing with, and living in, the world. Intrinsic preferences, though possibly inborn, aren't always available to our conscious minds. The way we are raised and the situations we confront may force us to react in ways opposed to our inherent preferences. The MBTI allows us to arrive at a "reported" type and then examine the conclusion in light of our experiences, beliefs and feelings, all the time being free to accept or reject the result. Over the years, the MBTI has become the most widely used personality measure for non-psychiatric populations (Myers and Myers, 1980). What the MBTI does not do, however, is merely classify people. Type does not refer to something that is fixed, permanent. Each type has its own ways of reacting to situations, but no one is true to type all the time. As McCaulley et al. (1983) point out, good type development often involves responding in ways that one does not spontaneously prefer. "The word *type* as used here refers to a dynamic system with interacting parts and forces. The characteristics and attitudes that result from the interactions of these forces do differ, but the basic components are the same in every human being" (p. 397).

13.1. FROM JUNG TO THE MBTI

The seminal work on type theory was done by Carl Gustav Jung, the Swiss psychologist and contemporary of Sigmund Freud. His study P*sychological Types* was published in 1921 after almost twenty years' work in treating individuals and discussing problems and solutions with colleagues, as well as "from a critique of [his] own psychological peculiarity" (Jung, 1971, p. xi). In his difficult yet eminently readable book, Jung looks at the problem of type in the history of classical and medieval thought as well as in biography, poetry, philosophy, and psychopathology.

An excellent biography of Katherine Cook Briggs and her daughter, Isabel Briggs Myers, is Frances Saunders' book (1991); and *Gifts Differing* (Myers and Myers, 1980) gives an excellent discussion of their theory. Katherine Cook Briggs was a lifelong student of the differences among individuals and how they relate to the way in which one functions in the world. In part her interest in personal differences grew out of her desire to be a writer and create fictional characters, and for this reason she was particularly interested in Jung's treatment of biography in his book.

Discovering Jung's work in the English translation in 1923, Briggs is alleged to have said, "This is it" (Saunders, 1991, p. 59). Unfortunately, she was so impressed with Jung's work and terminology that she burned her own notes and adopted the latter's terminology. She shared this interest in personality with her daughter Isabel (later Isabel Briggs Myers) who continued studying type. With the onset of World War II, Myers desired "to do something that might help people understand each other and avoid destructive conflicts" (Lawrence, 1980). She decided to find a way to put the theory to practical use and from this came the idea for a "type indicator." Her first task was to develop an item pool that would reflect the feelings and attitudes of the differing personality types as she and her mother had come to understand them. The first

period of development involved item validation with friends and family and then collecting data on 5000 high school students and 5000 medical students. The second period began in 1956 when the Educational Testing Service (ETS) became the publisher. After the 1962 publication of the MBTI manual and form F, the popularity and use of the MBTI began to grow slowly. In 1975, Consulting Psychologists Press took over publication, and since then the use of the instrument has expanded greatly. It has now been translated into Japanese and Spanish, and is also being used in England and Australia. According to McCaulley (1976), the fact "that similar career choices by the same types occur in disparate cultures suggests that Jung's theory taps some fundamentally important human functions that cut across cultural teaching."

13.2. PSYCHOLOGICAL TYPE: ATTITUDES AND FUNCTIONS

In *Psychological Types,* Jung postulated that everyone has a basic orientation to the world which indicates the directions in which energies or interests flow: to the outer world of people and events (extroversion, E) or to the inner world of ideas (introversion, I). He referred to this as an attitude toward the world. Either type, in the conscious aspects of life, processes information either through the senses (S) or by intuition (N) and makes decisions on the basis of this information either by logical, impersonal analysis (thinking,T), or on the basis of personal, subjective values (feeling, F). Jung regarded both thinking and feeling to be rational processes and so the term "feeling" here does not carry the common connotations associated with emotions. As to why there are four functions (S, N, T, F), not more or less, Jung (1971, pp. 540–41) says he arrived at that number on purely empirical grounds. Through sensation we establish what is present, with its meaning determined through thinking. Feeling tells us its value, with possibilities delineated by intuition. The jungian dichotomies are as follows:

Direction of energy/interest:	E or I
Perceiving functions:	S or N
Judging (decision-making) functions:	T or F

To these three Jungian pairs, Katherine Briggs added a fourth: a judging (J) or perceptive (P) orientation to the world. In her research she discovered that individuals tend to function primarily in either the perceiving or the judging mode. That is, some people (P) like to gather more and more information and adapt to situations as they arise; others (J) prefer to lead a more structured, ordered existence, making lists, and trying to control events.

A person's preferences are indicated by these dichotomies, but each person is free to use sensing or intuition, and, similarly, thinking or feeling. As with handwriting, anyone can write a signature using either the left or the right hand; however, most have a preference for one over the other and tend to develop the skill in one more than in the other. The four dichotomies (EI, SN, TF, JP) can be arranged in a four by four table or matrix, giving sixteen personality types from interactions. Table 13-1 summarizes the attitudes and functions, and Figure 13-1 gives an example of the matrix, with breakdowns of percentages for engineering disciplines. Then

TABLE 13-1 THE FOUR MBTI PREFERENCES

Direction of energy or interests		
E	(Outer world of people)	Extroversion
I	(Inner world of ideas and actions)	Introversion
Preference of perception		
S	(Immediate and practical experience)	Sensing
N	(Possibilities and meanings of aspects of experiences)	Intuition
Preferences for decision making		
T	(Logical, objective)	Thinking
F	(Subjective, personal, value-based)	Feeling
Orientation to outside world		
J	(Ordered, planned)	Judgment
P	(Spontaneous, adaptive)	Perception

brief general characteristics of each type will be given (Myers and McCaulley, 1985; see also Singer, 1972). McCaulley, Macdaid, and Kainz (1985) discuss ways of estimating type frequencies among the general population.

Orientation to Life: Extroversion (E) and Introversion (I). The first pair, extroversion and introversion, focuses on how one approaches the world. Ever since Jung first posited these descriptors of behavior, the terms have become part of the language and as used here they carry the standard psychological connotations. The outer-directed extrovert enjoys social contact and depends on interaction with others for personal satisfaction. The inward-looking introvert, on the other hand, tends to withdraw from such interactions, preferring quiet for concentration rather than the quick action of the extrovert. The easy communication of the extrovert is a problem for the introvert, who, preferring ideas, may have trouble communicating. In problem-solving, the extrovert tends to place greater weight on the situation and other people's views, whereas the introvert tends to focus more on the conceptual framework of the problem (McCaulley, 1987). No one is purely extroverted or introverted, though some individuals clearly may represent extremes of each type. Instead, the terms refer to preferred orientations. Anyone can exhibit both introverted and extroverted behavior. For example, an introverted teacher may approach a class with some fretfulness, mustering up all of his or her energy to begin the class, but once settled into the course, may feel comfortable and act the complete extrovert—within the confines of the class. Yet, the preferred orientation is that of a cautious introvert. Each person carries the capability of developing both orientations but by preference

tends to develop one of them. The same is true of the other three function pairs. This is an important point to remember while reading about the MBTI. Myers and McCaulley (1985, p. 5) caution that the Indicator is no substitute for good judgment and that the proper way to use it is as a stimulus to the user's insight.

Extrovert (E). (roughly 70 percent of the general population; about 33 percent of the engineering student population)

- Likes people.
- Likes action.
- Acts quickly.
- Communicates easily.
- Is applications-oriented.
- Feels energized by interaction with others.

Introvert (I). (30 percent of the general population; about 67 percent of the engineering student population)

- Prefers quiet for concentration.
- Likes ideas and concepts.
- Has trouble communicating.
- Relies on inner illumination.
- Prefers to work alone and is energized by doing so.

Perception or Becoming Aware: Sensing (S) and Intuition (N). The second pair, sensing (S) and intuition (N), characterizes the perceptive function, or how one becomes aware of, or perceives, the world. The sensing person leans toward working with known facts rather than looking for possibilities and relationships as the intuitive person often prefers to do. He or she also tends toward step-by-step analysis and prefers to work by established methods. Intuitives favor inspiration and may work in bursts, quickly jumping to conclusions or solutions. Unlike sensing individuals, they are impatient with routine and may appear to be more imprecise. Using their imaginations, they see possibilities, whereas sensing individuals use their senses and work through the powers of observation. To a sensing type, soundness, common sense, and accuracy characterize real intelligence, which for an intuitive is shown by flashes of imagination and insight in grasping complexities. Attitudes characteristically developed from the preference for intuition include a reliance on sudden insight, an interest in the new, and a preference for learning through an intuitive grasp of meanings (McCaulley, 1978). A synopsis of the two types shows the following.

Sensing (S). (70 percent of the general population; 53 percent of engineering student population)

- Uses senses and powers of observation.
- Works through step-by-step analysis.
- Likes precision.
- Prefers established methods.
- Is patient with routine.
- Works steadily.

Intuition (N). (30 percent of the general population; 47 percent of the engineering student population)

- Is imaginative, sees possibilities.
- Relies on inspiration.
- May be imprecise.
- Jumps to solutions (is quick).
- Works in bursts.
- Dislikes routine.

Decision Making: Thinking (T) and Feeling (F). Once all the data are in, whether by sensing or by intuition, one must then decide how to process the information and come to a decision. A person who prefers to be logical and analytical, weighing facts impersonally and objectively, shows a preference for thinking (T) as the mode of decision making; someone who bases decisions on subjective, personal values and standards uses feeling (F). Both poles are accessible to everyone, and often most individuals move freely between them; however, each person has a preferred mode.

Thinking (T). (60 percent male/40 female in general population; 74 percent of engineering students: 77 percent male/61percent female)

- Is objectively analytical.
- Works through cause and effect.
- Tends to be logical.
- Tends to be tough-minded.
- Tends to be impartial.

Feeling (F). (40 percent male/60 percent female in general population; 26 percent of engineering students: 23 percent male and 39 percent female)

- Understands people.
- Desires harmony.
- Stresses interpersonal skills.

Living in the World: Judgment (J) and Perception (P). The fourth preference pair is used to identify the way an individual functions in the world. The previous sections considered the attitudes (E and I) and the functions (S, N, T, and F) which Jung used to categorize conscious mental processes. In an elaboration of Jung's ideas, Briggs and Myers added a further dimension: the attitude a person takes toward the world. This attitude is based on the person's relationship to or preference for the functions of perceiving and judging. An individual who prefers to use a perceiving function (S or N) to run his or her life tends toward being open to new perceptions, adapting to situations, and in general taking in information. This flexibility often leads to minimal planning and organization. For someone who uses a judging function (T or F) to conduct his or her outer life, the impetus is toward planning, organization, and closure. Thus, the JP preference indicates how an individual prefers to live in the outer world. If you are curious as to which of these applies to you, just think about the way you plan a vacation. Are you content to fly somewhere and then to take it from there, making plans as you go (P)? Or are you appalled by the thought of such a trip, preferring to schedule hotels, routes, stopovers, and so forth, well beforehand (J)? Do you find yourself taking in more and more information before finally writing that report—often at the eleventh hour (P)? Or do you plan it and work on it section by section, day by day (J)? As with all the pairs, both ways of living in the world are of course accessible to the individual. And even someone given to doing jobs at the last minute may find him- or herself having to be very much the schedule maker and planner in structuring family plans. So both choices are available. The dynamic interplay of all of the preferences (EI, SN, TF, JP) leads to sixteen combinations or types (see Figure 13-1).

Judging (J). (50 percent of the general population; 61 percent of engineering students)

- Prefers to live in a planned, orderly way.
- Likes to regulate and control events.

Perceptive (P). (50 percent of the general population; 39 percent of engineering students)

- Prefers to be flexible, spontaneous.
- Likes to understand and adapt to events.

Dominant and Auxiliary Processes. According to type theory, children are born with a predisposed preference for some functions over others (Myers and McCaulley, 1985). Lynch (1987) maintains that the dominant function is usually reflected by kindergarten age. In engineering terms, they are hardwired for a given type. This preference leads to fuller

development of the preferred function and greater competence in it. A preference for sensing, for example, leads to the development of characteristics commonly seen in a practical-minded sensing individual. At the same time, the opposite pole of the preference tends to be ignored; in the above example a sensing child gives less priority to intuition and thus develops along quite different lines from another child who prefers intuition. It is apparent then that environment ("software programming") plays a key role in one's development, either reinforcing or demotivating development along certain lines. This "falsification" of type can lead one to develop a less preferred function but overall still not feel in control or confident in his or her abilities. In good type development each person uses all four processes, but one process becomes the leading or dominant.

In the literature about type, the roles of the dominant and the auxiliary are often compared to those of a general and an aide. In an extrovert, the general (dominant function) is at the forefront making decisions and taking the lead, for all the world to see. As a result, we say that for an extrovert, "What you see is what you get." For an introvert, however, the aide (auxiliary function) stands as an intermediary with the outside world while the general makes plans inside a tent. The introvert, who focuses on the inner world, is difficult to know until one gets close enough to the individual. The dominant function remains hidden, which is why introverts are often misunderstood.

To see how the dominant and auxiliary functions are determined, consider an INFP and an ENFP. For the ENFP, the fourth pair (that is, the choice between judment and perception which indicates how the person lives in the world), here the P, indicates that this person prefers to conduct his or her outer life in the perceptive mode. So we only have to look back to the perceiving slot (the second letter, here N, intuition) to find the function used by this person in the outer world. If asked to characterize this individual's type, another person would see the intuitive aspects. Now, by definition, extroverts show the world their strongest function; therefore, the N in this case is the dominant function. For the ENFP the dominant is extroverted intuition; the auxiliary is a balancing introverted feeling (F) (introverted because the auxiliary always balances the dominant, which here is extroverted), with thinking as the third and sensing as the fourth or least developed. So for an ENFP:

Dominant:	N
Auxiliary:	F
Third:	T
Fourth:	S

For an INFP the P indicates the person extroverts his or her perceptive function. Thus a judging function is dominant since an introvert's strength is within. The other perceptive function is third, and the fourth, or least developed, function, is judging (T). Thus,

Dominant:	F	(introverted feeling)
Auxiliary:	N	(extroverted intuition—what world sees)
Third:	S	(sensing)
Fourth:	T	(thinking—least developed function)

These individuals trust introverted feeling the most and use it the most in directing their lives, with intuition in support of the thinking. To the world, they appear intuitive. Like most introverts they are easily misunderstood because their strength is inside, not as open to the world as the strength of an extrovert.

Good type development. Type development is seen as a lifelong process of increasing mastery or command over the functions of perception and judgment that one prefers, and corresponding but lesser development of the less interesting but essential processes. Myers and McCaulley summarize the process (1985):

- Development of excellence in the favorite, dominant process.
- Adequate but not equal development of the auxiliary for balance.
- Eventual admission of the least developed processes to conscious, purposeful use in the service of the dominant process, even though this use may require the dominant and auxiliary to temporarily relinquish control in consciousness so that the third or fourth function can become more conscious.
- Use of each of the functions for the tasks for which they are best fitted.

13.3. APPLICATIONS OF THE MBTI IN ENGINEERING EDUCATION

The differences described by type theory are familiar parts of everyday life, and so the theory can be used for a wide range of applications: education, counseling, career guidance, situations involving teamwork issues, and communication. Any university counseling or psychological center can provide the necessary testing services, or individuals can be certified through the training sessions such as those offered by the Association for Psychological Type (APT), the Center for Applications of Psychological Type (CAPT), or the Consulting Psychologists Press (see Section 13.6 for addresses). Thomas (1989) offers some preliminary results on "rapid MBTI self-classification."

Jensen and DiTiberio (1989) extensively examine its relevance in the teaching of writing. Provost and Anchors (1987) discuss the uses of the MBTI in higher education. McCaulley *et al.* (1983) consider the results of the ASEE-MBTI Engineering Consortium of eight universities (see Figure 13-1). Their results are summarized later in this section. In the MBTI manual Myers and McCaulley (1985) give numerous rankings of students and colleges by means of various preferences. Schurr, Ruble, and Henriksen (1989) look at the effects of different admissions practices on the MBTI and gender types. Several authors discuss the MBTI and problem solving, with McCaulley (1987) offering a jungian model. Yokomoto et al. (1987) discuss improvement of problem-solving performance and also consider student attitudes toward ethical dilemmas (1987). Three ethical dilemmas were presented to students, who were required to make a decision on what further action, if any, might be taken to resolve them. Analysis of the results showed several biases arising from personality differences, with feeling types recommending action more strongly than thinking types in one situation. Campbell and Kain (1990) investigated whether some types prefer certain forms of information presentation in problem solving. They found that the most time-efficient types (N and J) were also the least

accurate, similarly for NT's and NF's. S, P, SF, and ST types tended to be more accurate but took longer to achieve their accuracy. Campbell and Kain conclude that type plays a small role in a person's preference for presentation form, but a larger role in the accuracy and time efficiency of problem solving.

Teaching Methods. Lawrence (1984) synthesizes learning style research involving the MBTI. The MBTI can be used to develop teaching methods to meet the needs of different types, especially on the sensing-intuition dichotomy. As McCaulley (1987) points out, S and N types approach problems from opposite directions: S moves from the specific to the general; N from the "grand design to the details." She then makes a telling point: "In fields with relatively equal numbers of S and N students, such as engineering, the faculty have more of a challenge maintaining student interest than in fields, such as counseling, where students and faculty are more similar" (p. 47). Smith, Irey, and McCaulley (1973) found that personality traits influence student attitude and performance in self-paced instruction. They further note that a major weakness in college teaching appears to arise from a teacher's and student's lack of recognition of each other's differences, which gives rise to the need for different learning activities. Self-paced instruction, according to the authors, can be made more effective if instructional modules or packages are designed which fit different styles of student perception and judgment. Provost, Carson, and Beidler (1987) studied a sample of professor of the year finalists to see how outstanding teachers use their type preferences. This limited study doesn't conclude that most outstanding teachers will have a certain preference or be a certain type; however, it does show that type affects teaching style, assumptions one might make about teaching, and attitudes about what aspects of teaching are seen as rewarding. These teachers have been able to relate to other types and to appreciate the inherent diversity. From the students' standpoint, Rodman et al. (1985, 1986) looked at the self-perception of engineering students' preferred learning style and related it to the MBTI. Among other conclusions, their work shows that in engineering education major differences among types occur in the sensing and intuition classifications.

The sensing-intuition (SN) dichotomy is perhaps the most important one for an engineering educator, both from the standpoint of the instructor and from that of the students (especially as sensing relates to mastering a body of knowledge and the corresponding skills central to a field of practice). Intuition has to do with the ability to think complexly and contextually. The percentages of type in the general and university populations alone tell a significant tale. Sensing types predominate in the general population; intuitives, in a university environment. More college professors are intuitive types than sensing types, and they tend to write exams that more frequently fit their own type (Lynch, 1987). If memorization and recall are important, sensing and judging types will perform better; if hypothesizing and essay tests are required, intuitive students will have an advantage. Aptitude tests are also designed to measure knowledge in the domain of introverted intuitives (IN). The data show that introverts consistently score higher than extroverts on the SAT-Verbal. Intuitives also consistently score higher than sensing types. The sensing-intuition differences, according to Myers and McCaulley (1985), are greater than the extroversion-introversion differences.

In the classroom, the thinking-feeling (TF) preference appears to have less importance than the others, but it can be argued that a predominance of thinking types in a class could "freeze out" the few feeling types. Is it possible that feeling types self-select out of engineering

because of the more impersonal emphasis of the predominant thinking types in engineering? One colleague has suggested that it might be easier to teach ethics if students were more interested in human motivations (feeling types), rather than being concerned with building the best device (ST) or developing the most elegant theory (NT). Finally, it is important to remember that type theory does not make judgments on intelligence: All types can succeed in any area, and all types are represented in every area. What is important is that every type can learn to survive in the academic world. Paying attention to type differences and taking them into account in teaching goes a long way toward promoting such success. The fact that certain types predominate in certain careers says more about a type's attraction to the field than whether he or she will succeed in it. Once an individual has gotten past the educational barriers to a given field, being different from the prevailing type can be an advantage since he or she will see things that others miss.

Motivation. The MBTI can also be used to help students if the instructor understands the ways that different types are motivated. An instructor can help students gain control over their own learning and thereby reach more students. Even something as simple as a phrasing can be important. For example, feeling types respond better to a question that is phrased "How do you feel about . . . ?" whereas the thinking type prefers "What do you think . . . ?" Also, the quickness of the N types may discourage an S type, and in a classroom the quicker student is often more praised and honored; the "slower" student quickly forms an impression that he or she is lacking what the "best" students have. We use quotation marks to indicate that intelligence is not the consideration here. In the long run, the "slower" but more thorough and accurate S may be more correct and/or successful. And if not demotivated by the instructor, such a student may be a valuable addition to the class.

Curriculum and Materials. The MBTI can be used to analyze curricula, methods, media, and materials in light of the needs of different types. This should be done in conjunction with the other aspects of learning theories, such as that of Kolb (see Chapter 15). And it can be used to provide extracurricular activities that will meet the needs of all types

Interpersonal Relationships. The MBTI can also be used to help teachers and administrators work together more constructively. Type data from one sample show that administrators tend to be heavily J types [86 percent in Lawrence's (1984) sample]. As in other areas, such as personnel cases in industry, awareness of type differences can lead to a more harmonious working environment. On a personal level, knowledge of type can be very helpful in counseling (Provost and Anchors, 1987). Carey, Hamilton, and Shanklin (1985) use type theory to look at the relationship between communication style and roommate satisfaction. The differences between judging types and perceptive types can often lead to conflicts. What a perceptive sees as a strength in the desire to have complete information or knowledge before proceeding, a judging person often sees as procrastination. And what a judging type sees as decisive action, a perceptive may see as close-minded and precipative behavior. Differences on the extroversion-introversion and thinking-feeling dichotomies can also lead to problems. From type theory, interpersonal competence is related to extroversion and feeling (Myers and McCaulley, 1985). The focus of extroverts is on people and the external world; that of feeling types is on the effects of their actions and decisions on themselves and others.

In engineering, a great deal of work is done in teams. Clearly, it's important that the members work together harmoniously. A good preparation for this takes place in undergradu-

ate laboratories. Accounting for type differences and making students aware of each other's different strengths can go a long way toward easing the tension that arises when, say, a perceptive can't put an end to a literature search which his or her judging partner needs for the next day's oral report. Giving and receiving criticism in these situations can also depend on the individual's preferred way of functioning.

Student Retention. Retention and attrition are complex issues which every college or university must face. Godleski (1987) considers use of the MBTI to increase retention of underachieving college students. His preliminary results showed that there was no difference in extroversion or introversion, but a significantly larger number of sensing over intuitive types and perceptive over judging types who were in academic difficulty. Provost (1991) found type patterns among freshmen experiencing first-year difficulties, with analyses showing overrepresentation of TP combinations. Schurr and Ruble (1988) found that high school performance and the judging preference (J) were the best predictors of college performance. This report was a follow-up to their 1986 study which followed an entire entering college class. McCaulley (1976) describes a study at the Fenn College of Engineering at Cleveland State University comparing freshman who wanted to become engineers and seniors who successfully completed the program. The types in the four corners (the TJ or logical, decisive types) of Figure 13-1 increased their percentage from 45 percent as freshmen to 55 percent as seniors. The group showing the greatest loss, from 17.3 percent as freshmen to 9.2 percent as seniors, was the types sharing intuition and feeling (more frequently found in the behavioral sciences and communication). McCaulley offers some reasons for this pattern (p. 397):

1 People learn in different ways. If the faculty teaches one way, they will favor some types over others.

2 Faculty members serve as role models for students, but there appear to be no data to indicate that engineering faculty are appropriate models for engineers in industry. Students may not realize this.

3 Choice of textbooks (and programmed learning courses) can favor the learning pattern of some types and cause difficulties for others.

Staiger (1989) also uses type to identify subsets of electrical engineering students who need special attention from the point of view of retention and maintains that curriculum redesign should include teaching styles that will accommodate diverse learning styles, including guided design, cooperative learning, and developmental instruction. Kalsbeek (1987) offers a conceptual model for understanding student attrition. His comment offers an appropriate close to this section: By relating type data to student attrition, educators can consider how different types of students interact with types of academic environments and thereby respond appropriately to the challenges posed.

Distributions of Types in Engineering As Figure 13-1 indicates, all sixteen types are represented in all areas of engineering; however, even the quickest glance reveals that certain types self-select into and are retained very markedly in engineering. For example, the corners of the table are strongly over-represented—what has come to be called the "tough-minded"

FIGURE 13-1 DISTRIBUTION OF THE 16 MBTI TYPES AMONG ASEE-MBTI ENGINEERING STUDENTS (McCaulley, 1990) (© 1990, American Society for Engineering Education)

	ISTJ	ISFJ	INFJ	INTJ
Male	17.39	4.19	2.58	9.95
Female	12.22	6.48	3.53	7.07
Aerospace	20.18 +	4.39	3.51	20.18 +
Chemical	17.53	4.04	3.37	9.89
Civil	22.87 +	5.04	1.55	3.88
Computer	11.82	4.93	1.97	7.88
Electrical	19.10	3.64	2.33	12.54
Geological	10.78	2.94	4.90	11.27
Mechanical	16.80	4.44	1.93	10.62
Petroleum	16.30	3.26	0.54	7.07

	ISTP	ISFP	INFP	INTP
Male	6.83	2.45	3.90	9.24
Female	3.24	3.39	4.12	4.86
Aerospace	2.63	0.88	1.75	7.89
Chemical	5.17	1.35	4.49	7.64
Civil	5.81	4.65	2.33	4.65
Computer	3.94	1.48	6.40	6.90
Electrical	5.54	1.60	3.79	10.20
Geological	7.84	2.45	9.31	10.78
Mechanical	9.46	2.32	2.12	6.76
Petroleum	4.89	2.17	5.43	9.24

	ESTP	ESFP	ENFP	ENTP
Male	4.57	2.16	3.16	7.47
Female	2.21	3.24	6.48	7.22
Aerospace	0.88	1.75	3.51	6.14
Chemical	2.25	2.70	4.04	8.54
Civil	4.26	1.94	5.43	2.71
Computer	3.45	2.46	3.45	8.37
Electrical	3.79	1.75	2.04	5.83
Geological	2.45	0.98	2.94	11.76
Mechanical	5.02	2.32	1.54	6.37
Petroleum	6.52	2.17	6.52	7.61

	ESTJ	ESFJ	ENFJ	ENTJ
Male	12.56	2.80	1.71	9.05
Female	13.55	7.22	3.98	11.19
Aerospace	8.77	0.88	1.75	14.91
Chemical	11.01	3.37	1.57	13.03
Civil	20.93 +	3.88	2.71	7.36
Computer	16.26	7.88	1.97	10.84
Electrical	15.01	2.33	2.19	8.31
Geological	7.35	3.43	3.92	6.86
Mechanical	15.25	3.67	1.35	10.04
Petroleum	10.87	4.89	3.26	9.24

Note: Numbers preceding bar graphs represent the percent of the sample falling in that type. In bar graphs one inch represents 20% of sample. If percentage exceeds 20%, a + follows the bar.

TJ types; what is missing, relatively, is participation by the feeling types (the two inner columns in the type table). McCaulley (1990) raises the question "Are engineering schools preparing their students adequately for the 'people complexities' of the profession?" That feeling types are in such a minority may indicate that the answer is no. It is these groups which tend to drop or transfer out of engineering. One speculation worth exploring is whether underrepresented groups in engineering, such as minorities and women, tend to fall into type categories that are only slightly present in Figure 13-1. If it is true, as the data to date indicate, that women classify more as being F than T, it could be that they view the heavy T orientation of engineering as cold and unfriendly. If the ranks of engineering are to be filled in the future, and clearly the standard pool of potential engineering candidates of the past is dwindling, it is these groups that educators will have to look to and encourage.

The report of McCaulley *et al.* (1983) with the ASEE-MBTI Engineering Consortium provides data showing the breakdown of engineering students by type preference. Among their results were the following.

1 Engineering students markedly prefer thinking (74 percent) and judging (61 percent), with the stereotypical engineer falling into the TJ group. In the consortium data, this group accounted for almost half of the sample (males, 49 percent; females, 44 percent; with the males more often introverted, 56 percent). One would expect all majors to have the same proportion of each type (with 25 percent in each group if the distribution was equal); the fact that the opposite is true gives evidence to the usefulness of the theory.

2 Engineering students differ from other college students. Compared with a sample group of college freshmen, engineering students are more often introvert, thinking, and judging types. Only on the SN scale were they similar to their peers.

3 Male engineering students differ in type from female engineering students. In engineering, 77 percent of the males were T, whereas 61 percent of the females were T. The proportions of S and N were about the same.

4 Engineering disciplines attract different types of students. Figure 13-1 bears this out as well. The fields with the highest proportion of extroverts were industrial (56 percent), computer (55 percent), petroleum (51 percent) and mineral (51 percent). Introverts were more frequent in aerospace (61 percent), geological (60 percent) and electrical (59 percent) engineering. The fields with the highest proportion of the practical sensing types were civil (69 percent), industrial (61 percent), mechanical (61 percent), and mining (60 percent). Intuitives were frequent in geological (62 percent), aerospace (60 percent) and metallurgical (54 percent). As noted above, all fields had a majority of T types, with the highest proportions in aerospace (82 percent), electrical (80 percent), mechanical (80 percent) and physics (76 percent). The fields with the lowest proportion of T types were undecided students (68 percent), geological (69 percent), computer (69 percent) and general (70 percent) engineering.

5 All types survived to year two, but atypical types had lower retention rates. Judging types were slightly, but significantly, more likely to be retained (entering students were 63 percent J, retained were 65 percent J, $p < 0.01$). The practical SJ types were 34 percent of entering students but were 40 percent of those remaining. Note that there were no differences in retention between male and female, and feeling types were as likely to persist as their more analytical T counterparts.

Implications of consortium study The implications drawn from the consortium study merit serious consideration (McCaulley *et al.*, 1983).

1 Clearly, and one might say expectedly, many logical, analytical, and decisive types of students are drawn to engineering; however, overemphasis on these characteristics tends to result in an underemphasis on skills related to listening, understanding, and getting things done through people. Since a great part of engineering work depends on communication and teamwork, it is important that faculty stress the importance of these skills and even teach them specifically (which of course will be appreciated by the extroverted, feeling, and intuitive types).

2 Less typical engineering students, extroverts and feeling types, learn better if given frequent feedback and appreciation; unfortunately, the types which are attracted to the field are the least likely to give such feedback. So it is up to the faculty to teach and model such behavior, which in turn will encourage students to do the same in their own work. Type knowledge can also help in identifying behavioral patterns and needs that may be beneficial in advising students (see also Lynch, 1987).

3 Since the numbers of sensing (S) and intuitive (N) types are roughly equal, the implication, though debatable, is that half of the students learn best deductively, and about half, inductively. The sensing types benefit from clear instructions, starting with their practical experiences, and with new material presented with a step-by-step approach. Intuitives, on the other hand, prefer theoretical principles first, followed by mastery of details through problem solving. In order to reach the greatest number of students effectively, instructors must keep these differences in mind. Tests and other measures of evaluation should also be varied so that different types are given a fair chance.

13.4. DIFFICULTIES WITH PSYCHOLOGICAL TESTING

The MBTI is prone to the same kinds of problems that plague any psychological test:

1 A student may not understand a question because of phrasing or vocabulary. Though not likely applicable for an engineering student population, the MBTI requires at least eighth grade language skills (for children, the Murphy-Meisgeier Type Indicator is used for grades two through eight).

2 The wrong box may accidentally be marked.

3 Students may mark what they feel they "ought" to think or may try to "psych-out" the tester. Unconscious biases may also affect the results (Hammer, 1985).

4 Current environmental stress may change one's answers temporarily.

5 Results may be misinterpreted. With the MBTI a little learning can be a dangerous thing, for it's easy to turn the occasion into a parlor game and make it little more than a horoscope reading. Accurate interpretation is assured if a qualified tester is present such as a psycholo-

gist, a counselor, or someone certified to administer the MBTI.

6 Reliability. The MBTI is reliable, but people can change. Times of stress may lead to differing results, and over a period of years growth may be reflected in a change of type. However, such changes are expected and predicted within type theory. For example, as one enters middle age, it's common for compensatory development to occur in the less preferred functions (Myers and McCaulley, 1985). Although one's type doesn't change, the way it is experienced and reported may change and give different MBTI results. Seventy-five percent of people who have retaken the MBTI after one to six years have not changed or have done so in only one category. More information can be found in the reliability studies reported in Chapter 10 of the manual by Myers and McCaulley (1985). Hammer and Yeakley (1987) conducted a study to investigate the relationship between "true" type and reported type.

7 Validity. The MBTI has good face validity. The results seem true to the test taker. Does the MBTI measure what it is trying to measure? This is a problem with all psychological tests: What they try to measure is usually based on a psychological theory. Thus, is the underlying theory valid? If it is, does the test accurately measure this? Chapter 11 in the manual discusses more than 100 studies relating to validity. There is also high face validity when one person types another person whom they know well (Carlson, 1989).

13.5. CONCLUSIONS

The Myers-Briggs Type Indicator offers engineering educators a workable instrument with which to meet the changing needs of engineering education. Measuring preferences as indicated by the students themselves, it is not meant to measure the strength of a trait, as other psychological instruments do. Consequently, it is fairly simple to implement and interpret without requiring a staff psychologist within an engineering department. Attention to differences also makes tremendous common sense as the diverse needs of a new population of students must be met before they can succeed in engineering. We can increase participation in the field as well as increase productivity. Quite possibly, as McCaulley (1990) points out, use of the indicator may help move students toward greater maturity of cognitive development in Perry's model (see Chapter 14). Finally, to stress that engineering educators must acknowledge that students learn differently, Staiger (1989) concludes: "It would help to have the phrase 'equal opportunity for learning' included in all university admission statements as a constant reminder" (p. 143).

13.6. CHAPTER COMMENTS

There is much to consider in the areas of student types, development, and learning theory. And all interact, thereby further complicating an already difficult equation. In such a complex area, each theory looks only at a small part. The Myers-Briggs Type Indicator offers an

excellent starting point for looking at the differences between and among students. More information on the MBTI can be obtained through the organizations primarily involved in its development and dissemination.

Association for Psychological Type
9140 Ward Parkway
Kansas City, MO 64114
Center for Applications of Psychological Type
2720 N.W. 6th St.
Gainesville, FL 32609
Consulting Psychologists Press
3803 East Bayshore Road
P.O. Box 10096
Palo Alto, CA 94303

13.7. SUMMARY AND OBJECTIVES

After reading this chapter you should be able meet the following objectives.

1 Describe briefly the background of the Myers-Briggs Type Indicator and its development from the ideas of Carl Jung.

2 Discuss the attitudes and functions of conscious thought and how the four preferences interrelate to form the matrix of sixteen personality types.

3 Consider your own preferences in terms of the descriptions for each attitude and function, arriving at a rough estimate of your own type.

4 Explain the importance of considering type differences among engineering students in the development of instructional materials, tests, and evaluations.

HOMEWORK

1 Consider the process of selecting an adviser for graduate work.
a How close a match between student and adviser is necessary?
b Which are more important: EI, SN, TF, JP?
c How can you figure out the professor's type?

2 Think back to your undergraduate courses. Recall a particular teacher who wasn't fully effective because of a preference for one type over another in his or her approach to teaching. What could this person have done to improve his or her teaching?

3 Determine the dominant, auxiliary, third, and fourth functions for the following types:
a ESFJ
b ISFJ

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APPENDIX 13A. MBTI MODEL FOR PROBLEM SOLVING

The goals in using the MBTI model of problem solving are to improve the problem solving skills of students and to help them gain respect for others whose minds work differently from their own. The following is a brief and simplified overview of Myers' problem-solving model (Myers, 1991; McCaulley, 1987).

The strategy is to use one process at a time and to use it in its own area. Don't, for example, use sensing for seeking new possibilities or feeling to analyze an equipment problem.

1 Use sensing (**S**) to face the facts, to be realistic, to find what the situation is, to see your actions, and to see other people's actions. Do not let wishful thinking or sentiment blind you to the realities.

2 Use intuition (**N**) to discover all the possibilities, to see how you might change the situation, to see how you might handle the situation differently, and to see how other people's attitudes might change. Try not to assume that you have been doing the only obviously right thing.

3 Use thinking (**T**) to make an impersonal analysis of the problem; to look at causes and their effects; to look at all the consequences, both pleasant and unpleasant; to count the full costs of possible solutions; and to examine misgivings you may have been suppressing because of your loyalties to others or because you don't like to admit you may have been wrong.

4 Use feeling (F) to weigh how deeply you care about what your choice will gain or lose; to put more weight on permanent than on temporary effects, even if the temporary effects are more attractive right now; to consider how other people will feel, even if you think they are unreasonable; and to weigh other people's feelings and your own feelings in deciding which solution will work.

It is likely, and natural, that the individual will choose a solution that appeals to his or her favorite process, but such a solution will be more effective or successful if the facts, possibilities, consequences, and human values are considered. What can go wrong if any of these are ignored? Intuitives may base a decision on some possibility without discovering facts which may preclude the conclusion. Sensing types may settle for a faulty solution because they assume none better is possible. Thinking types may ignore human values. Feeling types may ignore consequences. Thus, what can make the process difficult is that the problem solver is asked to use strengths opposite to his or her own.

Using the attitudes:

1 Use extroversion (**E**) to see events in the environment that may influence the problem, to seek people who may have information about the problem, and to talk out loud about the problem as a way of clarifying the ideas.

2 Use introversion (**I**) to consider ideas that may have a bearing on the problem, to look for deeper truths that may be obscured by current fads, to take time to think alone deeply about the problem.

3 Use judgment (**J**) to stay on track and not be diverted, to plan ahead, and to push yourself and others toward a solution.

4 Use perception (**P**) to ensure that you have looked at all aspects of the problem, to keep your eyes open to new developments, and to avoid jumping to conclusions before all the facts are in.

The differences described by type theory are familiar parts of everyday life, and so the theory can be used for a wide range of applications: education, counseling, career guidance, situations involving teamwork issues, and communication.

. Three ethical dilemmas were presented to students, who were required to make a decision on what further action, if any, might be taken to resolve them. Analysis of the results showed several biases arising from personality differences, with feeling types recommending action more strongly than thinking types in one situation. Campbell and Kain (1990) investigated whether some types prefer certain forms of information presentation in problem solving. They found that the most time-efficient types (N and J) were also the least

accurate, similarly for NT's and NF's. S, P, SF, and ST types tended to be more accurate but took longer to achieve their accuracy. Campbell and Kain conclude that type plays a small role in a person's preference for presentation form, but a larger role in the accuracy and time efficiency of problem solving.

Teaching Methods. The MBTI can be used to develop teaching methods to meet the needs of different types, especially on the sensing-intuition dichotomy. **S and N types approach problems from opposite directions: S moves from the specific to the general; N from the "grand design to the details." "In fields with relatively equal numbers of S and N students, such as engineering, the faculty have more of a challenge maintaining student interest than in fields, such as counseling, where students and faculty are more similar"** (p. 47). Personality traits influence student attitude and performance in self-paced instruction. A major weakness in college teaching appears to arise from a teacher's and student's lack of recognition of each other's differences, which gives rise to the need for different learning activities. Self-paced instruction can be made more effective if instructional modules or packages are designed which fit different styles of student perception and judgment. Provost, Carson, and Beidler (1987) studied a sample of professor of the year finalists to see how outstanding teachers use their type preferences. This limited study doesn't conclude that most outstanding teachers will have a certain preference or be a certain type; however, it does show that type affects teaching style, assumptions one might make about teaching, and attitudes about what aspects of teaching are seen as rewarding. These teachers have been able to relate to other types and to appreciate the inherent diversity. From the students' standpoint, Rodman et al. (1985, 1986) looked at the self-perception of engineering students' preferred learning style and related it to the MBTI. Among other conclusions, their work shows that in engineering education major differences among types occur in the sensing and intuition classifications.

The sensing-intuition (SN) dichotomy is perhaps the most important one for an engineering educator, both from the standpoint of the instructor and from that of the students (especially as sensing relates to mastering a body of knowledge and the corresponding skills central to a field of practice). Intuition has to do with the ability to think complexly and contextually. The percentages of type in the general and university populations alone tell a significant tale. Sensing types predominate in the general population; intuitives, in a university environment. More college professors are intuitive types than sensing types, and they tend to write exams that more frequently fit their own type (Lynch, 1987). If memorization and recall are important, sensing and judging types will perform better; if hypothesizing and essay tests are required, intuitive students will have an advantage. Aptitude tests are also designed to measure knowledge in the domain of introverted intuitives (IN). The data show that introverts consistently score higher than extroverts on the SAT-Verbal. Intuitives also consistently score higher than sensing types. The sensing-intuition differences, according to Myers and McCaulley (1985), are greater than the extroversion-introversion differences.

In the classroom, the thinking-feeling (TF) preference appears to have less importance than the others, but it can be argued that a predominance of thinking types in a

because of the more impersonal emphasis of the predominant thinking types in engineering? One colleague has suggested that it might be easier to teach ethics if students were more interested in human motivations (feeling types), rather than being concerned with building the best device (ST) or developing the most elegant theory (NT). Finally, it is important to remember that type theory does not make judgments on intelligence: All types can succeed in any area, and all types are represented in every area. What is important is that every type can learn to survive in the academic world. Paying attention to type differences and taking them into account in teaching goes a long way toward promoting such success. The fact that certain types predominate in certain careers says more about a type's attraction to the field than whether he or she will succeed in it. Once an individual has gotten past the educational barriers to a given field, being different from the prevailing type can be an advantage since he or she will see things that others miss.

Motivation. The MBTI can also be used to help students if the instructor understands the ways that different types are motivated. An instructor can help students gain control over their own learning and thereby reach more students. Even something as simple as a phrasing can be important. For example, feeling types respond better to a question that is phrased "How do you feel about . . . ?" whereas the thinking type prefers "What do you think . . . ?" Also, the quickness of the N types may discourage an S type, and in a classroom the quicker student is often more praised and honored; the "slower" student quickly forms an impression that he or she is lacking what the "best" students have. We use quotation marks to indicate that intelligence is not the consideration here. In the long run, the "slower" but more thorough and accurate S may be more correct and/or successful. And if not demotivated by the instructor, such a student may be a valuable addition to the class.

Curriculum and Materials. The MBTI can be used to analyze curricula, methods, media, and materials in light of the needs of different types. This should be done in conjunction with the other aspects of learning theories, such as that of Kolb (see Chapter 15). And it can be used to provide extracurricular activities that will meet the needs of all types

Interpersonal Relationships. The MBTI can also be used to help teachers and administrators work together more constructively. Type data from one sample show that administrators tend to be heavily J types [86 percent in Lawrence's (1984) sample]. As in other areas, such as personnel cases in industry, awareness of type differences can lead to a more harmonious working environment. On a personal level, knowledge of type can be very helpful in counseling (Provost and Anchors, 1987). Carey, Hamilton, and Shanklin (1985) use type theory to look at the relationship between communication style and roommate satisfaction. The differences between judging types and perceptive types can often lead to conflicts. What a perceptive sees as a strength in the desire to have complete information or knowledge before proceeding, a judging person often sees as procrastination. And what a judging type sees as decisive action, a perceptive may see as close-minded and precipative behavior. Differences on the extroversion-introversion and thinking-feeling dichotomies can also lead to problems. From type theory, interpersonal competence is related to extroversion and feeling (Myers and McCaulley, 1985). The focus of extroverts is on people and the external world; that of feeling types is on the effects of their actions and decisions on themselves and others.

In engineering, a great deal of work is done in teams. Clearly, it's important that the members work together harmoniously. A good preparation for this takes place in undergradu

ate laboratories. Accounting for type differences and making students aware of each other's different strengths can go a long way toward easing the tension that arises when, say, a perceptive can't put an end to a literature search which his or her judging partner needs for the next day's oral report. Giving and receiving criticism in these situations can also depend on the individual's preferred way of functioning.

Student Retention. Retention and attrition are complex issues which every college or university must face. Godleski (1987) considers use of the MBTI to increase retention of underachieving college students. His preliminary results showed that there was no difference in extroversion or introversion, but a significantly larger number of sensing over intuitive types and perceptive over judging types who were in academic difficulty. Provost (1991) found type patterns among freshmen experiencing first-year difficulties, with analyses showing overrepresentation of TP combinations. Schurr and Ruble (1988) found that high school performance and the judging preference (J) were the best predictors of college performance. This report was a follow-up to their 1986 study which followed an entire entering college class. McCaulley (1976) describes a study at the Fenn College of Engineering at Cleveland State University comparing freshman who wanted to become engineers and seniors who successfully completed the program. The types in the four corners (the TJ or logical, decisive types) of Figure 13-1 increased their percentage from 45 percent as freshmen to 55 percent as seniors. The group showing the greatest loss, from 17.3 percent as freshmen to 9.2 percent as seniors, was the types sharing intuition and feeling (more frequently found in the behavioral sciences and communication). McCaulley offers some reasons for this pattern (p. 397):

1 People learn in different ways. If the faculty teaches one way, they will favor some types over others.

2 Faculty members serve as role models for students, but there appear to be no data to indicate that engineering faculty are appropriate models for engineers in industry. Students may not realize this.

3 Choice of textbooks (and programmed learning courses) can favor the learning pattern of some types and cause difficulties for others.

Staiger (1989) also uses type to identify subsets of electrical engineering students who need special attention from the point of view of retention and maintains that curriculum redesign should include teaching styles that will accommodate diverse learning styles, including guided design, cooperative learning, and developmental instruction. Kalsbeek (1987) offers a conceptual model for understanding student attrition. His comment offers an appropriate close to this section: By relating type data to student attrition, educators can consider how different types of students interact with types of academic environments and thereby respond appropriately to the challenges posed.

ASEE-MBTI Engineering Consortium Study*

The ASEE-MBTI Engineering Consortium data show the breakdown of engineering students by type preference. Among the results were the following.

1 Engineering students markedly prefer thinking (74 percent) and judging (61 percent), with the stereotypical engineer falling into the TJ group. In the consortium data, this group accounted for almost half of the sample (males, 49 percent; females, 44 percent; with the males more often introverted, 56 percent). One would expect all majors to have the same proportion of each type (with 25 percent in each group if the distribution was equal); the fact that the opposite is true gives evidence to the usefulness of the theory.

2 Engineering students differ from other college students. Compared with a sample group of college freshmen, engineering students are more often introvert, thinking, and judging types. Only on the SN scale were they similar to their peers.

3 Male engineering students differ in type from female engineering students. In engineering, 77 percent of the males were T, whereas 61 percent of the females were T. The proportions of S and N were about the same.

4 Engineering disciplines attract different types of students. Figure 13-1 bears this out as well. The fields with the highest proportion of extroverts were industrial (56 percent), computer (55 percent), petroleum (51 percent) and mineral (51 percent). Introverts were more frequent in aerospace (61 percent), geological (60 percent) and electrical (59 percent) engineering. The fields with the highest proportion of the practical sensing types were civil (69 percent), industrial (61 percent), mechanical (61 percent), and mining (60 percent). Intuitives were frequent in geological (62 percent), aerospace (60 percent) and metallurgical (54 percent). As noted above, all fields had a majority of T types, with the highest proportions in aerospace (82 percent), electrical (80 percent), mechanical (80 percent) and physics (76 percent). The fields with the lowest proportion of T types were undecided students (68 percent), geological (69 percent), computer (69 percent) and general (70 percent) engineering.

5 All types survived to year two, but atypical types had lower retention rates. Judging types were slightly, but significantly, more likely to be retained (entering students were 63 percent J, retained were 65 percent J, $p < 0.01$). The practical SJ types were 34 percent of entering students but were 40 percent of those remaining. Note that there were no differences in retention between male and female, and feeling types were as likely to persist as their more analytical T counterparts.

*McCaulley, M.H., Godleski, E.S., Yokomoto, C.F., Harrisberger, L., and Sloan, E.D., "Applications of psychological type in engineering education," *Engineering Education*, 394 (Feb. 1983).

Implications of consortium study The implications drawn from the consortium study merit serious consideration (McCaulley *et al*., 1983).

1 Clearly, and one might say expectedly, many logical, analytical, and decisive types of students are drawn to engineering; however, overemphasis on these characteristics tends to result in an underemphasis on skills related to listening, understanding, and getting things done through people. Since a great part of engineering work depends on communication and teamwork, it is important that faculty stress the importance of these skills and even teach them specifically (which of course will be appreciated by the extroverted, feeling, and intuitive types).

2 Less typical engineering students, extroverts and feeling types, learn better if given frequent feedback and appreciation; unfortunately, the types which are attracted to the field are the least likely to give such feedback. So it is up to the faculty to teach and model such behavior, which in turn will encourage students to do the same in their own work. Type knowledge can also help in identifying behavioral patterns and needs that may be beneficial in advising students (see also Lynch, 1987).

3 Since the numbers of sensing (S) and intuitive (N) types are roughly equal, the implication, though debatable, is that half of the students learn best deductively, and about half, inductively. The sensing types benefit from clear instructions, starting with their practical experiences, and with new material presented with a step-by-step approach. Intuitives, on the other hand, prefer theoretical principles first, followed by mastery of details through problem solving. In order to reach the greatest number of students effectively, instructors must keep these differences in mind. Tests and other measures of evaluation should also be varied so that different types are given a fair chance.