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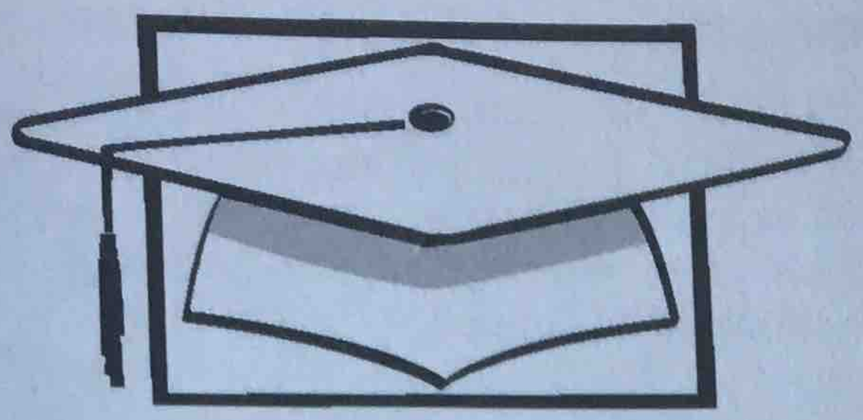


CHAPTER 3
Understanding the Teaching/Learning Process

Education is not preparation for life; education is life itself.

— John Dewey

INTRODUCTION

In Chapter 1 we identified “approach” as a key factor that will lead you to success in your engineering studies. We linked “approach” with “effort,” another key factor, explaining that the successful student is one who works both *hard* and *smart*. In this and the two subsequent chapters, we will focus on what it means to work “smart.”

This chapter provides an overview of the teaching/learning process. Understanding this process will help you take full advantage of both the teaching part and the learning part.

We begin by discussing the learning process. We define learning and describe its components – receiving and processing new knowledge, and demonstrating mastery of that knowledge. You will have the opportunity to find out how you prefer to receive and process new knowledge – insights that will be useful to you in designing your own learning process. We will also describe the characteristics of “expert” learners and encourage you to continuously improve your learning skills by observing your learning process and making changes based on those observations.

We conclude the section on learning with the important perspective that learning is a reinforcement process. This is an overarching principle that you should take advantage of at every opportunity.

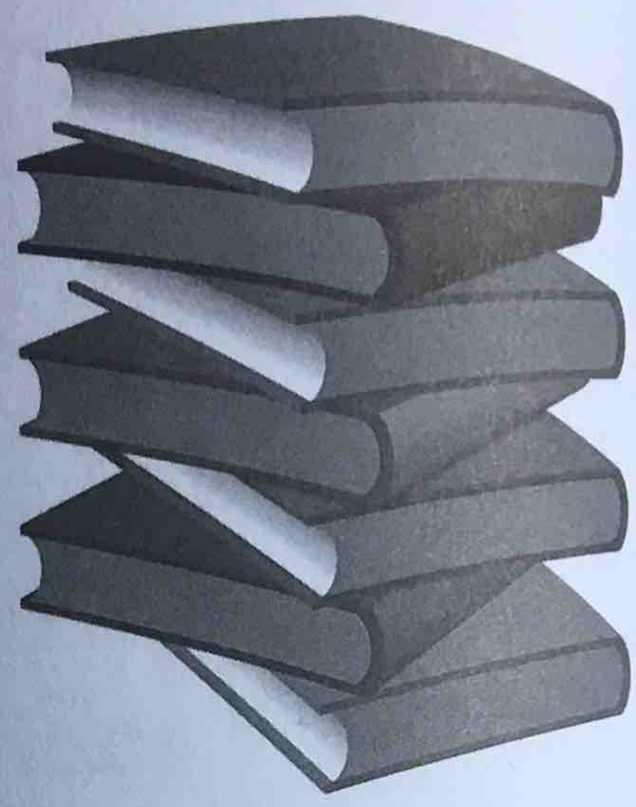
Next, we provide a brief overview of the teaching component of the teaching/learning process. We point out the ways teaching is delivered, including various teaching styles used by your professors. Being aware of how you are taught can enhance your learning experience.

Then we point out some common mistakes students make as they transition from high school to college-level engineering study. A serious (and costly) mistake is assuming that the same strategies and approaches that worked in high school will work here. We also provide an indication of approaches and strategies for avoiding these mistakes.

We conclude the chapter with a perspective on the subject of seeking help. Failing to utilize available resources – particularly professors and fellow students – is another mistake that some students make. “Standing on the shoulders of others” is fundamental to the very concept of an education.

3.1 WHAT IS LEARNING?

Although you've been an active participant in the learning process for many years, it is unlikely you have had any formal training in it. Becoming an expert learner requires not only that you devote time and energy to learning, but that you devote time and energy into learning *how* to learn.



Learning, broadly defined, is the process of acquiring:

- New knowledge and intellectual skills (cognitive learning)
- New manual or physical skills (psychomotor learning)
- New emotional responses, attitudes, and values (affective learning)

COGNITIVE LEARNING

Cognitive learning is demonstrated by knowledge recall and higher-level intellectual skills. Since acquiring new knowledge and intellectual skills will be the primary focus of your engineering education, it's useful to explore the process in some detail.

Bloom's "Taxonomy of Educational Objectives" [1] identifies six levels of intellectual skills within the cognitive domain. At the lowest level is the simple recall or recognition of facts. At the highest level is creativity. In between are increasingly more complex and abstract mental levels. The following are brief definitions of each level of intellectual skill, along with examples that represent the activities for each level.

Intellectual Skill	Definition	Examples of Intellectual Activity
Remembering	Retrieving, recognizing, and recalling relevant knowledge from long-term memory	arranging, defining (from memory), duplicating, labeling, listing, memorizing, naming, ordering, recognizing, relating, recalling, repeating, reproducing, stating
Understanding	Constructing meaning from oral, written, and graphic messages	classifying, describing, defining (in your own words), discussing, explaining, expressing, identifying, indicating, locating, recognizing, reporting, restating, reviewing, selecting, translating
Applying	Carrying out or using a procedure through executing or implementing	applying, choosing, demonstrating, dramatizing, employing, illustrating, interpreting, operating, practicing, scheduling, sketching, solving, using, writing
Analyzing	Breaking material into constituent parts; determining how the parts relate to one another and to an overall structure or purpose	analyzing, appraising, deriving, calculating, categorizing, comparing, contrasting, criticizing, differentiating, discriminating, distinguishing, examining, experimenting, predicting, questioning, testing

Evaluating	Making judgments based on criteria and standards through checking and critiquing	appraising, arguing, assessing, attaching, choosing, comparing, contrasting, critiquing, defending, judging, predicting, rating, selecting, supporting, valuing, evaluating
Creating	Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure	arranging, assembling, collecting, composing, constructing, creating, designing, developing, formulating, managing, organizing, planning, preparing, proposing, setting up, writing

In high school you primarily worked at the first two levels of demonstrating subject mastery – remembering and understanding. Often you could earn good grades by memorizing material and successfully repeating it back on exams or other assignments. In your university education, the expectations are higher. From the start, you will be expected to think at levels 3 and 4 – applying and analyzing – mastering concepts and applying them to solve new problems. Your performance will be evaluated on your ability to apply what you learn in one context to new contexts. In your first two years you may be given some problems that require you to think at levels 5 and 6 – evaluating and creating, but the strongest focus on these levels of thinking will come in your junior and senior years.

The importance of acquiring higher intellectual skills is underscored in an excellent book by John Bransford titled *How People Learn* [2]:

> All learning involves "transfer" – defined as the ability to extend what has been learned in one context to new contexts – from previous experiences. Educators hope that students will transfer learning from one problem to another within a course, from one school year to another, between school and home, and from school to the workplace. Transfer is affected by the degree to which people learn with understanding rather than merely memorize sets of facts or follow a fixed set of procedures.

I can assure you that mastering the learning skills presented in this chapter and the next two chapters will aid you in this process of "kicking it up a notch" from what was expected of you in high school.

PSYCHOMOTOR LEARNING

Psychomotor learning is demonstrated by physical skills – coordination, dexterity, manipulation, grace, strength, and speed, for example, actions that demonstrate the fine motor skills such as use of precision instruments or tools, or actions that demonstrate motor skills such as dance or athletic performance.

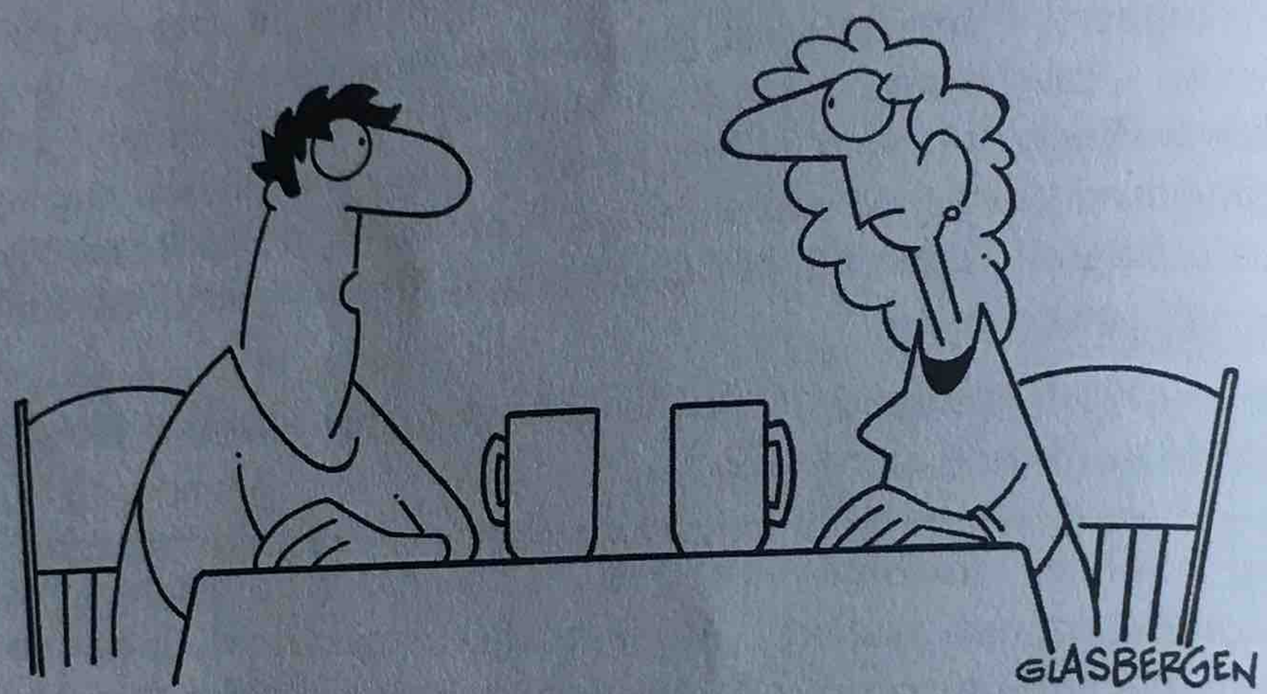
Within engineering education, examples of learning in this domain might include sketching, computer keyboard skills, machine tool operation, and certain laboratory skills.

AFFECTIVE LEARNING

Affective learning is demonstrated by behaviors indicating attitudes of awareness, interest, attention, concern, and responsibility. This domain relates to emotions, attitudes,

appreciations, and values, such as enjoying, respecting, and supporting. The ability to listen and respond in interactions with others is part of affective learning.

Many of the topics in this text fit into the affective learning category. Indeed, one of the primary purposes of this book is to guide your personal development in many of the areas listed above. This development will continue throughout your engineering education, even though it might not be addressed explicitly in your required coursework. For example, through your participation in study groups and laboratory and design project groups, you will grow in your ability to "listen and respond in interactions with others." However, you might have to elect to take a course in Interpersonal Communication to gain explicit training in this area. By doing so, you will avoid being the person in the cartoon below.



"I'm trying to be a good listener, but you keep breaking my concentration by talking!"

REFLECTION

Reflect on the three categories of learning – cognitive learning, psychomotor learning, and affective learning. What are some examples of learning you have experienced in each of the three categories? Undoubtedly you have acquired new knowledge (cognitive learning) and developed dexterity in some area such as typing or sketching or dancing (psychomotor learning). Do you have more difficulty coming up with examples under the affective learning category? Are you open to learning in areas such as enjoying, respecting, and supporting others?

3.2 HOW DO WE LEARN?

The process of learning new knowledge and intellectual skills (cognitive learning) involves two steps: 1) receiving new knowledge, and 2) processing that new knowledge.

RECEIVING NEW KNOWLEDGE

There are two key aspects to the way you receive new knowledge:

- The type of information you prefer
- The sensory channel through which you most effectively perceive external information

Research has shown that learners' preferences differ in each of these aspects.

I. What Type of Learner Are You?

Sensing learners. Sensing learners focus on things that can be seen, heard, or touched. They like facts and data, the real world, and above all, relevance. They are patient with details and enjoy solving problems by well-established methods.

Intuitive learners. Intuitive learners are dreamers. They prefer ideas, possibilities, theories, and abstractions. They look for meanings, prefer variety, and dislike repetition. They tend to dislike "plug and chug" courses and are impatient with detailed work.

II. Through What Sensory Channel Do You Perceive External Information Most Effectively?

Visual learners. Visual learners learn more effectively through the use of pictures, diagrams, flowcharts, graphs, sketches, films, and demonstrations.

Verbal learners. Verbal learners respond more to the written or spoken word. They like to read about things or hear explanations from an expert.

Reflection

When you receive new knowledge, what type of information do you prefer? Are you a sensing learner? Or are you an intuitive learner? Do prefer to receive information visually? Or verbally? What implications do your preferences have for your learning process?

Processing New Knowledge

Just as there are two ways to receive new knowledge, there are two aspects to processing that knowledge:

- the way you prefer to process information
- the way you progress toward understanding

Research has shown that learners differ with regard to their preferences in these two areas.

III. The Way You Prefer to Process New Knowledge

Active learners. Active learners tend to process information while doing something active with it. Consequently, active learners think out loud, try things out, and prefer group work. Sitting through lectures is particularly hard for active learners.

Reflective learners. Reflective learners prefer to think about information quietly first. They want to understand or think things through before attempting to do anything themselves. They tend to prefer working alone.

IV. The Way You Progress Toward Understanding

Sequential learners. Sequential learners prefer linear steps, with each step following logically from the previous one. They tend to follow logical stepwise paths in finding solutions.

Global learners. Global learners tend to learn in large jumps, absorbing material almost randomly without seeing connections, and then suddenly "getting it." They prefer to see the "big picture" and then fill in the details.

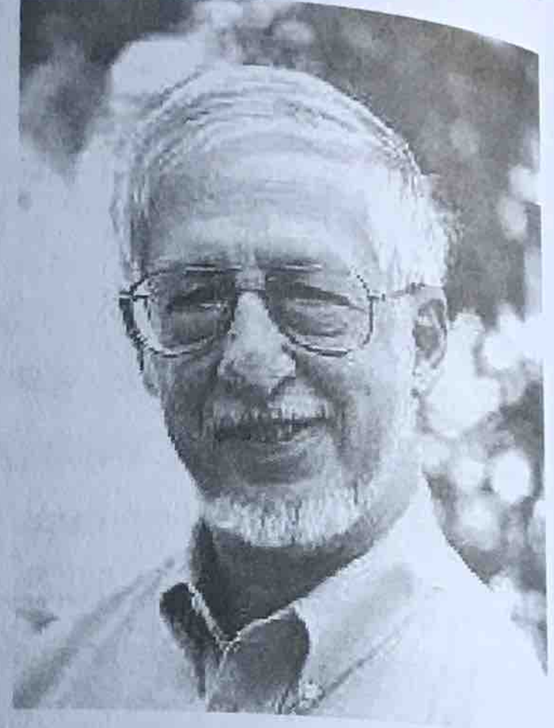
REFLECTION

How do you prefer to process new information? Are you an active learner who wants to do something with it? Or are you a reflective learner who wants to think about it first? How do you prefer to progress toward understanding? Are you a sequential learner, preferring to take logical steps? Or are you a global learner, preferring to start with the big picture and then fill in the steps? Is there any value to understanding how you prefer to process new information?

INDEX OF LEARNING STYLES QUESTIONNAIRE

You probably already have a sense of your preferred learning styles, but have never thought to articulate them. If you'd like to get an even more definitive indication, I encourage you to complete the *Index of Learning Styles Questionnaire* developed by Barbara Solomon and Richard Felder at North Carolina State University. The questionnaire can be completed online at:

www.engr.ncsu.edu/learningstyles/ilsweb.html

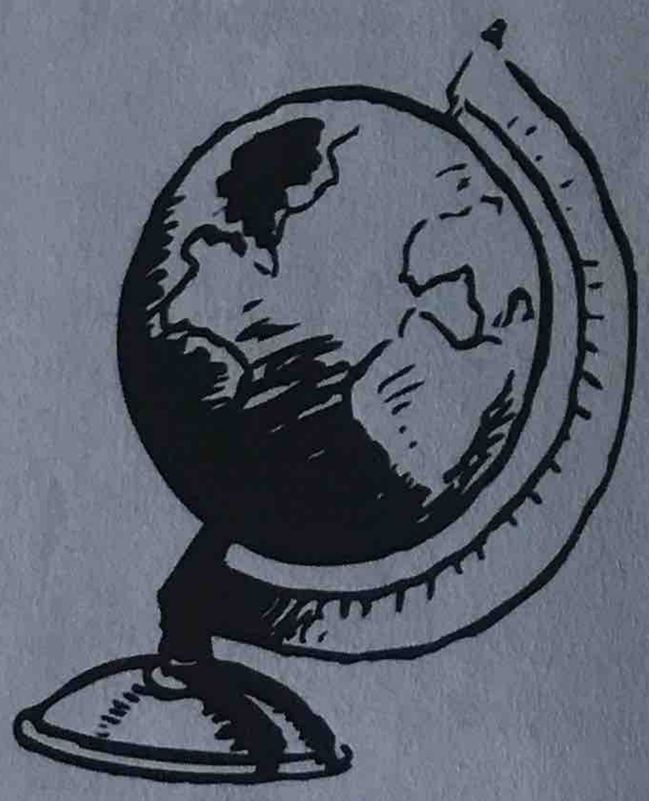


Richard Felder

At that website, you will be asked to choose one of two preferences for 44 items that cover four areas (two areas related to receiving information and two areas related to processing information).

You will immediately receive scored results indicating whether you have a strong preference, moderate preference, or are fairly well-balanced on each of the four scales.

As you'll learn later in this chapter, if your preferred ways of receiving new knowledge are ***verbal*** and ***intuitive*** and your preferred ways of processing new knowledge are ***sequential*** and ***reflective***, you are in step with the ways you are most likely being taught (i.e., traditional lecture format). However, you can almost certainly benefit by adopting the full spectrum of learning styles in your studies (sensory as well as intuitive; visual as well as verbal; active as well as reflective; global as well as sequential).



If your preferred ways of receiving new knowledge are ***visual*** and ***sensory*** and your preferred ways of processing new knowledge are ***global*** and ***reflective***, you may find a mismatch between the way you prefer to learn and the way you are being taught. The good news is that you are primarily responsible for creating your learning experience. Just make sure the way you study is compatible with your preferred learning styles. Some general advice from Richard Felder as to how to do this can be found at: www.ncsu.edu/felder-public/ILSdir/styles.htm.

Keep in mind, however, that:

All learners benefit from using learning styles on both sides of all four dimensions.

Doing things that are compatible with your style can help you compensate for mismatches with the dominant style of your teachers. Doing things that are on the opposite side of your learning style preference will give you a perspective on the material you might not normally get,

while helping you develop skills that will enhance your professional success – skills you might not develop if you only followed your natural inclinations.

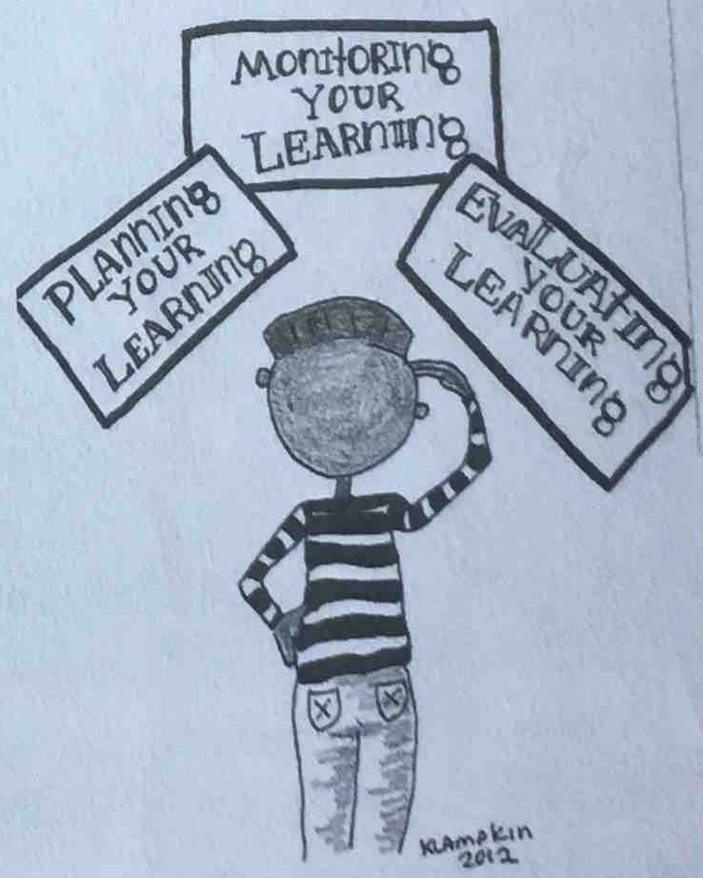
3.3 METACOGNITION – THE KEY TO IMPROVING YOUR LEARNING PROCESS

Famous Swiss psychologist Carl Jung put forth the concept of the "observing ego." This is the part of you that observes your "self." It observes what you do. It observes how you think. And it observes how you feel. And through this process of observing, it feeds back information (assessment) to enable you to make changes. Some examples of this process are shown below.

Activity	Observation	Feedback	Change
Running a 10K race	I'm running too fast.	I'd better slow down.	Slow down pace.
Falling asleep while studying	I'm not going to get my homework done.	A break will help.	Take a walk around the block.
Doing homework problems	I can't do Problem #5.	I need to seek help.	Go see instructor during office hours.
Attending math class	I'm not following what's being presented.	I could get clarification by asking a question.	Raise hand and ask question.

Improving your learning process by observing it, developing feedback on what you observe, and making changes based on that feedback are all part of *metacognition*. When engaging in the metacognition process, you should follow these steps:

1) Plan your learning
2) Monitor your learning
3) Evaluate your learning



I would encourage you to begin regularly observing your learning process. The easiest way to do this is to ask yourself questions.

1. When ***planning your learning***, ask questions like:

- What in my prior knowledge or experience will help me with this particular task?
- What should I do first?
- Why am I doing this task?
- How much time do I have to complete this task?

2. When ***monitoring your learning***, ask questions like:

- How am I doing?
- Am I on the right track?
- How should I proceed?
- What information is important to remember?
- Should I move in a different direction?
- Should I adjust the pace based on the difficulty of a subject (too difficult – slow down; too easy – speed up)?
- What do I need to do if I do not understand?

3. When ***evaluating your learning***, ask questions like:

- How well did I do on a particular task or assignment?
- Did my particular course of action produce more or less than I had expected?
- What could I have done differently?
- How might I apply this line of thinking to other problems?
- Do I need to go back through the task to fill in any blanks in my understanding?

REFLECTION

Think about the following characteristics of "expert" learners:

- Control the learning process rather than become a victim of it
- Are active, not passive, in their approach to learning
- Are motivated (e.g., enjoy learning, have short-term and long-term goals, etc.)
- Are disciplined (i.e., have learned good habits and use them consistently)
- Are more aware of themselves as learners (e.g., know their own strengths and weaknesses)
- Initiate opportunities to learn
- Set specific learning goals for themselves
- Have a larger repertoire of learning strategies from which to choose
- Know not only *what* to learn, but *how* to learn
- Plan their approach to learning
- Monitor their learning while it's happening (e.g., notice when they're not learning and adjust their learning approach)
- Are more adaptive because they *do* self-monitor while learning
- Reflect more upon their own learning
- Evaluate the effectiveness of learning approaches and strategies
- Are more sensitive to the demands of specific academic tasks
- Use learning strategies selectively
- Tend to attribute failures to correctable causes
- Tend to attribute successes to personal competence

Rate yourself on a scale of zero to ten on each of these items. Are there areas that need improvement? Are you willing to work at improving? Pick two or three areas you would like to improve in, and for each come up with three specific things you can do for each.

I hope I have persuaded you of the benefits of metacognition – that is, "observing" your learning process with the goal of becoming an expert learner.

3.4 LEARNING IS A REINFORCEMENT PROCESS

There is one more important principle that should influence every aspect of your participation in the teaching/learning process. It is that:

Learning is a reinforcement process.

A critical part of the learning process is what we call "reinforcement." That is, learning comes from repeated exposure to subject material – the more the better. Consider, as an example, the way we master the subject of "mechanics."

An Example: The Study of Mechanics

The way in which we learn the subject of mechanics, the study of forces and motion, can illustrate the importance of reinforcement in the learning process.

Our first exposure to mechanics may have come in high school physics. Next, we study a whole semester of mechanics in our freshman physics course. In our sophomore year, we may have a course in statics and, in our junior year, a course in engineering dynamics. If we are interested, we can take several senior-level courses and, for a thorough understanding of mechanics, we could pursue graduate study – a Master's or even Ph.D. degree.

Even then, if we were to begin to teach mechanics, we would find areas in which we were not completely clear, and probably only after a number of years of teaching would we feel that we were even approaching total mastery of the subject.

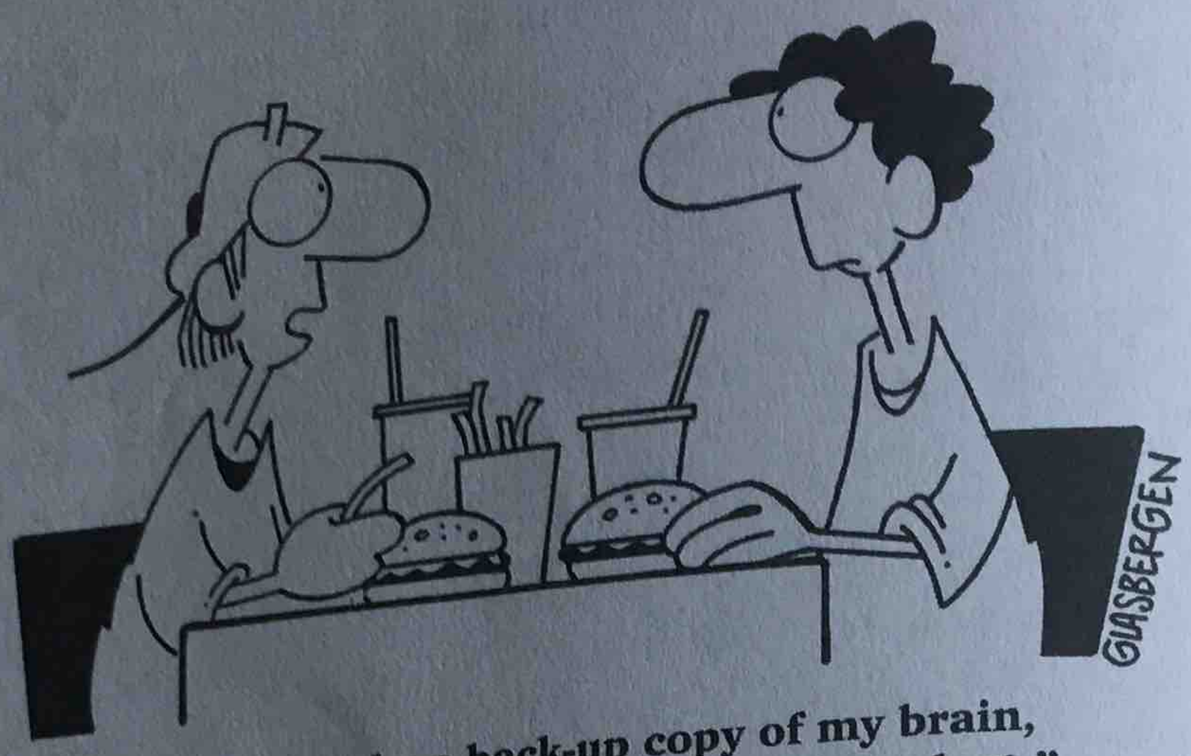
The point of this example is not to discourage you, but rather to encourage you to take advantage of every opportunity to reinforce your learning. Even for the brightest person, learning is a slow process that occurs over time and relies on repeated reinforcement. By knowing this, hopefully you will not fall into the common trap of thinking that you can "cram" in the material the night before a test (like the student in the picture).

The educational system is structured to give you the opportunity to reinforce the subject matter many times within a semester or quarter. Here are examples of the reinforcement process at its best.

When	What To Do
Before class	Prepare for the lecture by reviewing notes, reading text, attempting a few problems, formulating some questions
During class	Attend lecture, concentrate intently, take detailed notes, ask questions
After class, but before next class meeting	Review and annotate notes, reread text, work assigned problems, work extra problems, meet with a study partner or study group to go over material and problems
In preparation for test or exam	Review notes, review text, rework problems, meet with a study partner or study group to go over material and problems
In preparation for final exam	Review notes, reread text, rework problems, meet with a study partner or study group to go over material and problems

This systematic approach to learning that involves repetition, review, and reinforcement will carry you a long way toward becoming an expert learner. Once you master the specific skills presented in the next two chapters as well, you'll be an expert learner for sure.

If you keep the principle that "learning is a reinforcement process" in mind as you design your learning process, you won't find yourself in the situation in this cartoon.



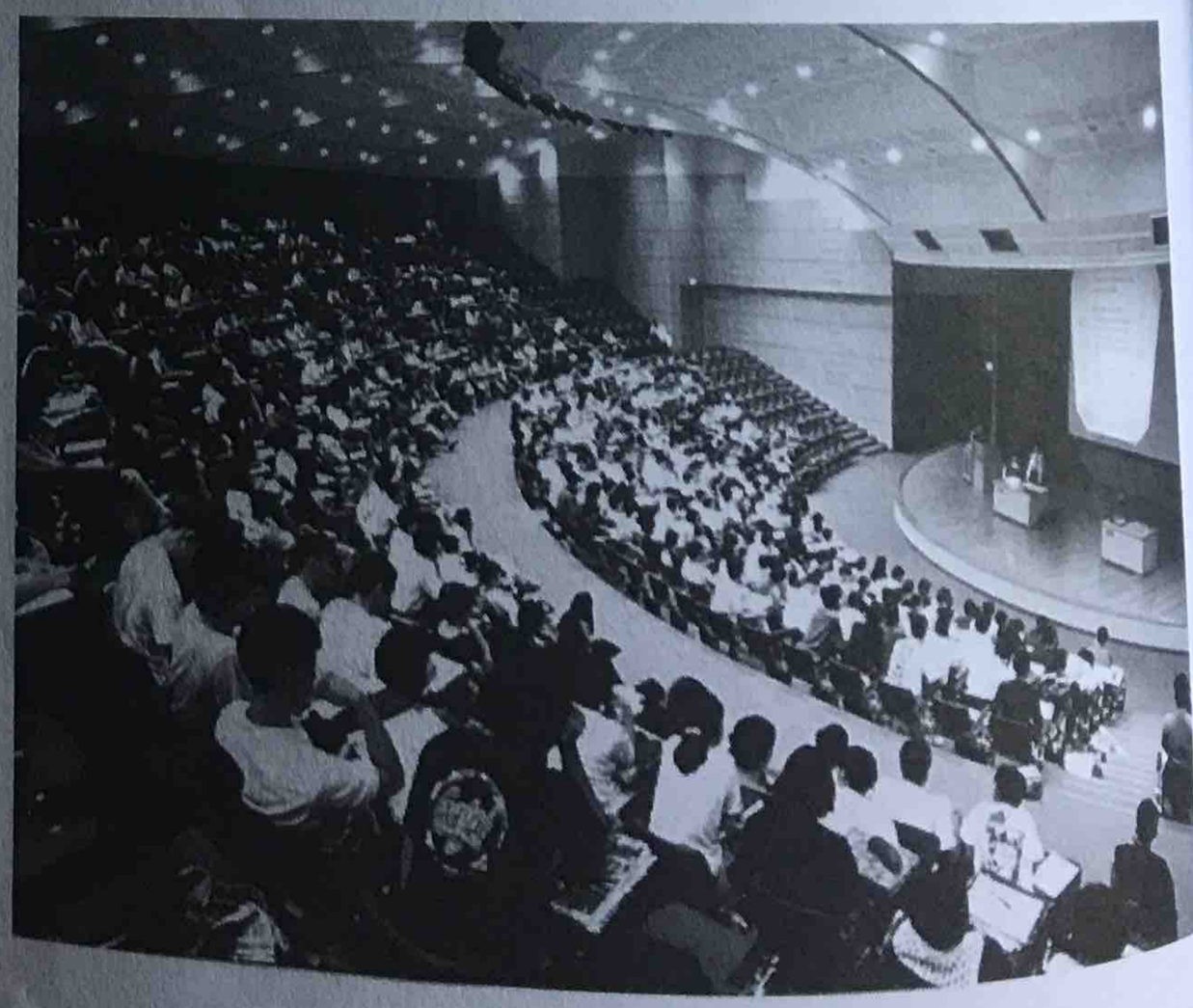
"I forgot to make a back-up copy of my brain, so everything I learned last semester was lost."

3.5 Understanding the Teaching Part of the Teaching/Learning Process

The teaching part of the teaching/learning process is primarily achieved by the following well-known ***teaching modes***:

- Large lectures, in which one professor teaches 100-300 or more students
- Small lectures, in which one professor teaches 20-30 students
- Recitations, in which a teaching assistant reviews the material and solves problems for small groups of ten to 15 students
- One-on-one tutoring, in which one tutor works with one student

Despite their obvious differences, all four teaching modes have one feature in common. Each involves a knowledgeable person communicating what he or she knows to a less knowledgeable person. Generally, most of the communication is one-way – i.e., from the teacher, teaching assistant, or tutor to the student. And most importantly, ***students learn relatively little*** from participating in any of these modes.



That last statement should alarm you or at least cause you to question how I could make such a provocative claim. Here's how. Imagine you're in an engineering course and your professor introduces a new principle. You go to the lecture, recitation, and

tutoring sessions, but you don't do anything outside of those activities. Then you are given an exam on the principle. What score would you expect to make?

The limited effect of these teaching modes – especially the large lecture format – becomes quite apparent if you envision the process as one educator has aptly described it:

> ***The information passes from the notes of the professor to the notes of the student without passing through the mind of either one.***

That there is a major difference between high school and university-level study is illustrated by the 80/20 rule [3]. In high school roughly 80 percent of what you needed to know came from the teacher and in-class work. Only 20 percent of the learning occurred outside the classroom. In college, this rule is reversed. Only 20 percent of what you learn will come from the professor and class lectures. Eighty percent of what you learn will come from work you do outside the classroom. ***This is perhaps the most important concept you must grasp about the college learning environment.***

TEACHING STYLES

Even within the general lecture format, there are variations in the way teaching is done. In reading Section 3.2, you should have discovered your preferred learning styles. Your effectiveness in creating your learning experience will be determined not only by your understanding of the ways you best learn, but also by seeing them in the context of how you are being taught.

The following is an overview of the various dimensions of teaching styles, outlined by Dr. Richard Felder of North Carolina State University (and author of the Foreword to this book), a world-renowned expert on teaching and learning styles in engineering education [4]. Dr. Felder examines five categories of the teaching process and describes two possibilities for the approach your professors might take for each of these categories. The teaching styles most prevalent in math/science/engineering courses (abstract, verbal, deductive, passive, and sequential) are underlined.

1) **What type of information is emphasized?**

   Concrete – Facts, data, observable phenomena
   Abstract – Principles, concepts, theories, mathematical models

2) **What mode of presentation is stressed?**

   Visual – Pictures, diagrams, films, demonstrations
   Verbal – Spoken words, written words

3) **How is the presentation organized?**

   Deductive – Start with fundamentals, proceed to applications
   Inductive – Start with applications, proceed to fundamentals

4) **What mode of student participation is facilitated?**

   Active – Student involved (talking, moving, reflecting, solving problems)
   Passive – Student as spectator (watching, listening)

5) **What type of perspective is provided on the information presented?**

   Sequential – Step by step progression
   Global – Context and relevance are provided

REFLECTION

Think about the classes you are taking in terms of each of the five categories listed on the previous page. Do your instructors predominantly use the teaching styles that are underlined or do they use the other one? Do they use some combination of the two? Pick the teaching style under each of the five categories that you would learn best from and place an asterisk next to it. How many match the ones most common in your courses? How many differ? What meaning does this have for you?

By now, I hope you're asking yourself some very good questions, like:

- What value is it to me to understand how my professors teach?
- If the way my professors teach differs from the way I prefer to learn, does that mean I can't learn the material and I am perhaps in the wrong major?
- If some students prefer to be taught one way and other students prefer to be taught another way, why wouldn't the professor use both ways?

These are complex and interesting questions and I would encourage you to seek out the answers. Here are some of my thoughts for starters.

BENEFITS OF UNDERSTANDING HOW PROFESSORS TEACH. There are several benefits to understanding the different ways of teaching. Perhaps primary among these is that the knowledge will guide you in designing your learning process.

But equally important is that you will be doing lots of teaching yourself. When I was Dean of Engineering, someone would ask me from time to time, "Do you do any teaching?" Even though I knew they really meant "Was I teaching any courses?" and I wasn't, I would respond, "I'm always teaching." Throughout your time as a student and during your professional career, you will constantly be teaching others what you know – in formal and informal meetings, through your written communications, and in almost everything you do.

Understanding the different ways of transmitting knowledge will be an extremely useful skill in all aspects of your life and career. And who knows? Maybe someday you'll decide to become an engineering professor.

WHAT IF THE WAY I PREFER TO LEARN DIFFERS FROM THE WAY I AM TAUGHT? Rather than view this as a problem, I suggest you view it as an opportunity. Just because you prefer to be taught one of two possible ways doesn't mean you can't learn the other way. During your learning process, you can learn even more by translating what you were taught into the way you prefer to learn. For example, if you need to know the context and relevance (global perspective) for what you are being taught and your professor doesn't provide it, it's likely that you will learn even more if you develop it on your own than if the professor had provided it.

Also remember that there is a difference between preference and competence. You may like doing something but not be good at it. For example,

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I love to sing but I can't carry a tune. Conversely, you may be good at something, but not like doing it. I'm sure I'd be good at accounting, but I wouldn't want to do it for a living.

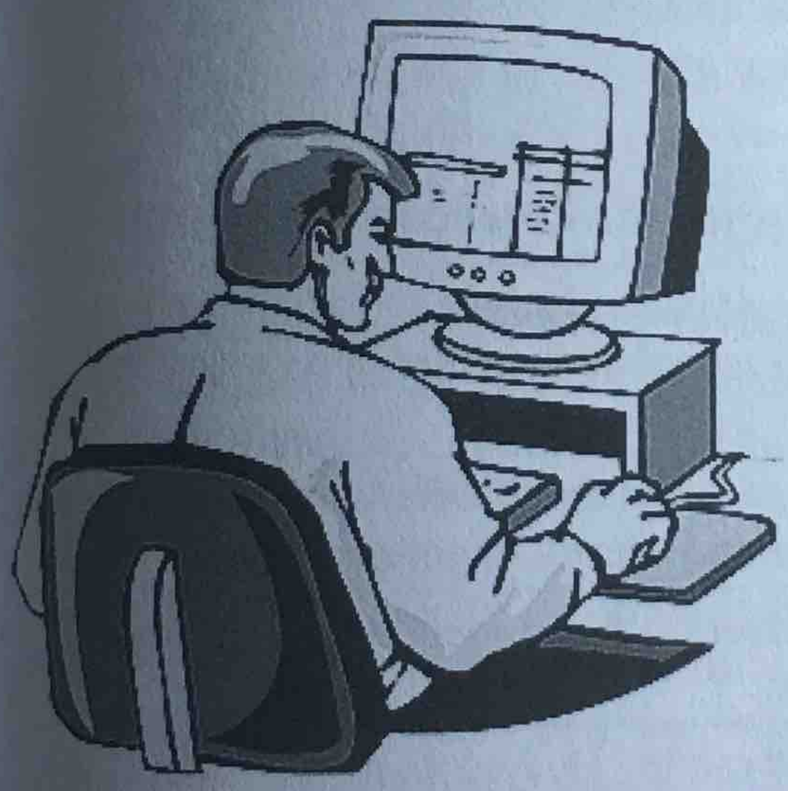
Strive to improve your ability to get the most out of all teaching styles – the ones you prefer and the ones you don't. You might prefer to study by yourself but find that you are very good studying collaboratively with other students. As a student and as a professional, you'll be learning from and teaching people who have different preferences from yours. Your effectiveness will depend on your ability to use different ways of getting your points across.

The bottom line is you will benefit by developing your skills on both sides of the four learning style dimensions. Good engineers are observant, methodical, practical, and willing to check calculations and replicate experiments over and over to be sure they're right (sensing skills). They also have to be innovative, deal with theories and models, and think deeply about the meaning of their observations and results (intuitive skills). Good engineers have to deal with both visual and verbal information. They must both reflect on things and also take action. And they need to both be aware of the big picture and also proceed in a stepwise manner.

REFLECTION

Think about your ability to do various things. Are there things you like to do, but don't do well? Are there things that you do very well, but don't like doing? Or do you generally only like doing the things you do well? How can understanding the difference between preferences and competence benefit you in your education?

Above all, there is no need for you to drop out of school or to change majors. You can learn to learn no matter how you are being taught. Besides, there's a place in the engineering profession for individuals with different preferences for the way they are taught. Think about the various engineering job functions described in Chapter 2 – analysis, design, test, development, sales, research, management, consulting, and teaching. Although one individual might be best suited for one job function (e.g., someone who prefers to be taught visually might make a good design engineer) and another individual might be best suited for another job function (e.g., someone who prefers to be taught verbally might make a good analytical engineer), all engineering job functions require individuals who can both learn and teach in a variety of styles.



WHY DON'T YOUR PROFESSORS USE A VARIETY OF TEACHING STYLES? Many do. And in time, more and more will. There is an impetus for change within engineering education. *Interactive lectures, problem-based learning, inquiry-guided learning,* and *just-in-time teaching* are examples of teaching methods that are gaining acceptance within engineering education. These methods bring more student involvement, context, and relevance into the classroom.

But change is slow. Formal training in teaching methods is not a required part of the process of becoming a math, science, or engineering professor. In the absence of such training, most professors tend to teach the way they were taught. And so the most prevalent teaching styles of the past (abstract, verbal, deductive, passive, sequential) tend to be propagated into the future.

Whatever you do, don't use the way your professor teaches as an excuse for not learning. If you believe you are having difficulty because of the way you are being taught, you might speak to your professor and suggest ways in which he or she could help you get more out of the lectures. You might ask, for example, that the professor work out more problems in class. Or if you tend to be a global learner, ask the professor to address "the big picture." You might also ask your professor to recommend additional resources that would aid you in your learning process. One caution: Do this politely and in a constructive tone. No one likes to think he or she is being criticized.

3.6 Mistakes Students Make

As we discussed in Chapter 1, engineering study is challenging, but you have the ability to do it. What's critical for your success is to avoid many of the mistakes that students make early on. If you do, you're likely to be one of the many who succeed. If you don't, you'll increase the chance you'll be among those who don't succeed.

A big mistake is to assume your college engineering studies will be like high school and the same strategies and approaches that worked there will work here. In reality, the faster pace and higher expectations for learning require new strategies and improved learning skills. Included with each mistake listed below is a general strategy for overcoming it. Taking advantage of these success strategies will require that you absorb, practice, and refine the learning skills that are described in this chapter and in Chapters 4 and 5.

Mistakes Students Make	Strategies for Overcoming Them
Assume engineering study will be like high school.	Work to understand and adjust to the differences between high school and college-level engineering study.
Program yourself for failure through too many commitments.	Create a life situation that enables you to devote adequate time and energy to your studies.
Spend little time on campus.	Immerse yourself in the academic environment of the institution.
Neglect studying.	Schedule study time. Devote significant time and energy to studying.
Delay studying until test is announced.	Master the material presented in each class prior to next class.
Study 100% alone.	Study collaboratively with other students.
Come to each lecture unprepared.	Review notes, read text, and attempt problems prior to each lecture.
Avoid professors.	Interact regularly with professors outside the classroom.
Cut classes and/or don't get the most out of lectures.	Attend classes and practice good listening skills. Ask questions in class.

Fail to take notes or take notes but fail to use the notes properly in the learning process.	Take effective notes and use a systematic learning methodology to study from notes.
Skim over the material in an assigned chapter in a rush to get to the assigned homework problems.	Use reading for comprehension methodology (see Section 5.1) to understand the general concepts thoroughly before attempting problems.
Fail to solve assigned problems. Don't approach problems using a systematic problem solving method.	Solve not only assigned problems but extra problems; use systematic problem solving methods.

Our purpose in this chapter and in Chapters 4 and 5 will be to guide you in developing important learning strategies and skills that will move you from the left-hand column into the right-hand column. If you are able to do this, the likelihood you will succeed in your engineering studies will be greatly enhanced.

REFLECTION

Review the list of "Mistakes Students Make." Do any of these describe the way you are approaching your engineering studies? Do you think you would benefit by changing to the strategy described in the right-hand column? Pick one or two items and make a commitment to make the required changes.

3.7 DON'T BE HUNG UP ON THE IDEA OF SEEKING HELP

Do you feel that seeking help is a sign of weakness? That if you make it on your own you will get more out of your education? The idea that we can make it through life without help from others is simply not true.

The truth is we all rely heavily on others to live, grow, and thrive. We come into this world totally dependent on our parents or guardians for our very survival. As we grow, most of what we learn we are taught by others – parents, family, teachers, peers. In school when we use a textbook, in engineering or any other discipline, we benefit from the many experts who have evolved the subject over years to the point where we can readily understand it. This point is perhaps best underscored by a famous quote by Isaac Newton, who is generally viewed as one of the greatest thinkers in the history of humankind:

If I have seen further, it is by standing on the shoulders of giants.

These few observations alone should be sufficient to disabuse you of the notion that you can go it alone. Although part of our country's early mythology glorified the rugged individualist, this image was always seen as a romantic ideal – nice to dream about but impossible to become.

If you have somehow been led to believe that working independently is the best way to approach your engineering studies, think again. Don't let such misconceptions stand in your way – as they undoubtedly will. Instead, take full advantage of the many resources and learning opportunities your campus offers you. The really smart student does.

At your college or university, there are two immediate resources available to help you with your academic work:

- **Your peers**
- **Your professors**

The value of making use of your peers and your professors is best explained in the following excerpt from an excellent Harvard University study on the teaching/learning process [5]:

> Is there any common theme that faculty members can use to help students, and indeed that students can use to help themselves? The answer is a strong yes. All the specific findings point to, and illustrate, one main idea. It is that students who get the most out of college, who grow the most academically, and who are the happiest, organize their time to include interpersonal activities with faculty members, or with fellow students, built around substantive academic work.

I assume that you want to be one of those students who get the most out of college, who grow the most academically, and who are the happiest. Now you know what you need to do: Organize your time to include interpersonal activities with faculty members, or with fellow students, built around substantive academic work. However, you may not know how to bring about these results. In Chapter 4 we will provide you with specific strategies on making effective use of your professors and will discuss other sources of help available to you including tutoring and other academic resources. In Chapter 5 we will address the important issue of making effective use of your peers.

REFLECTION

Are you a person who likes to help others? Do you like others to help you? If you get pleasure from helping others, why wouldn't you want to give others the same pleasure by letting them help you? Imagine that even after giving it your best effort, you just can't understand some material that was presented in a class. Who would you be most inclined to ask for help? Your professor? A classmate? No one?

Many online sites also can provide various types of help. One excellent resource that can help you make up for any deficiencies you might have in mathematics and science is the Khan Academy website (www.khanacademy.org). There you will find 3,200 videos, each approximately ten minutes in length, covering mathematics from arithmetic to calculus and science from biology to chemistry and physics. I hope you'll check out a few of these videos to see what is there and whether any can help you.

There are many online sites that can provide you with knowledge and help develop your study skills. Two of the best are the "Study Guides and Strategies" website: www.studygs.net and the "College Survival" website: www.universitysurvival.com/student-success-skills of the University of West Virginia. On these two websites you will find lots of information on topics

related to studying and learning, time management, reading, writing, and thinking. Mastering much of the material there would go a long way toward developing you into a "master" student.

3.8 ACADEMIC SUCCESS SKILLS SURVEY

Before you go to the next chapter, complete the *Academic Success Skills Survey* at the end of this chapter. Note any items you check as "Neutral," "Disagree," or "Strongly Disagree" and commit to improving yourself in those areas. As you study the subsequent chapters of this text, give particular attention to the sections that address those areas.

SUMMARY

This chapter provided an introduction to the teaching/learning process. You may not have previously given much thought to how this process works. Hopefully you now understand that the institution focuses primarily on the *teaching* part, while the *learning* part is left up to you.

We began by looking at the learning process. We defined learning and described its component parts. You identified your preferred ways of receiving and processing new knowledge – an awareness that can aid you in designing your learning process. We also encouraged you to continuously refine your learning process through metacognition: closely observing your learning process, feeding back what you observe, and making changes based on your observations.

We also provided you with a perspective on the importance of reinforcement in the learning process. Taking a systematic approach to your learning that involves repetition, review, and reinforcement will go a long way toward making you an expert learner.

Then we turned to the teaching part of the teaching/learning process. We discussed the various teaching styles used by your professors and the benefits of understanding how your professors teach.

Next we pointed out mistakes commonly made by students as they transition from high school to university-level engineering study. Your success will depend to a great extent on your ability to avoid these mistakes.

We closed the chapter with a perspective on the concept of seeking help. I hope you are persuaded that "standing on the shoulders" of others is fundamental to the very concept of an education and you will take full advantage of all the resources available to you – particularly your peers and your professors.

In the next chapter, we will focus on what you can do to get the most out of the teaching part of the teaching/learning process. By practicing the approaches presented there, you will lay the strongest possible foundation on which to build your learning process.

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PROBLEMS

1. Review the 11 attributes presented in Chapter 1 that the ABET *Engineering Criteria 2000* mandates for engineering graduates. Which primarily involve cognitive learning? Which are most likely to involve psychomotor learning? What psychomotor skills might you acquire? Which of the attributes are most likely to involve affective learning? Which affective skills might you acquire?
2. Consider the 11 attributes presented in Chapter 1 that the ABET *Engineering Criteria 2000* mandate for engineering graduates. In the table below indicate the extent to which each requires one of Bloom's higher-level thinking skills – applying, analyzing, evaluating, creating. Fill in each box with a "1" – none or very little; "2" – moderate extent; "3" – significant extent.

	Applying	Analyzing	Evaluating	Creating
Apply knowledge of math, science, and engineering				
Design and conduct experiments				
Design a system, component, or process				
Function on multidisciplinary teams				
Identify, formulate, and solve engineering problems				
Understand professional/ethical responsibility				
Communicate effectively				
Understand global and societal context				
Recognize need for lifelong learning				
Knowledge of contemporary issues				
Use techniques, skills, and modern engineering tools				

3. Go online at www.engr.ncsu.edu/learningstyles/ilsweb.html and complete the "Index of Learning Styles Questionnaire" developed by Barbara Soloman and Richard Felder at North Carolina State University. Write a two-page paper on why it is beneficial for you to understand your preferred learning styles. Include changes in your behaviors you plan to make based on this new information.
4. Review the list of characteristics of expert learners presented in the Reflection exercise in Section 3.3. Divide the list into two categories: 1) those that describe you and 2) those that don't describe you. Take the list of characteristics that don't describe you and rank the items in importance. Pick the most important item and develop a written plan that includes steps you will take to move this item to the "describe you" list.

5. Consider the 80/20 rule described in Section 3.5. How does it fit with your past and current experiences? In high school, how many hours did you spend in class? How many hours did you spend learning outside of class? How does this compare to the 80/20 rule? Currently, how many hours do you spend in class? How many hours would the 20/80 rule suggest you should spend learning outside of class?

6. How does the statement that "learning is a reinforcement process" match your past learning experiences? Can you think of a specific example where you learned something through repeated reinforcement? Can you think of a specific example of something you would have liked to learn but didn't because of inadequate reinforcement? Write down five things you can do differently to take advantage of this idea. Implement what you wrote down.

7. Based on the five teaching styles presented in Section 3.4, determine how the way you prefer to learn compares to the way you are being taught. For each category, check the box that best describes the teaching style most prevalent in your math/science/engineering classes. Then check the box that describes the way you prefer to learn.

Type of Information Emphasized

Teaching style	Most prevalent in your classes	What you prefer
Concrete		
Abstract		

Mode of Presentation Stressed

Teaching style	Most prevalent in your classes	What you prefer
Visual		
Verbal		

Way Presentations Are Organized

Teaching style	Most prevalent in your classes	What you prefer
Deductive		
Inductive		

Mode of Student Participation

Teaching style	Most prevalent in your classes	What you prefer
Active		
Passive		

Type of Perspective Provided

Teaching style	Most prevalent in your classes	What you prefer
Sequential		
Global		

In what categories does the way you prefer to be taught *match* the way you are being taught? What are the implications for your learning? In what categories does the way you prefer to

be taught *differ* from the way you are being taught? What are the implications for your learning?

8. Using your favorite Internet search engine, research one of the teaching approaches mentioned in Section 3.5:
   - Interactive lectures
   - Problem-based learning
   - Inquiry-guided learning
   - Just-in-time teaching

   Write a one-page paper describing and critiquing the method.
9. Go to the Khan Academy website (www.khanacademy.org) and review the list of videos available there. Pick two videos that address areas you could improve in. Watch the videos and write a one-page statement about what you learned.
10. Go to the "Study Guides and Strategies" site (www.studygs.net). Pick a topic that you would like to learn more about (e.g., active listening, influencing teachers, managing stress). Study the material presented on that topic and prepare a 2-3 minute presentation on what you learned. Find a willing student and deliver the presentation to him or her.
11. Go to the "University Survival" website (www.universitysurvival.com/student-success-skills). Pick one of the following topics, read it, and prepare a 2-3 minute presentation for your *Introduction to Engineering* class on what you learned:
    - Managing your time
    - Overcoming your personal sound barrier to change your habits
    - Taking notes – math, science, and engineering classes
    - Knowing how to get things done
    - Understanding what constitutes academic dishonesty
    - Succeeding in an interview
    - Knowing how to build a network
    - Handling criticism

    Make a commitment to put what you learned into practice.
12. Complete the *Academic Success Skills Survey* at the end of this chapter. Assign a point value to each question, based on the following point scale:

Strongly agree	+2
Agree	+1
Neutral	0
Disagree	-1
Strongly disagree	-2

    Compute your average score for the 16 statements in the survey. Then rate yourself as "outstanding," "good," "fair," or "poor" in practicing good academic success skills.
13. Pick six of the 16 areas in the *Academic Success Skills Survey* you think are the most important for academic success. What is your average score for these?
14. From the six academic success skills you identified as most important in Problem 13, pick the two skills you feel you most need to improve. Develop a plan for improving in each area. Implement the plan.

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ACADEMIC SUCCESS SKILLS SURVEY

1. I interact regularly with my professors in positive, beneficial ways, both in and out of the classroom.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

2. I make effective use of my peers by regularly engaging in group study and collaborative learning.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

3. I schedule my time, utilizing time and priority management principles.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

4. I would give myself an A+ on the amount of time and energy I devote to my studies.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

5. I prepare for each lecture by reviewing my notes, reading ahead in the text, attempting some problems, and writing down questions.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

6. I keep up in my classes by mastering the material presented in the last class meeting before the next class meeting.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

7. I am aware of the importance of being immersed in the academic environment of the institution and spend as much time on campus as possible.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

8. I practice good study skills in areas such as note-taking and preparing for and taking tests.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

9. I am aware of the best methodologies for reading for comprehension and practice those methodologies during my learning process.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

10. I recognize the importance of goal setting and I have clear academic goals.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

11. I am effectively managing the various aspects of my personal life, such as interactions with family and friends, personal finances, and outside workload.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

12. I am highly motivated through a clear understanding of the rewards graduating in my chosen major will bring to my life.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

13. At my university, I know other students in my classes and feel part of an academic learning community.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

14. I am aware of and make optimal use of campus resources such as the writing center, counseling center, student health center, library, and career center.

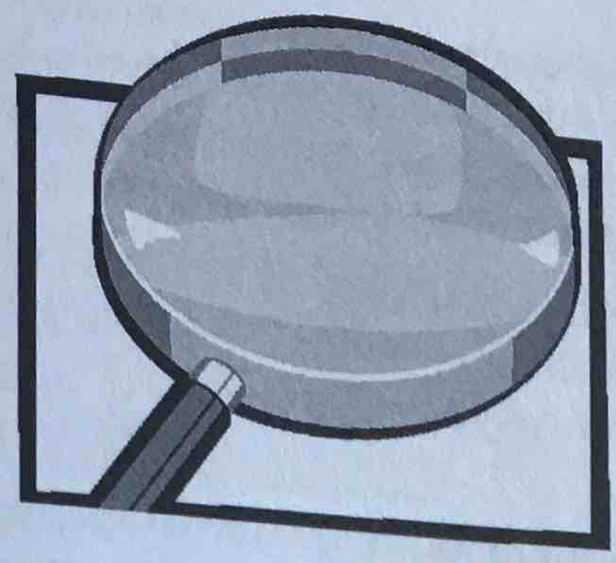
☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

15. I feel good about myself and about my situation, and I am confident about my ability to succeed academically.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE

16. I feel good about my institution and about the educational experience I am receiving.

☐ STRONGLY AGREE ☐ AGREE ☐ NEUTRAL ☐ DISAGREE ☐ STRONGLY DISAGREE



Chapter 6
Personal Growth and Student Development

You will either step forward into growth,
or you will step back into safety.

— Abraham Maslow

Introduction

The focus of this chapter is your personal growth and your development as a student. Your success as a student and, later, as an engineering professional will depend on the extent you grow and develop both during and after college.

We begin the chapter by tapping into the paradigm of "continuous improvement" espoused by U.S. business and industry, and we urge you to adopt a personal plan of continuous improvement for every area you need to strengthen or change. We call this process *student development*.

To achieve the changes that your student development plan will entail, we present a step-by-step process based on behavior modification theory.

To change yourself, you must first understand yourself. We therefore address three topics that conduce to self-understanding:

- The noted American psychologist Abraham Maslow's "Hierarchy of Needs" lists basic human needs that must be met before you can concentrate on achieving your highest need – *self-actualization*.
- A discussion of self-esteem shows you the domino effect that your personal development plan will have on your sense of self. As you make changes in thoughts and actions that move you closer to your goals, you will feel increasingly better about yourself.
- A presentation about peoples' personality types sharpens your understanding of yourself and others.

We then go into detail on the important topic of understanding others – which in large measure is an extension of the process of understanding yourself. Your success in your career will depend on your ability to work with people who are different from you, whether it be their personality type, learning style, value system, or culture.

Next, we return to and expand upon personal assessment. We home in on ways to identify your strengths and weaknesses so that your personal development plan is as comprehensive as possible. *Within this context, we address two important (and often overlooked) areas of personal development:* communication skills and mental/physical wellness.

Teamwork and leadership are then discussed as key parts of developing your communication skills, particularly interpersonal communications. Becoming effective as both a team member and leader will have a big impact on your success as an engineering student and, later, as an engineering professional.

Finally, we leave you with several motivational messages and point you to a large catalog of motivational and inspirational quotes that can help in strengthening your commitment to ongoing self-development.

6.1 Personal Development - Receptiveness to Change

I usually start the first meeting of my Introduction to Engineering course by asking:

"How many of you want to change something about yourself?"

Generally, only three or four out of 30 students raise their hands.

This resistance to change, I think, has the same roots as students' reluctance to seek help (discussed in Chapter 3) in that both are seen by students as an admission that something is "wrong" with them.

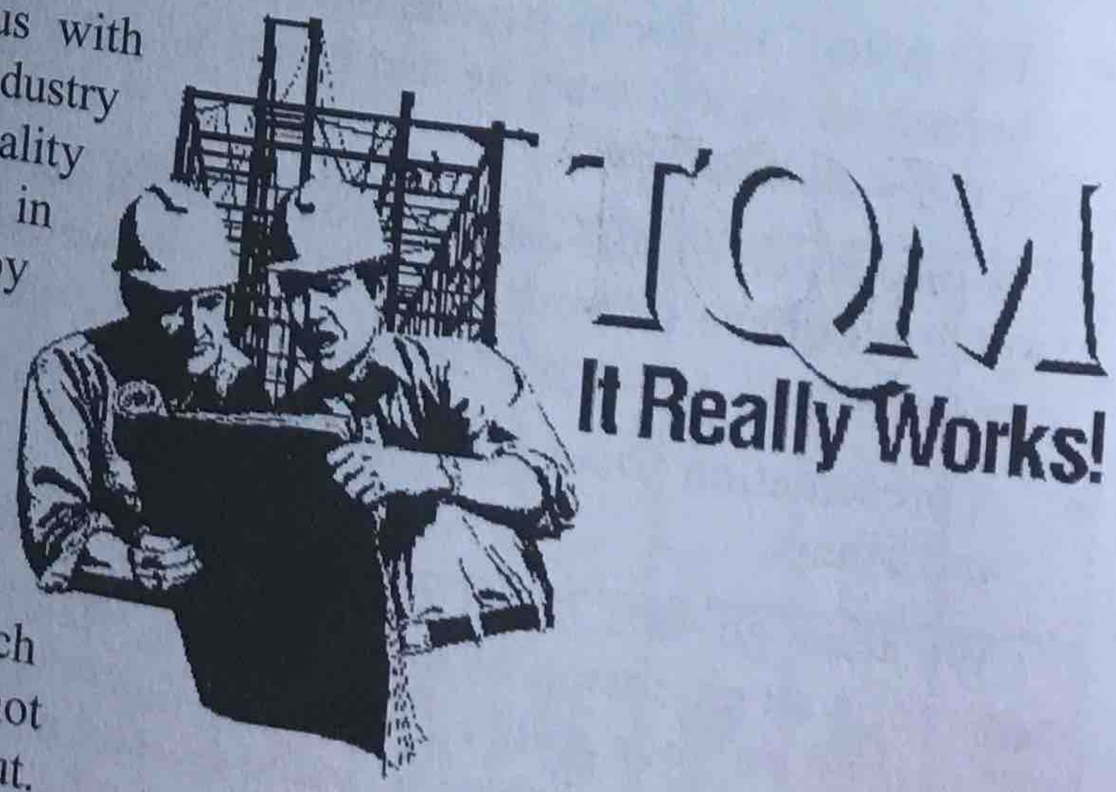
This, we have already shown, is a counterproductive attitude, but not for students alone. Resistance to change was a powerful force in post-World War II business and industry practices in the United States and a big factor in losing our number-one position in world manufacturing at the time. While other countries such as Japan, Korea, Taiwan, and Germany were striving for continuous improvement, we in the U.S. were satisfied with the status quo. Our motto for a long time was:

> ***If it ain't broke, don't fix it.***

Only recently, in the last 40 years or so, has U.S. industry changed its tune dramatically, replacing the status quo paradigm with one of continuous improvement to regain its competitive edge.

Total Quality Management

The term that has become synonymous with continuous improvement in business and industry practices worldwide is "Total Quality Management," or simply TQM. Developed in the 1950s and early 1960s primarily by Japanese industrialists – along with input from noted American statistician W. Edwards Deming – TQM espouses the philosophy that no matter how good we are, we should strive to continuously improve our quality [1]. Practitioners of TQM do not attach shame or feel resistance to change. They are not only receptive to change; they actively seek it out.



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As part of your engineering education, you will undoubtedly hear a lot about TQM (or its current counterpart *Six Sigma*). For now, though, a general overview of the TQM process will suffice. Like the engineering design process, the TQM process consists of a series of steps or stages. The first involves defining what quality means – a definition that will change from one context to the next, depending on who the customer is and what the customer's needs are. Next, performance measures (*metrics*) are established. Last, a detailed plan is drawn up and implemented to meet or exceed the performance measures.

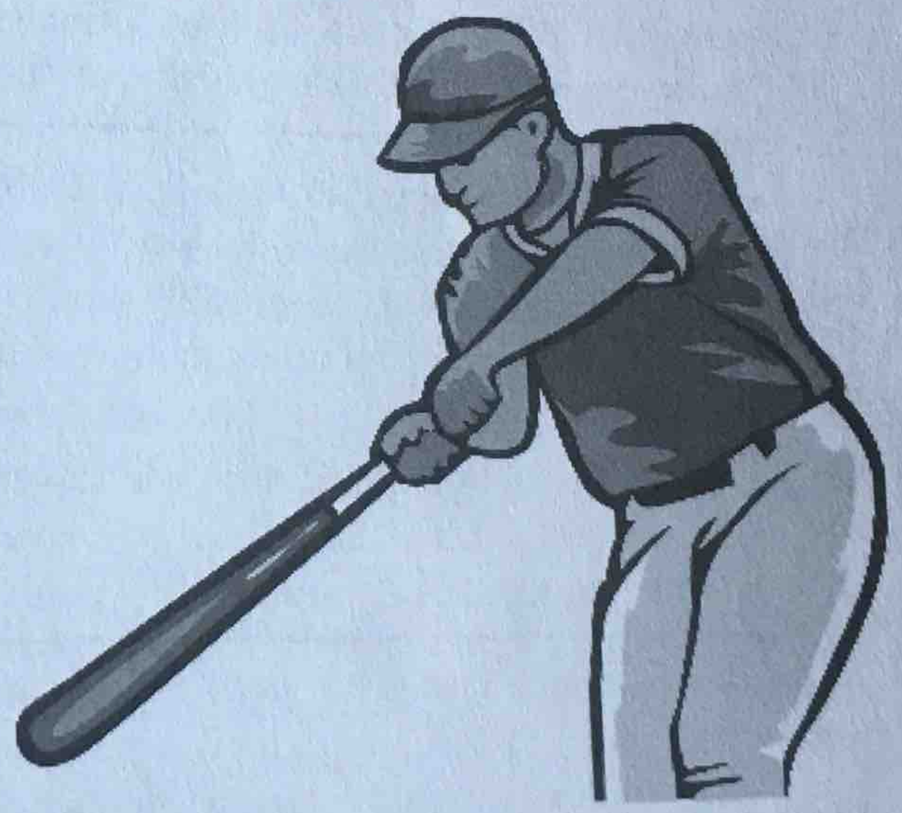
"Personal" Total Quality Management

I hope I can persuade you to adopt a ***personal TQM philosophy***. The "customer" can be you or someone else, such as your parents, your spouse or partner, your professors, or your future employer. Regardless of whom you choose, what's important is that you strive to change, grow, and improve yourself *continuously* in every area that impacts your effectiveness in meeting and exceeding the needs and expectations of your customer. Your motto should be:

> ***Even if it ain't broke, try to improve it.***

Consider, for example, a major league baseball player whose batting average is .315. This person was a superstar in high school, a superstar in college, and now a star in the major leagues. He makes $20 million a year. Yet he still works two hours a day with his batting coach to raise his average to .320. In fact, the reason his batting average is .315 is that he wasn't satisfied when it was .295.

The basic message is that successful people recognize the need to strive continuously to change, grow, and improve. Wanting to improve has nothing to do with the idea that there is something wrong with you.



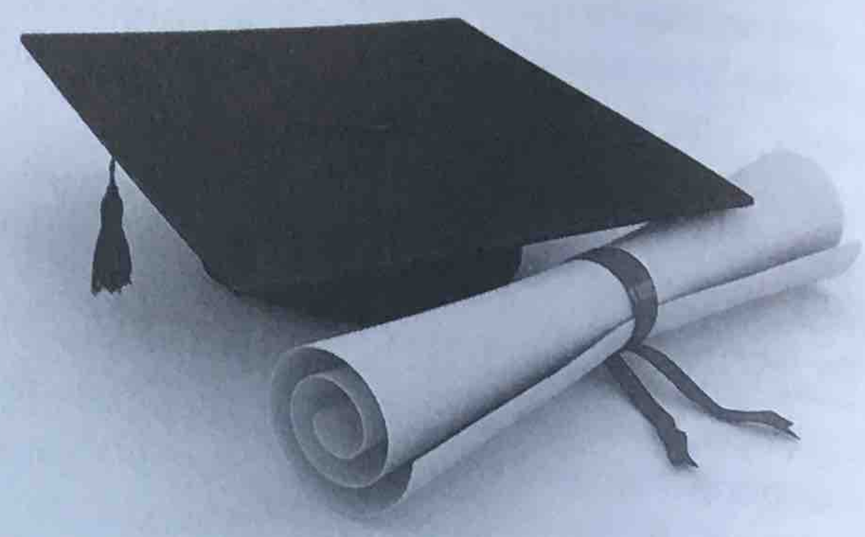
Reflection

Reflect on the idea of growing, changing, and improving. Do you embrace the idea? What would you like to change about yourself? Become a better writer? Improve your "people skills"? Stop procrastinating? Learn to cook? Feel more comfortable in your own skin?

Student Development

When I talk about a personal TQM philosophy as applied to becoming a more effective student, I call it student development, and I tailor both the TQM process and vocabulary to make them more student-oriented. The general concept of continuous improvement, however, remains unchanged.

The cornerstone of student development is well-defined goals – the counterpart of TQM's first step of defining a customer's needs. As a student, your immediate goal is earning your B.S. degree in engineering. That's a given. You may have other goals as well – achieving a certain grade point average, finding the job you want upon graduation, and performing well in that job. Over the long term, you may want to have a successful career as a practicing engineer or become president of your own company.



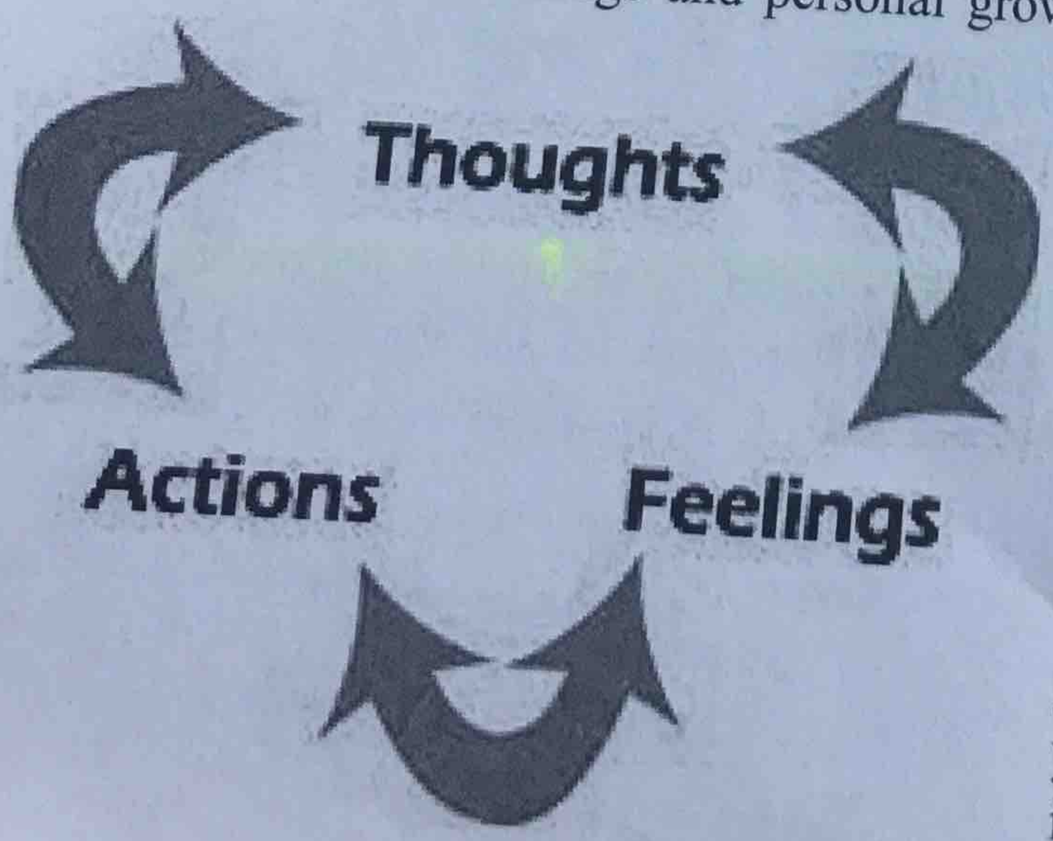
In previous chapters, we have talked extensively about the importance of goals. With regard to student development, they play other roles as we;;: They specify the areas in which you need to grow, change, or develop; and they provide the necessary foundation for tracking the progress of your personal growth (the counterpart of TQM's second step of defining performance metrics). Only with clear goals can you, or anyone else, make value judgments about your behavior. Let me give you an example.

> If a student were to tell me, "My friends have invited me to go to Las Vegas this weekend," I would have no way of assigning a value judgment to her statement. If, however, she added, "I probably won't go, because I really want to graduate this year, and I'm a little behind in my thermodynamics class," a value judgment would be easy to make, and I would support her decision not to go.
>
> On the other hand, if the same student explained, "I just finished my final exams. I studied really hard and did great," a value judgment would again be easy and I'd be inclined to say, "Congratulations! You've earned it. Have a great time in Vegas."

In this example, it was not until I knew the student's goal *("I really want to graduate this year.")* that I could place a value judgment on her proposed weekend trip. Our goals, then, provide the context we need to assess what we do – or propose to do.

VALUE JUDGMENTS APPLIED TO OUR ACTIONS, THOUGHTS, AND FEELINGS

In forthcoming sections, we will examine in depth how our goals and value judgments fit into a larger process of change and personal growth. As a preface to this examination, let's look more closely at value judgments – the *metrics* of our personal TQM program – and the behaviors to which they apply.



In the example I just gave, my value judgments pertained to the student's action (or proposed action). **Actions**, what you say and do, are one part of human behavior. You also have **thoughts**, the ideas, attitudes, values, worldviews, and mindsets you hold; and **feelings**, the emotions you have. Obviously, your actions, thoughts, and feelings are deeply interrelated: Your feelings can affect your

thoughts and actions, your actions can impact your thoughts and feelings, and so forth. But it is helpful to separate them out when talking about student development, for doing so establishes a framework for analyzing, understanding, and changing yourself.

Value judgments can be made based on an analysis of your actions, thoughts, and feelings. For this purpose, you can classify your actions in one of two ways: **productive** or **non-productive**.

Productive actions support the achievement of your goals.

Non-productive actions do the opposite: they interfere with or work against the achievement of your goals.

Similarly, you can classify your thoughts as either **positive** or **negative**.

Positive thoughts result in your choosing productive actions.

Negative thoughts result in your choosing non-productive actions.

If you return to the example on the previous page, you can see how thoughts can affect actions in either positive or negative ways. When the student in the example announced, *"My friends have invited me to go to Las Vegas for the weekend,"* she proposed an **action**. Before acting on the proposal, however, she voiced two **positive thoughts**: *"I really want to graduate this year"* and *"I probably won't go,"* which led to a **productive action** – i.e., staying home to catch up in her thermodynamics class.

In this case, we see positive thoughts bringing about a productive action. The reverse can also happen, as the following examples of negative thoughts leading to non-productive actions show:

Negative Thought	Non-Productive Action
"I'm so far behind, I don't get anything out of going to class."	Cut class.
"I learn better studying by myself."	Spend 100 percent of study time alone.
"Physics is too hard. I just can't do it."	Procrastinate; put off studying.
"Professors don't seem to want to help me. They make me feel stupid."	Avoid seeking help from professors outside of class.
"I don't like having my life run by a schedule."	Waste time by not scheduling it.
"I don't have time for student organizations."	Avoid participation in student organizations.
"I'm not good at writing and don't like doing it."	Avoid opportunities to develop writing skills.

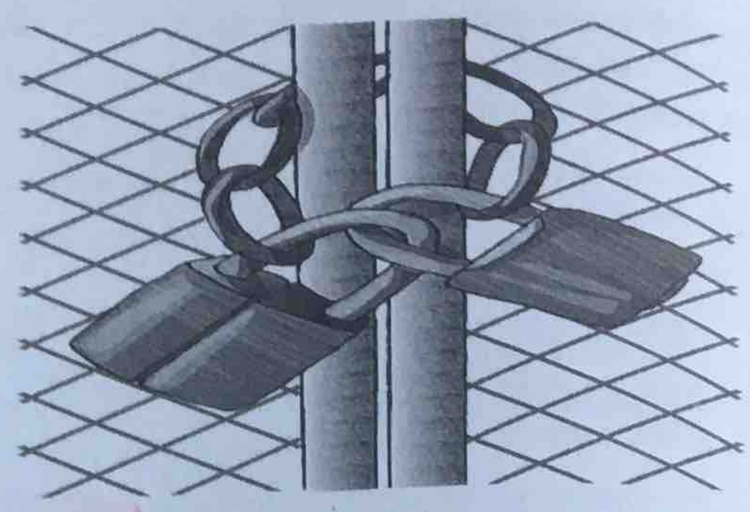
Finally, our **feelings** can be classified as either **positive** or **negative**.

Positive feelings produce positive thoughts, which in turn lead to productive actions.

Negative feelings produce negative thoughts, which lead to non-productive actions.

Sources of feelings, particularly negative ones, are not always easy to pinpoint. Because they are often connected to our self-esteem, they may be hidden, locked away in our unconscious minds as nature's way of protecting us from dangerous or unpleasant experiences. If this is the case, it normally takes time and a concerted effort with the help of a therapist or counselor to uncover them.

Self-esteem and the consequent feelings we have, conscious or unconscious, are extremely important factors in the student development process. We will discuss these factors later in the chapter, but for now it is enough for you to know that feelings constitute a distinct part of being human. And, like our thoughts, they can be judged as either positive or negative.



To give you just one example of how our feelings can affect our thoughts and actions, read the following story about "Jane R."

> Jane R. gets terrible feelings of anxiety when she has to speak in public. She has thoughts like, "I'm a lousy speaker." Before she speaks, she gets so nervous that she does a poor job.
>
> Out of desperation, she goes for counseling. During therapy, she recalls that in elementary school she was criticized by her teacher when called on to read aloud to the class. This experience left her traumatized.
>
> In therapy she realizes that it was okay for a third-grader to make a mistake when reading aloud. She also realizes that her teacher wasn't intentionally trying to harm her. As a result, she is able to forgive herself and her teacher. By diffusing the negative feelings, she begins to think, "Maybe I can do a good job of speaking in public." And she

If we were to analyze the cause-effect relationships of Jane R.'s feelings, thoughts, and actions first before and then after her therapy, the process could be diagrammed as follows:

BEFORE THERAPY

Negative Feeling	→	Negative Thought	→	Non-Productive Action
Very anxious prior to making presentations		"I'm a lousy public speaker."		Does a poor job when making a presentation

AFTER THERAPY

Positive Feeling	→	Positive Thought	→	Productive Action
Feel okay, even optimistic about future presentations		"Maybe I can do a good job of speaking in public."		Performs well on subsequent presentations

REFLECTION

Reflect on your recent actions. What are examples of actions you took that were supportive of your goal of becoming an engineer (productive actions)? What thoughts led you to take these actions (positive thoughts)? What are examples of actions you took that worked against or interfered with your goal of becoming an engineer (non-productive actions)? What thoughts led you to take those actions (negative thoughts)?

THERAPY AND COUNSELING AS CHANGE AGENTS

Jane R.'s story calls attention to the potential value of counseling and therapy in the process of personal development. Although psychotherapy typically requires a costly and lengthy

commitment, some counseling may be available to you on your campus through the student health center or counseling center.

Jane R.'s case also illustrates the basic premise of counseling or therapy, which is that any ongoing, unresolved negative feelings likely resulted from some traumatic childhood experience, which has been buried away in the unconscious mind. If this is the case, the job of the psychotherapist is to dig beneath one's surface feelings to find their root cause. Once uprooted, the originating source and feelings generally lose the cathectic force they were able to exert over the years, and the individual is then able to deal with them on a conscious, rational level – or as Jane R. did, discard them entirely.

This is, of course, a very cursory overview of the counseling process, but I hope it gives you a basic understanding of how therapy works and when it is useful to overcome certain obstacles standing in the way of your personal growth.

BEHAVIOR MODIFICATION AS A PROCESS FOR CHANGE

Behavior modification is another effective mechanism for changing your actions, thoughts, and feelings. It's probably the most accessible and practical approach if you are truly committed to personal growth.

The premise of behavior modification is somewhat different from that of counseling/therapy. It assumes that human behavioral change should start with your actions, which you consciously choose. If these actions are non-productive, you have the option to replace them with productive actions and so instigate a process that filters down to your thoughts and feelings.

According to behavior modification theory, you have less control over your thoughts than your actions. You cannot help having negative thoughts. However, you can become more conscious of them and thus have the power to change them. Generally, you can do this by finding a higher context for your thinking. Your goal will provide that context.

An Example

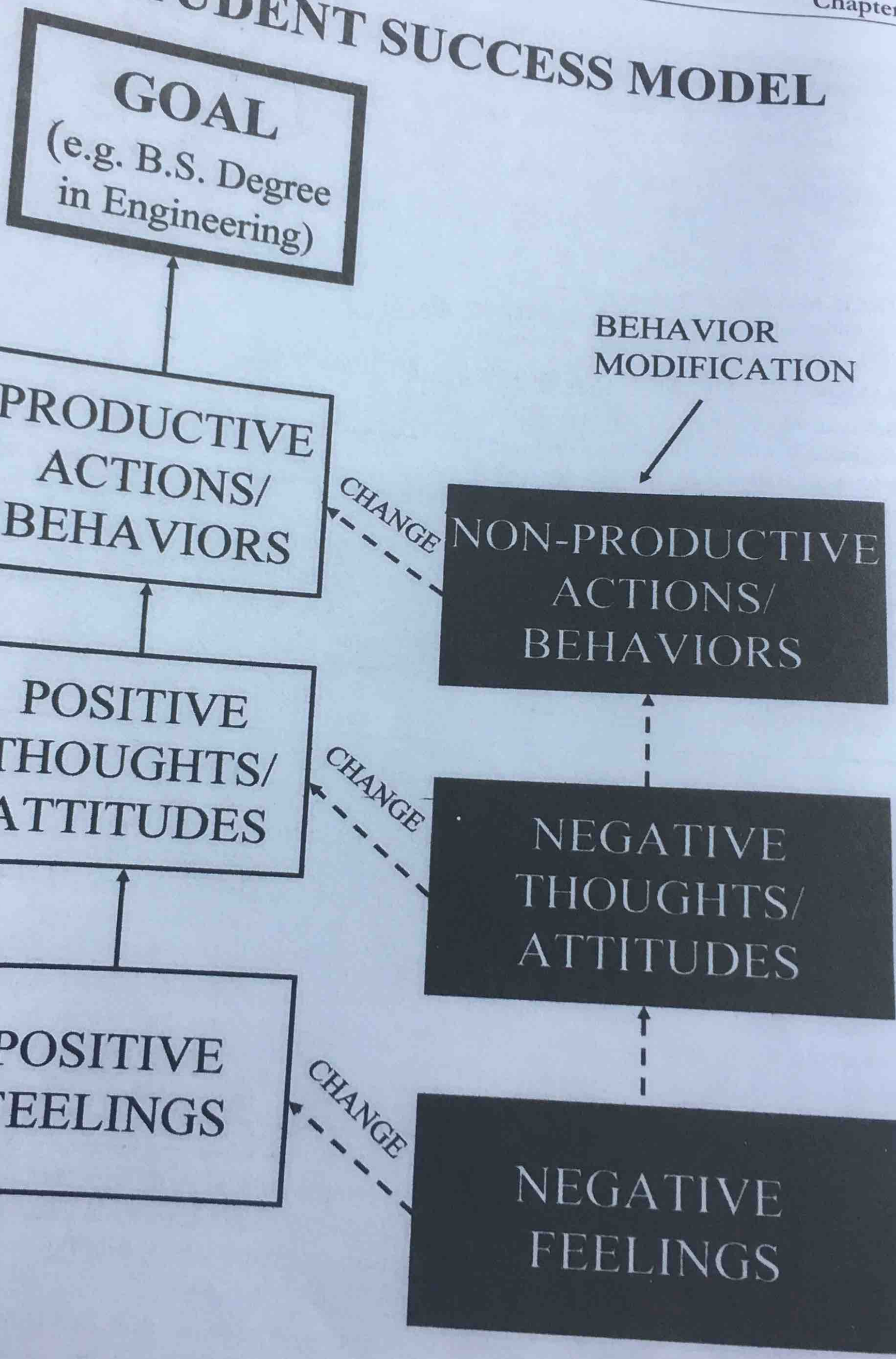
You have a test coming up in your math class. A productive action would be to study from 7:00 to 10:00 p.m. tonight. Behavior modification would hold that you are completely capable of choosing that action. However, you may have thoughts such as "I'd rather go out with my friends" or "I'm tired and don't feel like studying tonight." These are negative thoughts because, if acted on, they will lead you to a non-productive action (i.e., not studying).

Your challenge is to recognize that such thoughts are negative and try to change them. For example, the thought that "I don't feel like studying tonight" can be changed to "I really do want to study tonight because doing well in my math class will move me closer to getting my engineering degree."

As noted earlier, you have much less direct control over your feelings, because they are often tied to your self-esteem. While the issue of self-esteem will be dealt with in a subsequent section, you saw roughly how counseling/therapy starts with one's feelings to enact changes in one's behaviors. A similar rough sketch can be drawn to show how behavior modification works:

If you begin to choose productive actions in support of a personal goal, and if you work to change negative thoughts to positive ones in support of those actions, in time you will feel more positive about yourself and about your life.

STUDENT SUCCESS MODEL

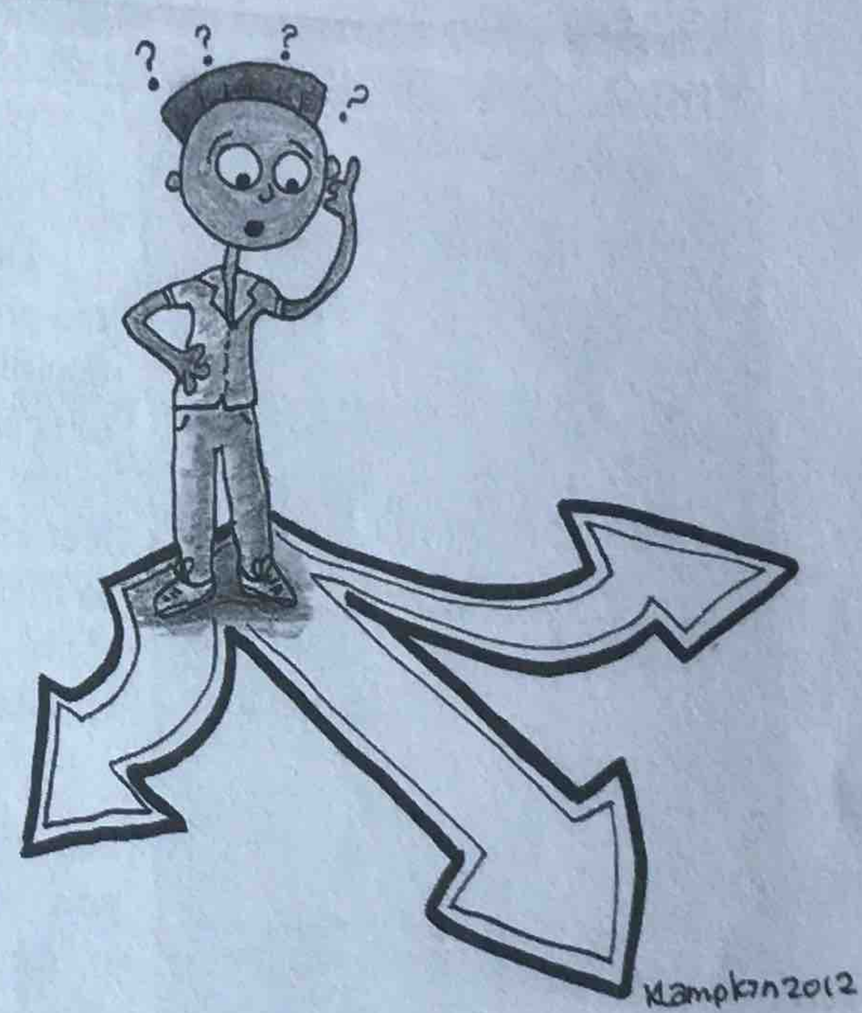


As illustrated in the Student Success Model on the previous page, achieving your goal of graduating in engineering will likely require that you change your actions from non-productive to productive ones, your thoughts from negative to positive, and your feelings from negative to positive. Through these changes you will grow and develop as a student.

6.2 MAKING BEHAVIOR MODIFICATION WORK FOR YOU: THREE STEPS TO ACHIEVE CHANGE

Sound easy? Just change those negative thoughts to positive ones, start choosing productive actions, and everything will be just great. Actually, you will find that change is not so easy. Changing your behavior requires you to successfully navigate three steps, each of which can present significant barriers to change:

Step 1. **Knowledge** - "You know what to do."
Step 2. **Commitment** - "You want to do it."
Step 3. **Implementation** - "You do it."



STEP 1. KNOWLEDGE - "YOU KNOW WHAT TO DO."

By *knowledge*, we mean: ***You know what to do.***

One of the main purposes of this book is to provide you with the knowledge of those strategies and approaches that will enhance your effectiveness as an engineering student. Much of that knowledge was presented in Chapters 3, 4, and 5. Hopefully, you have studied those chapters and recognize that implementing many of the strategies and approaches presented there will require you to change your behaviors.

Some examples of these changes are presented below.

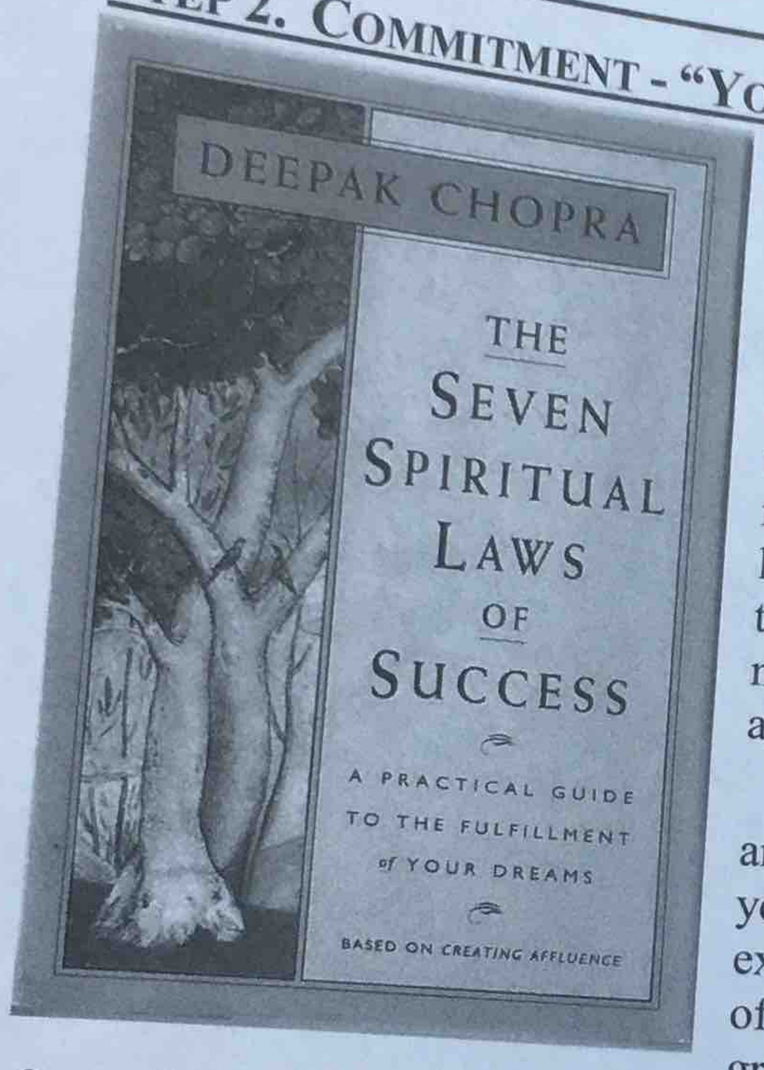
Non-Productive Action	CHANGE	Productive Action
Neglect studying	→	Devote significant time and energy to studying.
Delay studying until test is announced	→	Master the material presented in each class prior to the next class.
Study 100% alone	→	Spend time studying with other students.
Come to lectures unprepared	→	Review notes, read text, and attempt problems prior to each lecture.
Avoid professors	→	Interact regularly with professors outside the classroom.
Spend little time on campus	→	Immerse yourself in the academic environment of the institution.
Avoid participation in student organizations	→	Participate actively in student organizations.

Gaining the knowledge presented in Chapters 3, 4, and 5, however, does not guarantee that you put it into practice.

New Knowledge Is No Guarantee

A prime example of how new knowledge does not always produce change is smoking cigarettes. When I was growing up, people simply did not know that smoking caused cancer. Today, no one can deny knowing that it does. The relationship between smoking and lung cancer is an example of a new knowledge base. However, many people still smoke. They failed to change because they did not make a commitment to act on the new knowledge.

STEP 2. COMMITMENT - "YOU WANT TO DO IT."



By *commitment,* we mean that you not only know what to do but that: ***You want to do it.***

Developing that commitment requires you to go through the process of examining each academic success strategy and deciding whether you want to put it into practice. Do I want to schedule my time? Do I want to study from class to class rather than from test to test? Do I want to prepare for each lecture? Do I want to study with other students? Do I want to make effective use of my professors? Do I want to spend more time on campus? Do I believe these strategies and approaches will enhance my academic success?

A commitment to doing something typically relies first and foremost on a change in attitudes. That is, to commit to your new knowledge base, you need to first change any pre-existing negative attitudes. To do this, you need to be aware of those attitudes, particularly the ones that will obstruct your growth. A quote from Deepak Chopra's excellent book *Seven Spiritual Laws of Success* [2] shows the way:

> Most of us, as a result of conditioning, have repetitious and predictable responses to the stimuli in our environment. Our reactions seem to be automatically triggered by people and circumstances, and we forget that these are still choices that we are making in every moment of our existence. We are simply making these choices unconsciously.
>
> If you step back for a moment and witness the choices you are making as you make those choices, then in just this act of witnessing, you take the whole process from the unconscious realm into the conscious realm. This procedure of conscious choice-making is very empowering.

If negative attitudes are keeping you from changing your behaviors, try the following approach:

(1) Identify key areas in which your attitudes (e.g., studying with other students, seeking one-on-one instruction from your professors during office hours, becoming involved in student organizations) have the potential to significantly impact your academic success.

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(2) For each area, describe those attitudes.
(3) For each attitude, answer the question, "Is this attitude working for me or against me?"
(4) For each negative attitude, try to figure out its origin (i.e., "Where did it come from?").
(5) Then, answer the question, "How can I change this negative attitude to one that will work for me?"

As this example illustrates, changing your attitudes is a necessary precursor to changing your actions.

Example of This Process

Let's imagine that a student believes he is failing a math course because the professor comes across as boring, unprepared, and aloof. This student has the attitude that "I can't pass a course if I don't like the professor." He sees himself as a "victim" in which passing his math course is totally in the control of his professor. Once he becomes conscious that this is a negative attitude (interfering with his goal of academic success) and realizes that the attitude can be changed, he can go about changing it to a positive one.

An example of a positive attitude would be: "I can pass the course even if I don't like the professor, but it is going to require me to pursue strategies such as sitting in on another instructor's lecture, getting old exams, or seeking help from students who passed

Freshman Engineering Student Attitudes Survey. At this point, you might find it useful to get some feedback on the attitudes you hold. Go to: www.discovery-press.com/discovery-press/studyengr/attitudesurvey.pdf. There you will find an instrument you can use to measure your attitudes in 70 areas related to your success as an engineering student. This instrument is based on the Pittsburgh Freshman Engineering Attitudes Survey (PFEAS) [3]. If you identify any negative attitudes, try to change them using the steps described in the previous section.

Lifelong Learning. One very important attitude is how you view learning and particularly *lifelong learning*. Do you think learning is confined to the time you are in school and to the courses you are required to take? If so, this is a limited view that will not put you in good stead in your life and career.

Developing a view toward lifelong learning is particularly important in engineering because of the rapid growth of technological knowledge and innovation. Depending on your specialty, the half-life of knowledge in your field – the time it would take for half of everything you learn in school and beyond to become obsolete – ranges from 2.5 years to 7.5 years. This means that as a practicing engineer you will have to update one-half of everything you know every few years.

Given this rate of change, it is no surprise that one of the eleven attributes ABET requires of engineering graduates is:

a recognition of the need for, and an ability to engage in, life-long learning

If you think you'll know everything when you march up the aisle to receive your bachelor of science degree in engineering, you couldn't be more wrong. Industry representatives often call new engineering graduates "freshouts," a description referring to the fact that it will be several years before they will know enough to even earn their salary.

To a great extent, the process of expanding your knowledge and skills and keeping up-to-date in your field will be your responsibility. Take every opportunity to read books and journals. Talk to more knowledgeable people where you work. Attend professional meetings. Take short courses and attend seminars. Take additional university courses, whether as part of an advanced degree program or for your own professional development.

REFLECTION

How do you view learning? Do you limit your learning mainly to what is required in your classes? Or do you look for other opportunities to learn? What are some examples of things you could do to learn more than what is covered in your classes? What is your view toward lifelong learning? Are you excited about learning continuously through your career and life?

STEP 3. IMPLEMENTATION - "YOU DO IT!"

The final stage is implementation. By *implementation*, we mean that you not only know what to do and want to do it, but that: ***You do it!***

This is probably the most difficult step to take. Change can be hard, no matter how knowledgeable and committed you may be.

There are many reasons why you may fail to change behaviors that you know you should – behaviors that, in effect, work against you. For example, let's assume that you are not putting sufficient effort into studying and are doing poorly in your classes. How can this be? You want to be successful in school. You want to get all of the rewards that a career in engineering will bring to you. Still, you are not doing what is required for success.

BARRIERS TO IMPLEMENTING PRODUCTIVE ACTIONS

One primary reason you may not be willing to change is there is payoff for you to keep doing what you are doing. You have adopted your current behavior patterns because they satisfy some need or want. Abandoning old, familiar behaviors means, to some extent, finding new ways to satisfy those needs.

For example, you may go home or to your residence hall as soon as you get out of class. You may do this because you get a great deal of pleasure from the distractions you find there, such as friends, family, TV, music, food in the refrigerator, telephone, and the Internet. Choosing to stay on campus to study with other students, to seek help from professors, or to use the resources of the library may be less enjoyable to you. You may have to really work on yourself to change your thought from "I enjoy going home" to "If I go home, it's likely that I won't study. I'm going to stay at school until I get my work done."

Or you may have difficulty choosing to do things you don't find easy or pleasurable. Most people do. The impact on one's success of choosing to do difficult tasks rather than enjoyable

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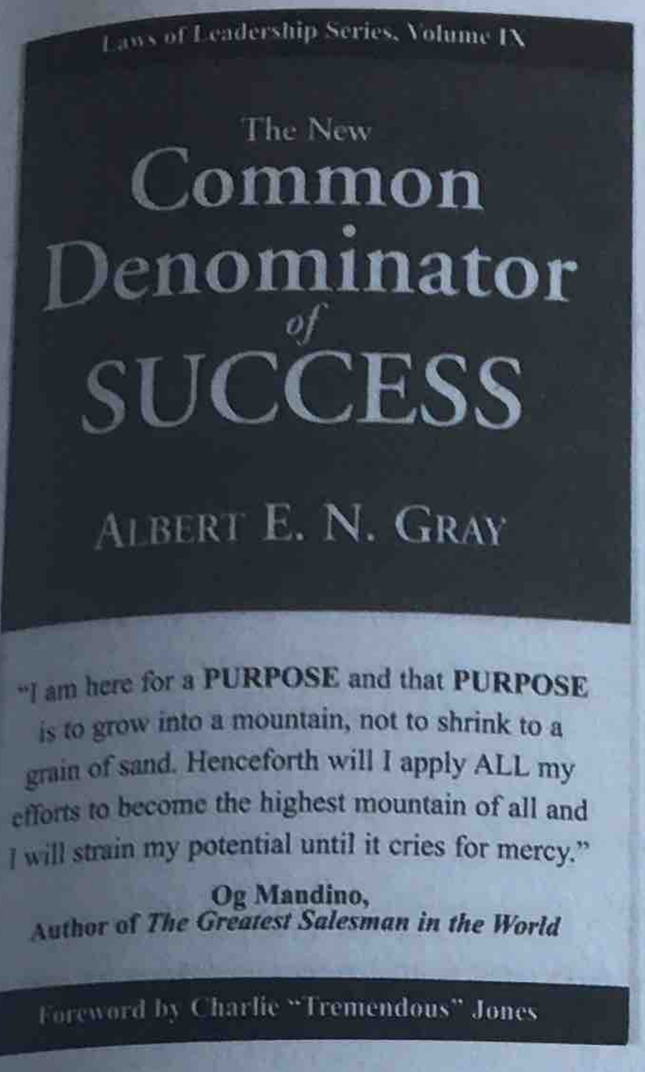


ones is perhaps best stated in a remarkable presentation by Albert E. N. Gray to a national meeting of life insurance underwriters in 1940 titled "The Common Denominator of Success" [4]

As so well put by Mr. Gray:

The common denominator of success – the secret of every [person] who has ever been successful – lies in the fact that they formed the habit of doing things that failures don't like to do.

Gray goes on to explain why a person would choose to do things they don't like doing:

Successful [people] are influenced by the desire for pleasing results. [They] have a purpose strong enough to make them form the habit of doing things they don't like to do in order to accomplish the purpose they want to accomplish. Failures are influenced by the desire for pleasing methods and are inclined to be satisfied with such results as can be obtained by doing things they like to do.

I hope your commitment to your goal of becoming an engineer is strong enough to influence you to choose productive behaviors, even if you don't like doing some of them.

I would also encourage you to read the complete text of Mr. Gray's inspiring presentation. See: www.discovery-press.com/discovery-press/studyengr/CommonDenominator.pdf.

Personal Perspective

In some ways I don't envy you. You have so many more distractions than I had when I was a student. When I was a student there were no cell phones, video games, MP3 players, PCs, Internet, YouTube, email, text messaging, or 500 channels of high definition television. When I look at the list of the "50 Greatest Technological Inventions of the Past 25 Years" in Chapter 2 (Page 71-72), I see lots of "pleasing methods" that I didn't have to tempt me.

To a great extent, your ability to manage those things so that they help you achieve your goals rather than interfere with you achieving your goals will be a key factor in your success. I hope you are able to make the right choices. I don't know of anyone who says, "I sure wish I had watched more television and played more video games when I was younger."

REFLECTION

Reflect on Albert E.N. Gray's concept that people who are successful develop the habit of doing things that people who are failures don't like to do. Do you see the wisdom in this idea? What are things that you don't like to do that need to be done if you are to be successful in your math/science/engineering courses? Is your commitment to your goal of graduating in engineering strong enough to influence you to develop the habit of doing these things?

There are other reasons why you might choose non-productive behaviors. Human psychology is very complicated and doesn't always make sense. You may be afraid to study because if you do and still fail, it will reflect on your ability. Or you may be trapped in a "victim" role, preferring to blame your failure on external factors or other people. Perhaps you feel you were forced to go to college by your parents. By not studying you are showing them that you are your own person – that you are not going to do what they want you to do. **Making change requires you to accept responsibility for your actions and to begin to view yourself as the creator of your life.**

6.3 UNDERSTANDING YOURSELF

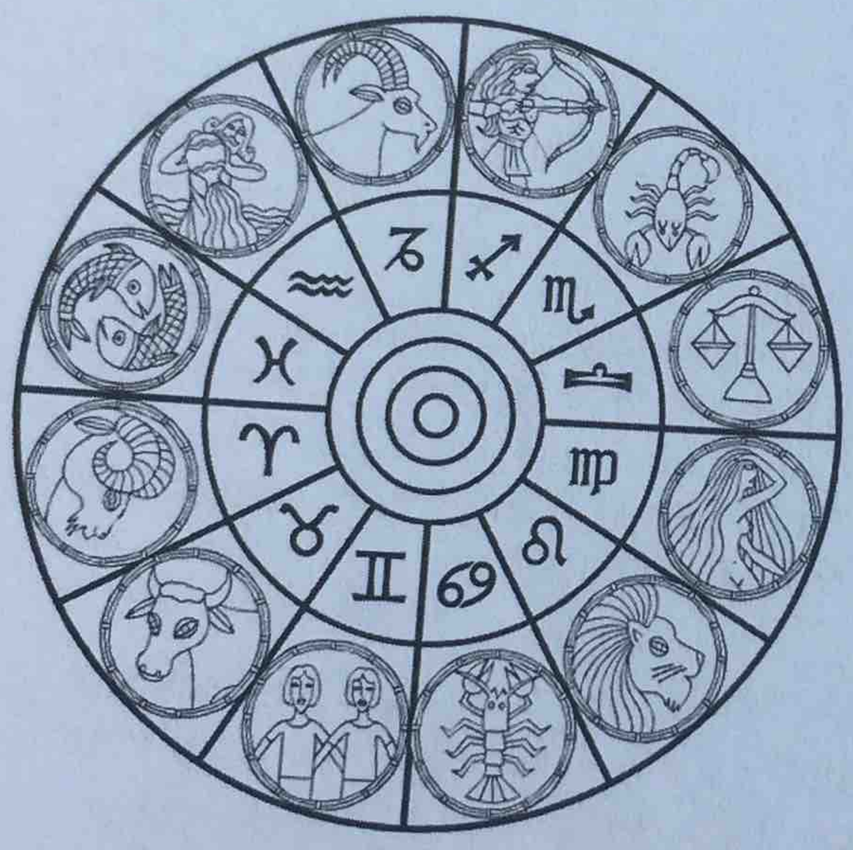
There is one subject that you don't study in school – a subject that is the key to your happiness and quality of life. That subject is YOU! The most exciting adventure you will ever embark on is the journey of self-discovery and self-awareness.

Understanding yourself is an essential aspect of becoming a productive and happy person. There are other benefits as well. As you grow in your understanding of yourself, your ability to understand other people will likewise grow.

But nobody said it would be easy. As Benjamin Franklin noted:

There are three things extremely hard: steel, a diamond, and to know one's self.

Understanding yourself is a lifelong process because human beings are very complex. As a result there are many different models or frameworks to describe human behavior and psychology.



Some of these frameworks are more useful than others. In fact, some are not even valid. I always wonder how I am supposed to believe that one-twelfth of the people in the world (all those born under my zodiac sign) have something in common with me.

Others are over-generalizations. For example, I have a friend who read a book on the importance of birth order [5]. What a bore he became! He went around asking people their birth order. If they said they were first-born, he would tell them that they were reliable, conscientious, driven to succeed, serious, self-reliant, well-organized, and on and on. This is an example of a framework that tries to put all people into one of three categories (i.e., firstborn, middle child, or last born) – an obvious oversimplification.

In Chapter 3 we presented a model for the different ways students prefer to receive and process new knowledge. Hopefully, by understanding your preferences, you have grown and developed in your ability to better design your learning process.

In this section, we will present two additional models that can be useful to you as an engineering student. The first is **Maslow's Hierarchy of Needs** [6]. This hierarchy will give you an understanding of basic needs that must be met if you are to be motivated to succeed in your studies.

One of these needs is feeling good about yourself. Because your ***self-esteem*** is a very important factor in your productivity and overall happiness, we will address it in some detail.

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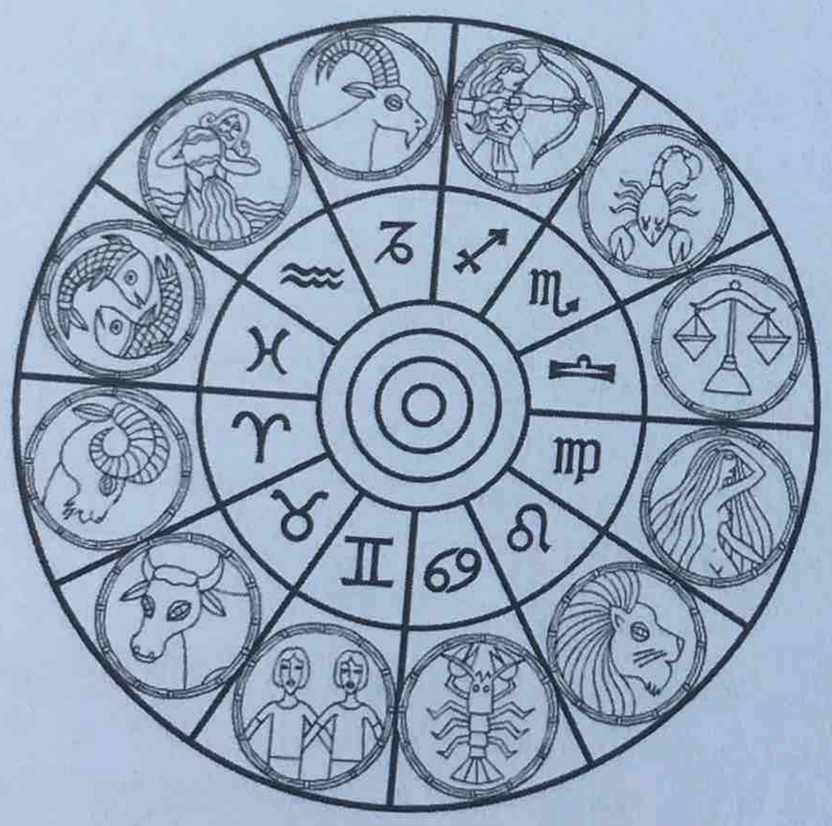

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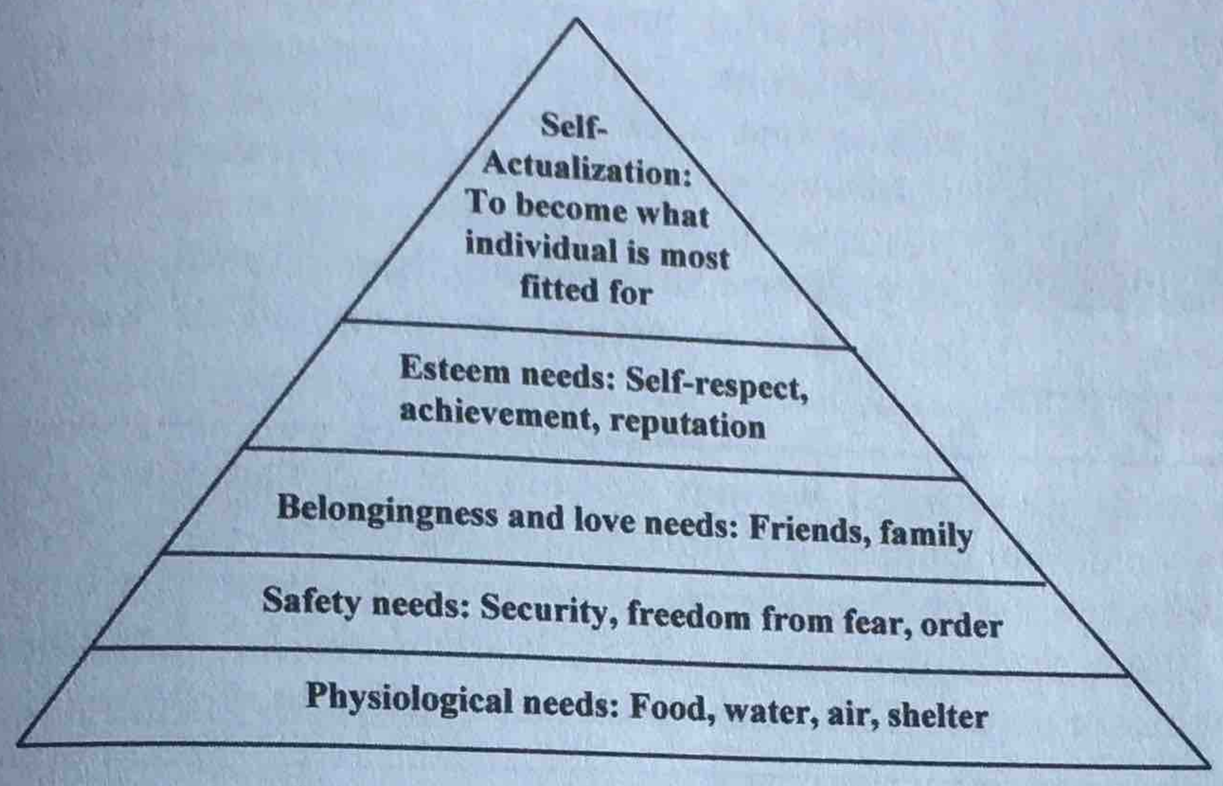
One of these needs is feeling good about yourself. Because your ***self-esteem*** is a very important factor in your productivity and overall happiness, we will address it in some detail.

Finally, we will discuss the **Myers-Briggs Type Indicator** as a way to characterize different personality types, and we will note how engineering students on average differ in personality types from the general population.

MASLOW'S HIERARCHY OF NEEDS

Famed psychologist Abraham Maslow focused his research on the relationship between human motivation and needs, particularly unmet needs. Motivation, he claimed, is the inner drive that propels behaviors and actions. To illustrate the connection between motivation and needs, he developed this hierarchy:



MASLOW'S HIERARCHY OF NEEDS

According to Maslow's theory, needs must be satisfied from the bottom up. If a lower-level need exists, you will be highly motivated to satisfy that need. When lower-level needs are satisfied, higher-level ones become important, and you become motivated to satisfy those needs.

At the lowest level are **your physiological needs** for food, water, air, and shelter. If you are reading this book, you probably are satisfying these needs. If not, it is unlikely that you will be able to focus on your academic work.

> ***Needs Are Not Wants***
>
> It is important to distinguish between needs and wants. **Needs** are things that you must have, things that are essential. **Wants** are things that you desire. For example, you may want to have an expensive car, but having one is not essential. Don't let unnecessary wants distract you from academic success.

At the second level are **your safety needs**, including the need for security and freedom from fear of physical and psychological threats. Again, I hope that these needs are not issues for you. If you are afraid of a bully in your residence hall or a former boyfriend or girlfriend, it is doubtful that you will be able to concentrate adequately on your studies.

At the third level are **your social needs**, such as needing to belong, to be accepted, and to receive support and affection from others. These social needs are generally met by family and friends. If you left home to go to college, you may be experiencing a period in which these social needs are not being met. It is important, therefore, for you to develop new friends and relationships in your new environment. Unmet social needs can interfere with your studies. The good news is that many of your classmates are also looking to satisfy these same needs.

Abraham Maslow

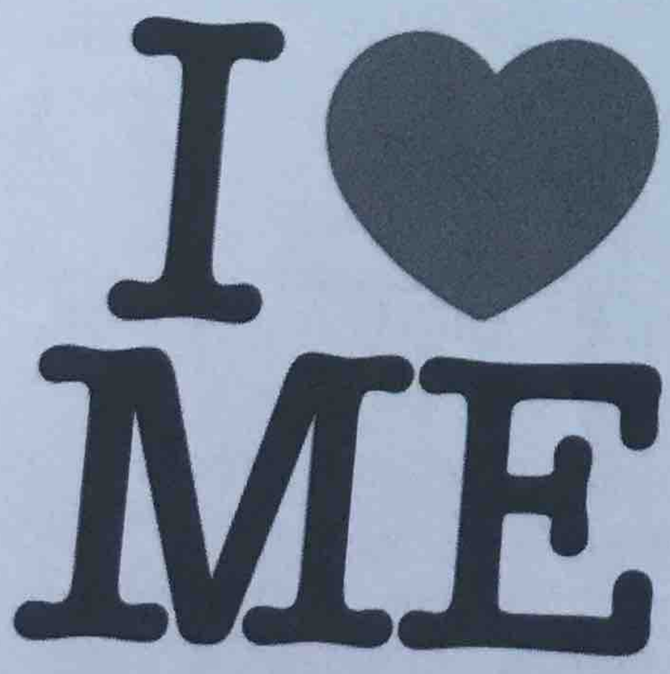
Maslow's fourth level centers on **your needs for esteem**, including self-respect, achievement, and recognition. You need to feel good about yourself and to feel as though you have the respect and appreciation of others. As an engineering student, you build self-esteem through appreciation for your academic success and through co-curricular accomplishments. But equally important is how you treat other people. (We will elaborate on the topic of self-esteem in the next section.)

The fifth and highest level is **your need for self-actualization**. Self-actualization means fully developing your abilities and ambitions. It is the need you have to reach your highest potential, or put in simple terms, "to do your best." This is the need that causes you to want to excel on a test, to do your best in a game of tennis, and generally to learn, to grow, and to develop in a myriad of ways. As Maslow explains:

> Even if all other needs are satisfied, we may still often expect that a new discontent and restlessness will soon develop, unless the individual is doing what he or she, individually, is fitted for. Musicians must make music, artists must paint, poets must write if they are to ultimately be at peace with themselves. What humans can be, they must be. They must be true to their own nature. This need we may call ***self-actualization***.

Obviously, to be a successful student, you must be able to pursue your need for self-actualization. This means that you must first satisfy your physiological, safety, social, and esteem needs.

SATISFYING YOUR NEED FOR SELF-ESTEEM



As indicated by Maslow's Hierarchy of Needs, self-esteem is a fundamental human need. We cannot be indifferent to the way we feel about ourselves. Self-esteem is a critically important factor in virtually every aspect of life. It influences what we choose to do, how we treat others, and whether we are happy or not.

Many problems faced by our society such as drug and alcohol abuse, crime and violence, poverty and welfare abuse, teenage pregnancy, the disintegration of the family, and the high dropout rate among high school students are directly related to the low self-esteem of many of our citizens. Several years ago, the California Legislature established a Task Force to Promote Self-Esteem to make recommendations on what the state could do to enhance the self-esteem of its citizens [7].

The Task Force defined *self-esteem* as:

> Appreciating my own worth and importance and having the character to be accountable for myself and to act responsibly toward others.

According to Nathaniel Branden [8], self-esteem is made up of two interrelated components:

Self-efficacy - your sense of competence
Self-respect - your sense of personal worth

To be self-efficacious is to feel capable of producing a desired result. Self-efficacy derives from your confidence in the functioning of your mind and your ability to understand, learn, and make decisions.

Self-respect comes from feeling positive about your right to be happy, from feeling that you are worthy of the rewards of your actions, and from feeling that you deserve the respect of others.

It is important to have both self-efficacy and self-respect. If you feel competent but not worthy, you may accomplish a great deal, but you will lack the capacity to enjoy it. You may feel that you must continually prove your worth through achievement. Overachievers and "workaholics" are generally striving to meet their need for self-respect by feeling competent and productive.

There is a strong correlation between our self-esteem and our behaviors. According to Branden, healthy self-esteem correlates with:

Rationality	Realism
Intuitiveness	Creativity
Independence	Flexibility
Cooperativeness	Willingness to admit mistakes
Benevolence	Ability to manage change

Poor self-esteem correlates with:

Irrationality	Blindness to reality
Rigidity	Fear of the new and unfamiliar
Rebelliousness	Inappropriate conformity
Defensiveness	Overcontrolling behavior
Fear of others	Hostility toward others

REFLECTION

Consider the ten items listed in this section that correlate with healthy self-esteem. How many of the items describe you? Consider the ten items listed in this section that correlate with poor self-esteem. How many of those items describe you? What might you do to change yourself with regard to any items that correlate with poor self-esteem?

It is no surprise that high self-esteem is one of the best predictors of personal happiness [9]. The value of self-esteem is not merely that it allows you to feel better, but also that healthy self-esteem will be a key factor in your productivity and success. According to Branden:

High self-esteem seeks the challenge and stimulation of worthwhile and demanding goals. Reaching such goals nurtures self-esteem. **Low self-esteem** seeks the safety of the familiar and the undemanding. Confining oneself to the familiar and the undemanding serves to weaken self-esteem.

How can you enhance your self-esteem? The feedback loop between your actions and your self-esteem described by Branden points the direction. That is, the level of your self-esteem influences how you act. Conversely, how you act influences the level of your self-esteem.

Recall our discussion of behavior modification in Section 6.2, which is based on the premise that you **choose** your actions. You can choose productive actions or you can choose non-productive ones. You have less control over your thoughts, but you can catch negative thoughts and work at changing them to positive thoughts. Behavior modification also asserts that if you choose productive actions in support of a personal goal and you work at changing your negative thoughts to positive thoughts in support of those actions, in time your feelings will change. You will feel better about yourself and your life. Your self-esteem will improve.

Your college years provide a unique opportunity for you to enhance your self-esteem by building both your self-efficacy and your self-respect.

Your engineering education will strengthen your problem-solving skills, your technical knowledge, and your ability to work with others. All of this will increase your confidence in your ability to face life's challenges and to achieve whatever goals you set for yourself. Through this process, you will build your self-efficacy.

Your engineering education will afford opportunities to build your self-respect and your feeling of personal worth as well. Academic success will bring positive feedback from your professors and fellow students. More tangible rewards such as scholarships, internships in industry, and admission to graduate school can be yours. You can be president of an engineering honor society, be the team leader of your institution's entry in a national engineering student competition, be paid to work on a professor's research project, or be the co-author of paper that is presented at an international conference. These accomplishments will be respected by others and will enhance your sense of self-worth. And you won't have to feel this way:

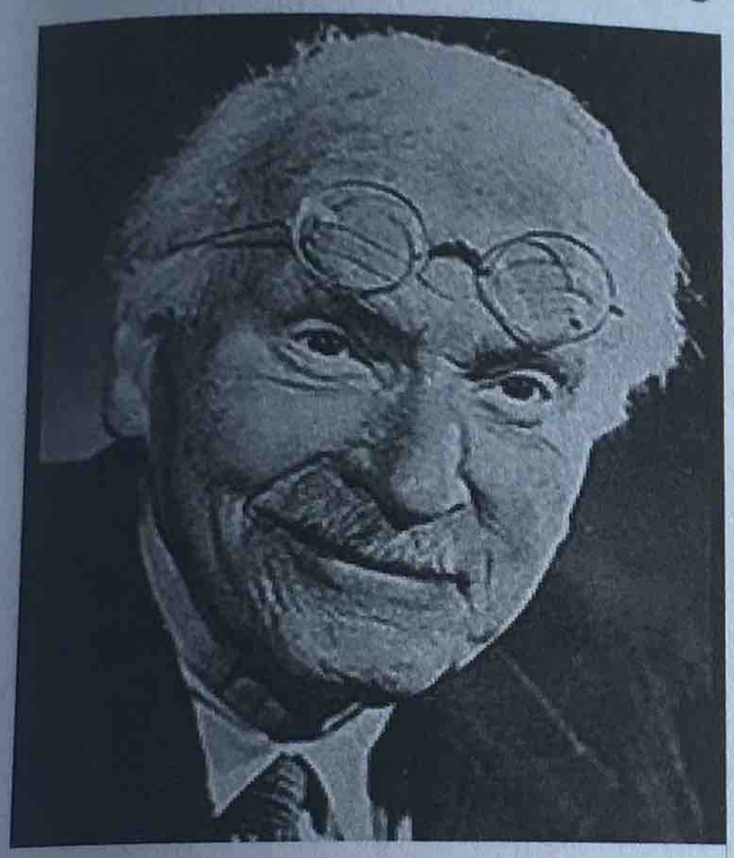
"I'VE GOTTA BE ME . . . BUT I CAN'T HELP THINKING SOMEONE ELSE WOULD BE MORE QUALIFIED!"

Success in engineering study will enhance your feeling of competence and your self-respect. These together will build healthy self-esteem. But it is up to you. You can let the negative feelings associated with low self-esteem produce negative thoughts that lead you to non-productive actions and failure. You can also choose productive actions and positive thoughts that will lead you to success and to feeling good about yourself.

MYERS-BRIGGS TYPE INDICATOR (MBTI)

Individuals are different. We each have preferences for how we interact with the world around us, how we learn, and how we make decisions.

I, for example, am an extrovert. I am energized by interactions with other people. I like lots going on around me and like to get tasks accomplished. I am a linear thinker. I can figure out anything that is logical. The hardest assignments I had in high school were to memorize poems. I just couldn't do it. It wasn't logical. Furthermore, I'm not very creative. I would be the worst at painting a picture or decorating an empty room.



Carl Jung

Finally, I like things to be planned and orderly. I don't like surprises. I'm not very spontaneous. When I go on vacation, I make reservations. My worst fear would be to arrive somewhere and find there were no accommodations.

You may be very different from the way I am. You may have very different preferences. People may tire you out. You may prefer to work alone. You may be very creative and artistic. You may prefer being flexible and spontaneous as opposed to being organized and orderly. You might like to arrive in a European city late at night with no reservations. You may be very intuitive, easily grasping the "big picture" through your imagination or bursts of insight.

The famous Swiss psychologist Carl Jung did seminal work on psychological types [10]. Jung's work led to the Myers-Briggs Type Indicator (MBTI), a matrix widely used today to lead to self-understanding [11]. The MBTI characterizes individuals in four areas:

(1) Does the person's interest flow mainly to:	
The outer world of actions, objects, and persons?	E-extrovert
The inner world of concepts and ideas?	I-introvert
(2) Does the person prefer to perceive:	
The immediate, real, practical facts of experience and life?	S-sensing
The possibilities, relationships, and meanings of experiences?	N-intuiting
(3) Does the person prefer to make judgments or decisions:	
Objectively, impersonally, considering causes of events and where decisions may lead?	T-thinking
Subjectively and personally, weighing values of choices and how they matter to others?	F-feeling

(4) Does the person prefer mostly to live:	
In a decisive, planned, and orderly way, aiming to regulate and control events?	J-Judging
In a spontaneous, flexible way, aiming to understand life and adapt to it?	P-Perceiving

The result of this characterization is to place individuals into 16 personality types based on combinations of four pairs of letters (E or I, S or N, T or F, J or P).

I would encourage you to learn not only about your own personality type but also about the other 15 personality types. Learning about other personality types will help you understand how others may differ from you.

There are two ways to find out your personality type. One is to take the MBTI test. It is very likely that it is administered somewhere on your campus – either by the testing office, the counseling center, or the career center.

The second way is to take a similar test that is based on the same research that led to the MBTI: the Keirsey Temperament Sorter II. The handy thing about this test is that it can be taken and scored free of charge on the Internet at: www.keirsey.com/sorter/register.aspx.

The Keirsey Temperament Sorter II requires you to choose one of two descriptors for each of 70 items. Based on the results, you will be placed into one of the same 16 categories as the MBTI. These are also described in terms of four temperaments, each having four variants, shown below with the corresponding Myers-Briggs personality types.

Temperament	Variant 1	Variant 2	Variant 3	Variant 4
Guardian	Supervisor (ESTJ)	Inspector (ISTJ)	Provider (ESFJ)	Protector (ISFJ)
Artisan	Promoter (ESTP)	Crafter (ISTP)	Performer (ESFP)	Composer (ISFP)
Idealist	Teacher (ENFJ)	Counselor (INFJ)	Champion (ENFP)	Healer (INFP)
Rational	Field Marshall (ENTJ)	Mastermind (INTJ)	Inventor (ENTP)	Architect (INTP)

One feature of the Keirsey website is that it enables you to access descriptions of each of the 16 personality types. If those descriptions aren't enough, I highly recommend two excellent resources: Keirsey's book *Please Understand Me II: Temperament, Character, Intelligence* [12] and *Do What You Are: Discover the Perfect Career for You Through the Secrets of Personality Type* [13].

You might be interested to know that engineering students tend to differ from the general population, as the table below shows [14]:

	General Population	Engineering Students
Introvert (I)	30%	67%
Intuiting (N)	30%	47%
Thinking (T)	50%	75%
Judging (J)	50%	61%

As you can see, engineering students have a greater tendency than the general population to be introverts rather than extroverts, to prefer to use a logical approach to make decisions, and to prefer to live in a planned, orderly way. Although a higher percentage of engineering students are intuitors than the general population, more than half of engineering students prefer to gain information using their senses. In Myers-Briggs lingo, the most frequent personality type found among engineering students is ISTJ, followed in order by ESTJ, INTJ, INTP, and ENTJ.

6.4 UNDERSTANDING OTHERS/RESPECTING DIFFERENCES

One of the most important areas of your personal growth is respecting people who are different from you. Engineering, now more than ever, is a team-oriented profession. Your success as both an engineering student and engineering professional will be closely related to your ability to interact effectively with others. As an engineer, you will be required to work with, supervise, and be supervised by people differing from you in learning styles and personality types and in gender, ethnicity, as well as cultural background.

DIFFERENCES IN LEARNING STYLES AND PERSONALITY TYPES

Understanding and respecting the different learning styles presented in Chapter 3 and the various personality types presented in Section 6.3 of the current chapter can help you work effectively with people who differ from you. Ned Herrmann, in his excellent book *The Creative Brain,* [15] puts forth some pertinent ideas about such differences:

(1) Differences are not only normal, but they are also positive and creative.

(2) Appreciating and using these mental differences make change easier to deal with because it makes us more creative.

(3) As we appreciate the full spectrum of mental gifts – ours and those of others – we can make better choices in our lives, especially in selecting educational and career directions.

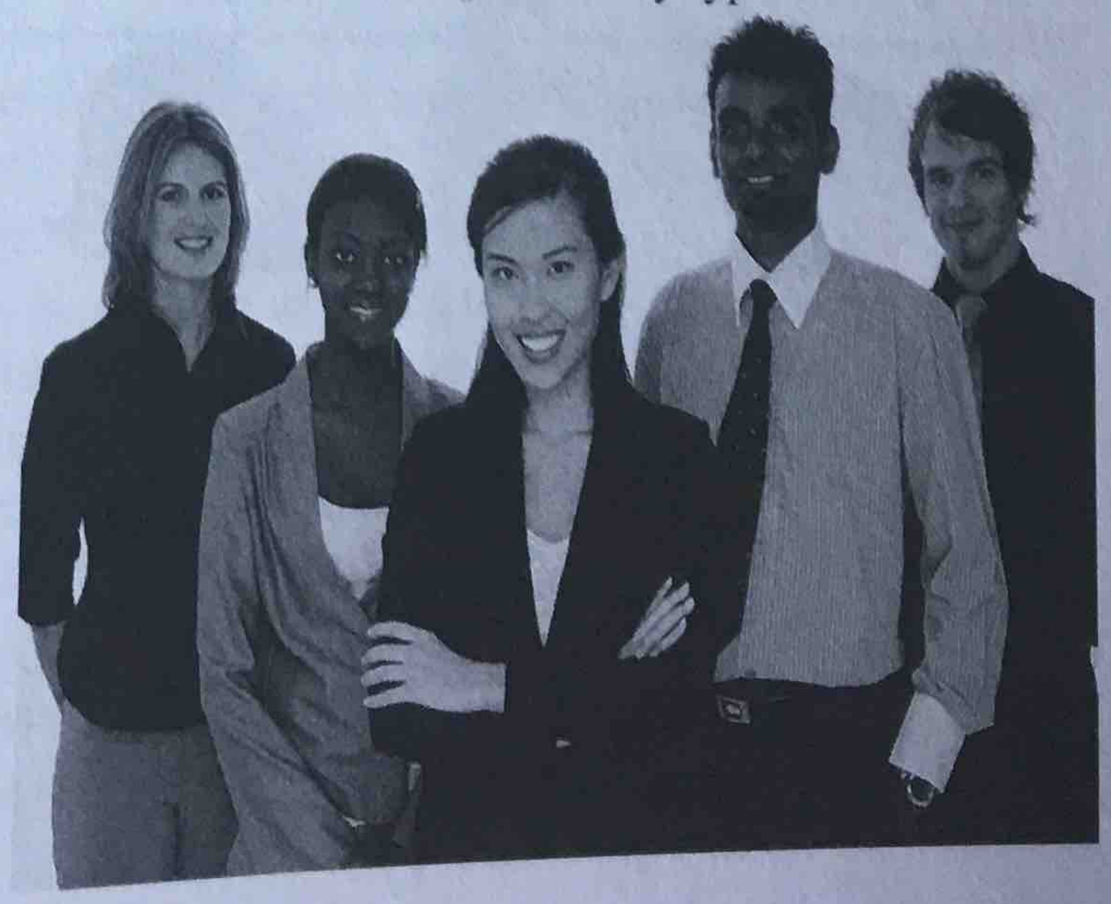
(4) If those who manage others acknowledge and honor personal preferences and give people the chance to match their work with their preferences, they will be able to see tremendous gains in productivity.

(5) As we learn to value and, above all, affirm one another's unique mental gifts, we can participate in the formation of true community – perhaps our best hope for survival in this strife-torn world.

I'm sure you'll agree that this is an impressive list of the benefits that can come to you by better understanding the differences in people's learning styles and personality types.

ETHNIC AND GENDER DIFFERENCES

Other critically important areas of difference concern gender and ethnicity. Forty years ago, 98 percent of engineers in the U.S. were white males. This is no longer the case. The percentage of women and ethnic minorities among engineering and computer science graduates has been increasing steadily. As the chart below indicates, 43 percent of engineering graduates were women, ethnic minorities, and foreign nationals. And that percentage is expected to grow.



B.S. Degrees Awarded in Engineering and Computer Science Ethnic and Gender Groups - 2010/11 [16]

	Number	Percentage
Non-Minority Women	8,504	11.1%
African-Americans	3,251	4.2%
Hispanics*	5,613	7.3%
Native-Americans	360	0.5%
Asian-Americans	9,541	12.4%
Foreign Nationals	5,597	7.3%
TOTAL	**32,866**	**42.8%**

* Excluding Puerto Rico

Unfortunately, prejudice, bigotry, and discrimination continue to be problems in our society. We tend to have a compulsive need to build ourselves up by putting others down.

How we treat others is closely related to self-esteem. If we don't feel good about ourselves, it is likely that we won't feel good about others. This is well stated in the report of the California Task Force to Promote Self-Esteem [7]:

> The more we appreciate our own worth and importance, the more we are able to recognize and appreciate the worth and importance of others as well.

We now live in a multi-ethnic, multicultural society. The old *melting pot* idea is no longer operative. As a nation, we are now more like a "mosaic," or a mixture of separate and different peoples, each having its own unique characteristics. Indeed, the concept of a *melting pot* has become offensive. Why should I strive to be the same as you? The quality of my life and the contributions I make are related to my special qualities and uniqueness as an individual. If I come from a different background and experience than you, I can act and think in ways that you cannot.

As an engineering student and a future engineering professional, you need to learn to respect and value people from different ethnic backgrounds. This may require you to work through certain prejudices, even if they seem as "innocuous" as telling racist jokes. Just remember a prejudice is nothing more than a thought or attitude that you have the capacity to change.

A Personal Story

I grew up in a very racist environment. At the time I completed high school in 1957 in Jacksonville, Florida, the worst forms of institutional racism and legalized segregation were in effect. Certainly with that kind of upbringing, I had a lot of changing to do. After spending several years at a northern liberal college, I became a zealous supporter of the civil rights movement and came to abhor the evils of the racist society I grew up in. This is undoubtedly why I devoted a significant portion of my professional career to working affirmatively to undo the effects of racism.

I could tell innumerable stories of how I became aware of the many negative impacts of racism. One that comes to mind is the lesson I learned about ethnic jokes. I used to have a favorite Polish joke, one I thought "won me points" whenever I told it. Then, when I was working on my Ph.D. degree, I took a Russian course to meet my language requirement. I arrived a bit late to the first class, only to find the instructor agitated and upset.

As it turned out, he was of Polish descent and the subject of Polish jokes had somehow come up. At the second class meeting, he brought in a research paper documenting the demeaning effects the Polish joke phenomenon had on the self-image of Polish-American children. I promise you that I have never told that Polish joke nor any other ethnic joke since that day.

As we discussed in Section 6.2 and as my personal story demonstrates, new knowledge can produce change. Sensitivities can develop by understanding the injustices around us.

For many years I visited universities regularly to assist them with their efforts to increase the representation of underrepresented minorities in their engineering programs. I always asked to meet with minority students to get their perspective. It broke my heart when they told me that white students resisted forming laboratory groups with them, left the seats next to them vacant, or acted surprised when they did well on tests. I hope you will not engage in these very harmful and unnecessary behaviors.

STEREOTYPING IS UNNECESSARY AND UNFAIR

One of the primary bases of prejudice is ***stereotyping***.

A ***stereotype*** is a fixed conception of a person or a group that allows for no individuality.

Engineering students are often labeled as *nerds* who care only about how things work and have no interest or skill in dealing with people. The obvious problem with general descriptions like this is that the stereotype doesn't apply to all individuals in the group.

Just as I'm sure you would not like to be labeled as a *nerd* merely because you are an engineering student, I hope you will refrain from stereotyping others. The best way to approach people who differ from you in any way is to suspend judgment. Resist the urge to draw conclusions about someone you don't even know. Indeed, view occasions to get to know individuals as opportunities to learn!

Stereotyping also works against gender parity. Sheila Widnall, Secretary of the Air Force in the Clinton administration, wrote a powerful paper [17] outlining some of the obstacles experienced by women who study science and engineering. According to Dr. Widnall:

> Studies of objective evaluations of the potential and the accomplishments of women give quite discouraging results. Such studies in which male or female names are applied to resumes, proposals, and papers that are then evaluated by both male and female evaluators consistently show that the potential and accomplishments of women are undervalued by both men and women, relative to the same documents with a male attribution.

I hope that you agree that we have a long way to go in providing equal and fair treatment to all people.

Reflection

Reread Secretary Widnall's passage above. Is it clear what she is saying? Do you think you would have a different reaction to the same resume if it had a man's name on it than if it had a woman's name on it? Do you think you would be more inclined to fund a proposal if it was attributed to a man than if it was attributed to a woman? Do you think the unequal treatment described in the passage is widespread? How does the thought that it is make you feel?

YOUR EFFECTIVENESS IN CROSS-CULTURAL COMMUNICATIONS

What can you do to improve your effectiveness in working with and communicating with people who differ from you? First and foremost, you should seek out opportunities to interact with men and women from different ethnic and cultural backgrounds. You can learn a great deal from them and improve your interpersonal communication skills in the process. If you truly want to grow in this area, take a course in cross-cultural communications. I think you will not only find the subject very interesting, you also will learn skills that will come into play throughout your life.

If we all practiced the *Silver Rule,* originally credited to Confucius, in our interactions with others, we probably wouldn't need to discuss this issue at all:

> ***What you would not want others to do unto you, do not do unto them.***

Abiding by this adage, we certainly wouldn't put others down, stereotype others, treat others unfairly, resent others, or make others the butts of our jokes, since we would not like to have these things done to us.

REFLECTION

Contrast the Silver Rule above with the more widely quoted Golden Rule (*Do unto others as you would have others do unto you*). How do the two rules differ? Is there a difference between telling people what they should do to others and telling people what they shouldn't do to others? Can you think of some examples where you did something to someone that you wouldn't want another person to do to you?

As a nation we have made significant progress in the area of race relations and multiculturalism, but not nearly enough. Robert Cottrol of Rutgers Law School gives us an optimistic vision for the future [18]:

> ***Perhaps our most important contribution to the twenty-first century will be to demonstrate that people from different races, cultures, and ethnic backgrounds can live side by side; retain their uniqueness; and, yet, over time form a new common culture. That has been the American story. It is a history that has much to tell the world.***

I hope YOU will contribute to making this vision a reality!

6.5 Assessment of Your Strengths and Areas for Improvement

Once you are committed to personal development, you need to start by assessing your strengths and areas for improvement. We talked about this earlier in the chapter when we introduced the concept of a "personal TQM philosophy," and discussed making value judgments about our actions, thoughts, and feelings based on our goals.

Another basis for assessing your strengths and areas for improvement was presented even earlier – in Chapter 1, where we looked at models for viewing your education.

Assessment Based on Attributes Model

If you recall, the **Attributes Model** indicates the knowledge, skills, and attitudes that you should gain from your engineering education. A personal assessment based on this model involves evaluating how strong you are with regard to each of the following attributes:

An ability to apply knowledge of mathematics, science, and engineering
An ability to design and conduct experiments, as well as to analyze and interpret data
An ability to design a system, component, or process to meet desired needs
An ability to function on multidisciplinary teams
An ability to identify, formulate, and solve engineering problems
An understanding of professional and ethical responsibilities
An ability to communicate effectively
A broad education necessary to understand the impact of engineering solutions in a global and societal context
A recognition of the need for, and an ability to engage in, life-long learning
A knowledge of contemporary issues
An ability to use the techniques, skills, and modern engineering tools necessary for engineering practice

Assessment Based on Employment Model

Similarly, you could do a personal assessment based on the **Employment Model**. This model identifies those factors employers use in evaluating you when you apply for a job:

Communicates effectively in a variety of different ways, methods, and media
Possesses the ability to think both critically and creatively
Shows initiative and demonstrates a willingness to learn
Functions effectively on a team
Possesses the ability to think both individually and cooperatively

Demonstrates an understanding of engineering, science, and mathematics fundamentals
Demonstrates an understanding of information technology, digital competency, and information literacy
Maintains a positive self-image and possesses positive self-confidence

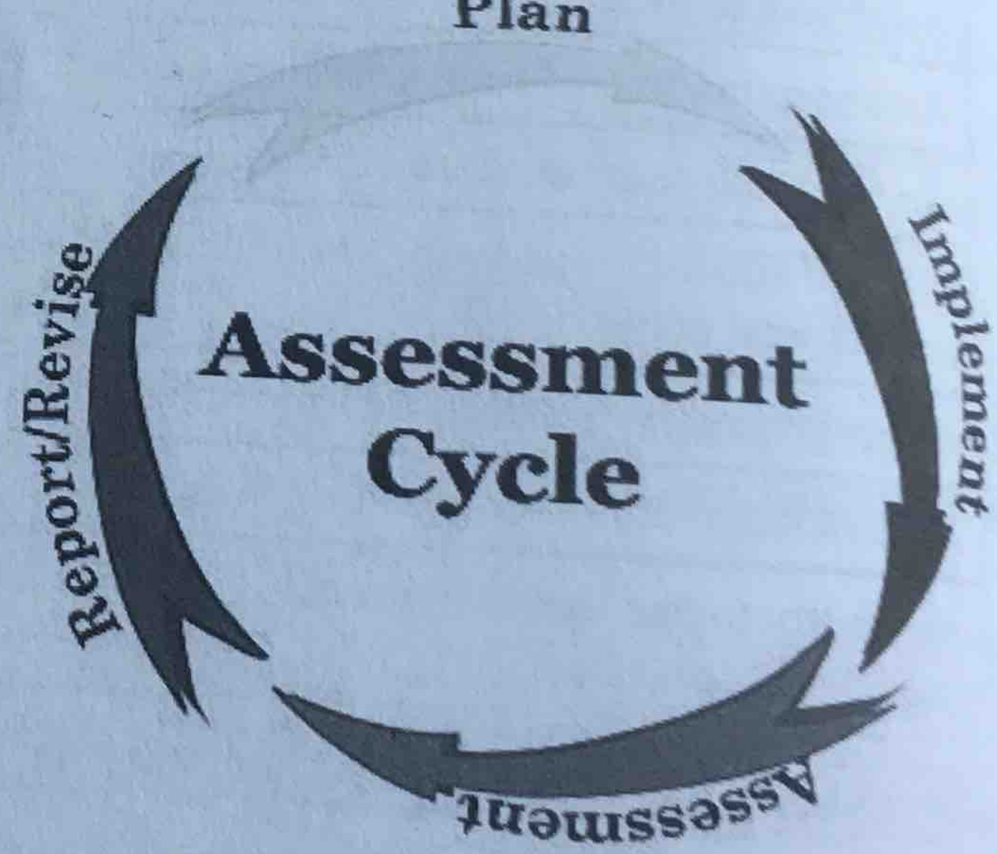
ASSESSMENT BASED ON ASTIN STUDENT INVOLVEMENT MODEL

Or you might conduct a personal assessment based on Alexander Astin's **Student Involvement Model**. This model measures the quality of your education as reflected by your level of student involvement in the following areas:

Time and energy devoted to studying
Time spent on campus
Participation in student organizations
Interaction with faculty members
Interaction with other students

HOW TO DO A PERSONAL ASSESSMENT

Whatever model you choose, doing a personal assessment simply involves rating yourself (e.g., on a scale of zero to ten; ten being highest) on each item. For example, on a scale of zero to ten, how would you rate your ability to work on teams? How would you rate your ability to identify, formulate, and solve engineering problems? How would you rate your ability to communicate effectively? How would you rate your grade point average? To what extent are you involved in student organizations?



For those items that get a high mark, just keep on doing what you are doing. We have a tendency to seek out areas in which we are strong. As a result our strengths are naturally reinforced and there is no need to structure a personal development plan around them.

PERSONAL DEVELOPMENT PLAN

What you need to work on are those areas that got low marks on your personal assessment – the very areas we all tend to avoid. For example, if you do not write well, you try to find classes that require little writing. If you are shy, you tend to avoid people. Avoidance behavior ensures that you will not improve in the very areas that most need your attention.

Realistically, you can't take on all your areas for improvement at one time. So you need to prioritize them in order of importance and choose several of the most important to work on. For each area chosen, create a *personal development plan*. What are you going to do in the next week? In the next month? In the next year?

As an example, if you are shy and lack good interpersonal communication skills, your plan might include some or all of the following actions:

(1) Talk more with people
(2) Discuss your problem with a professional in the counseling center
(3) Take an interpersonal communication course
(4) Read a book on self-esteem
(5) Join the campus Toastmasters Club
(6) Take an acting class
(7) Become involved in a student organization

The time you are in college is the time to work on areas you need to strengthen. You can make mistakes then and the price will be low. If, however, you avoid dealing with those areas in which you need to improve, they will follow you into the engineering work world.

There, the price of failure will be much higher!

6.6 Developing Your Communication Skills

An important area of your personal development is your ability to communicate. Although you will receive a certain amount of training through your formal education process, it is very likely to fall short of what you really need. In this section, we will explain the necessity for strong communication skills in engineering and suggest ways to supplement your required coursework in this area.

The Importance of Communication Skills in Engineering

Consider the following scenarios:

- As a result of your senior engineering design project, you invent a new Internet search engine. You want to patent, produce, and market the program before someone else beats you to it.
- With engineering diploma in hand, you are ready to launch your professional career, and you have narrowed your job search to four local engineering firms.
- As an engineer who designs and builds vehicles using alternate energy sources, you are assigned to a team to study the durability of a new composite graphite cloth for the vehicle's body. After six weeks of testing the material, your team is ready to make its recommendations to management.
- Shortly after you graduate with your degree in electrical engineering, you are hired into a position at a prestigious research lab, where your primary responsibility is to develop processes for manufacturing integrated circuits used in communications satellites. Four months into your work, you are selected to present your research findings at an upcoming meeting at NASA.
- As a mechanical engineer, you work for a popular amusement park, where you oversee the planning, design, and construction of new rides. In your current project, you supervise a