CHAPTER 1
INTRODUCTION: ENGINEERING AND THE ENGINEER

We recognize that we cannot survive on meditation, poems, and sunsets. We are restless. We have an irresistible urge to dip our hands into the stuff of the earth and do something with it.

(Samuel C. Florman, engineer and author)

What do engineers and, by extension, many other technical professionals do? What roles and functions do they fulfill? This chapter uses several means to offer answers to those and similar questions and thus lay the foundation for the book’s treatment of the professional or non-technical aspects of engineering. First, the roles of engineers are presented in the context of their frequent, dynamic interaction with clients, owners, customers, and constructors-manufacturers and other implementers. Then the chapter presents several definitions of engineering as another means of suggesting what engineers do within the framework of various constraints. These definitions also introduce the engineer’s creative role. A discussion of leading, managing, and producing invites engineers to engage in all three roles early, beginning as college students. Included is a description of the seven qualities of effective leaders. Building, in the broadest sense, is discussed noting that this activity in its various forms is widely practiced across engineering. The wisdom of developing productive habits concludes the chapter.

THE PLAYING FIELD
Engineers and other technical professionals interact dynamically among themselves and with clients, owners, customers, constructors, manufacturers, and other implementers. The interaction process, as illustrated in Figure 1.1, typically begins with a client, owner,
or customer retaining a professional (e.g., engineer or architect) to conduct a study, perform preliminary designs, prepare a complete design, and deliver a contract package consisting of plans and specifications or other formal design. The client-owner-customer could be a private or public sector entity, such as a business or a municipality.

The client, owner, or customer then selects a constructor, manufacturer, or other implementer to produce the structure, facility, system, product, or process. The client, owner, or customer sometimes retains the professional to monitor the construction-manufacturing-implementation process so the final structure, facility, system, product, or process conforms to the original plans and specifications.

Design followed by manufacturing or construction can occur within a single organization. For a self-contained manufacturing organization, the bottom two vertices of the triangle shown in Figure 1.1 collapse into one point. Similarly the bottom two vertices become one in a design-build organization, that is, a single firm that both designs and builds structures, facilities, or systems.

Figure 1.1 is most likely to apply to engineers and other technical professionals who, at any time in their careers, might be at any one of the three vertices of the

Figure 1.1 The engineer or other technical professional works with the client-owner-customer and the constructor-manufacturer-implementer to produce a useful structure, facility, system, product, or process.
triangle. This book frequently refers to the triangular model and its variations. In one sense, managing and leading are the processes by which the various entities shown in Figure 1.1 interact with each other in the worlds of engineering and business.

DEFINITIONS OF ENGINEERING

Besides using the interactions shown in Figure 1.1 to show the role of engineers, we can also take a more fundamental approach to understanding “what engineers do,” that is, examine some time-tested definitions of engineering. Aeronautical engineer Theodore von Karman said “Scientists explore what is, engineers create what never has been” (ECPD 1974). This succinct statement suggests how science and engineering differ; that is, creativity is essential in the latter.

ABET, Inc. (ABET 2002) offers this definition of engineering which focuses on a mathematics and science base, judgment, economic considerations, and the goal of benefiting society: “Engineering is the profession in which a knowledge of the mathematical and natural sciences gained by study, experience, and practice is applied with judgment to develop ways to utilize, economically, the materials and forces of nature for the benefit of mankind.”

The creative and humanist dimensions of engineering were captured by Herbert Hoover, the 31st U.S. President, who had a long and distinguished engineering career. Stressing the thrill of creating and the satisfaction of enhancing the quality of life, he said (Fredrich 1989): “It is a great profession. There is the fascination of watching a figment of the imagination emerge, through the aid of science, to a plan on paper. Then it brings jobs and homes to men. Then it elevates the standards of living and adds to the comforts of life. That is the engineer’s high privilege.”

Finally, Professor Hardy Cross (1952), using direct, plain words, clearly captured the central, people-serving goal of engineering when he wrote: “It is not very important whether engineering is called a craft, a profession, or an art; under any name this study of man’s needs and of God’s gifts that they may be brought together is broad enough for a lifetime.”

Based in part on the preceding definitions, the following six essential features of engineering appear:

- Science-based
- Systematic—However, except for trivial problems, judgment and other qualitative considerations always enter in
- Creative and innovative
- Goal-oriented—Satisfy the requirements and get the job done on time and within budget
- Dynamic—Technology, laws, public values, clients, owners, customers, stakeholders, and the physical environment continuously change
- People-oriented—Both in doing and in results in that engineering is essential to the survival of human communities and to the quality of life
LEADING, MANAGING, AND PRODUCING: DECIDING, DIRECTING, AND DOING

Leading, Managing, and Producing Defined

Another way of understanding what engineers and other technical personnel do, or could do, is examine their leading, managing, and producing roles. One paradigm for an organization, such as an engineering consulting firm, a manufacturing business, a government agency, an academic department, or a volunteer organization is that wholeness, vitality, and resiliency require attention to three different, but inextricably-related functions: leading, managing, and producing. The meaning of each of these terms is illustrated by the comparisons presented in Table 1.1. In a simplified sense, the leading, managing, and producing functions can also be represented by three Ds: deciding, directing, and doing.

Figure 1.2 uses the metaphor of a three-legged stool to suggest how attention to the leading, managing, and producing functions produces a stable organization—one that cannot easily be “knocked over.” While an organization might temporarily survive balanced on two of the three legs, all three legs are needed for long-term survival. For example, an engineering consulting firm with only managing and producing legs may be precariously balanced. It believes that current success guarantees future success. It can be sailing along just fine. But, without leading, it fails to see the rocks versus the navigable waters ahead. Author Warren G. Bennis (1989) said, “Many an institution is very well-managed and very poorly-led. It may excel in the ability to handle each day all the routine inputs, yet may never ask whether the routine should be done at all.”

With only leading and managing functions, exciting visions and careful operating plans are left lying on the table. Little or nothing happens—or what does happen fails to meet expectations. Finally, when only leading and producing are present, the organization lacks translation between the vision and the producing functions. This is sometimes the last stage of an organization started by a talented entrepreneur who cannot give up control. He or she hires managers who are expected to be clones—and, therefore, for all practical purposes, they add very little value. The organization produces, but very poorly. The vision, admirable and wise as it may be, does not get translated into services or products.

The Traditional Pyramidal, Segregated Organizational Model

Assuming you agree that each organization has leading (deciding), managing (directing), and producing (doing) responsibilities, consider the manner in which these corporate responsibilities might be met. More specifically, consider the matter of individual responsibility in achieving the three corporate responsibilities.

In what might be called the traditional pyramidal and segregated organizational model, as illustrated in Figure 1.3, the three functions reside in three separate groups of personnel. The vast majority of employees are the doers or producers, a distinctly different and much smaller group of managers are the directors, and one person, or perhaps a very small group, leads.

An aspiring and successful individual begins in a production mode and then passes serially or linearly maybe into managing and possibly into leading. Rather than being a
**Table 1.1** Although leading, managing, and producing form a continuum, distinctions are drawn among them.

<table>
<thead>
<tr>
<th>Leading</th>
<th>Managing</th>
<th>Producing</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Deciding where we want to go</td>
<td>Determining the best way to get there</td>
<td>Getting there</td>
<td>–</td>
</tr>
<tr>
<td>Deciding what ought to be done</td>
<td>Directing how things will be done, by whom, and when</td>
<td>Doing it</td>
<td>–</td>
</tr>
<tr>
<td>Moving forward to create something new</td>
<td>Taking care of what already exists</td>
<td>–</td>
<td>Kanter 1993</td>
</tr>
<tr>
<td>Selecting a jungle to conquer</td>
<td>Writing procedure manuals, setting up work schedules, sharpening machetes</td>
<td>Cutting through the jungle</td>
<td>Covey 1990</td>
</tr>
<tr>
<td>Deciding if the ladder is leaning against the right wall</td>
<td>Determining how to efficiently climb the ladder</td>
<td>Climbing the ladder and getting over the wall</td>
<td>Covey 1990</td>
</tr>
<tr>
<td>Dreaming during the day</td>
<td>Dreaming at night</td>
<td>–</td>
<td>Finzel 2000</td>
</tr>
<tr>
<td>Creating change</td>
<td>Reacting to change</td>
<td>–</td>
<td>Sanborn 2006</td>
</tr>
<tr>
<td>Using the right brain</td>
<td>Using the left brain</td>
<td>–</td>
<td>Covey 1990</td>
</tr>
<tr>
<td>Working through people and culture. Soft and messy</td>
<td>Working through hierarchy and systems. Hard and neat</td>
<td>–</td>
<td>Covey 1990</td>
</tr>
<tr>
<td>Influencing by permission</td>
<td>Influencing by position</td>
<td>–</td>
<td>Finzel 2000</td>
</tr>
<tr>
<td>Stressing people to work over paperwork</td>
<td>Stressing paperwork over people work</td>
<td>–</td>
<td>Finzel 2000</td>
</tr>
<tr>
<td>Causing people to want to do things</td>
<td>Causing people to have to do things</td>
<td>–</td>
<td>Badger 2007</td>
</tr>
<tr>
<td>Molding consensus</td>
<td>Searching for consensus</td>
<td>–</td>
<td>Martin Luther King in Goodale 2004</td>
</tr>
<tr>
<td>Creating teams</td>
<td>Directing groups</td>
<td>–</td>
<td>Sanborn 2006</td>
</tr>
<tr>
<td>Inspiring</td>
<td>Informing</td>
<td>–</td>
<td>Sanborn 2006</td>
</tr>
<tr>
<td>Having followers</td>
<td>Having employees</td>
<td>–</td>
<td>Sanborn 2006</td>
</tr>
<tr>
<td>Concentrating on what is right</td>
<td>Concentrating on who is right</td>
<td>–</td>
<td>Peyton 1991</td>
</tr>
<tr>
<td>Having very little formal education and training in this function</td>
<td>Having some formal education and training in this function</td>
<td>Having lots of formal education and training in this function</td>
<td>Finzel 2000</td>
</tr>
<tr>
<td>Very few personal models</td>
<td>Some personal models</td>
<td>Many personal models</td>
<td>Finzel 2000</td>
</tr>
<tr>
<td>Interruptions are the work</td>
<td>Work gets interrupted</td>
<td>–</td>
<td>Finzel 2000</td>
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trait that many can possess, albeit to different degrees, leading is considered the end of the line or ultimate destination for a very few. But is this the optimum way for an organization to meet its leading, managing, and producing possibilities? I don’t think so, although a command and control structure may be appropriate in certain situations.

The Shared Responsibility Organizational Model

An organization will be stronger if what I previously referred to as the three organizational responsibilities now also become individual responsibilities. The goal should
be to enable each member of the organization to be a decider, a director, and a doer as illustrated by Figure 1.4.

While the relative “amounts” of leading, managing, and producing will vary markedly among individuals in the organization, everyone should be enabled and expected to do all three in accordance with their individual characteristics. This shared responsibility organizational model, in contrast with the traditional segregated model, is much more likely to mine the organization’s gold, that is, extract and benefit from the diverse aspirations, talents, and KSAs that are typically present within an organization.

Because essentially all members are fully involved, the shared responsibility organization is more likely to synergistically build on internal strengths, cooperatively diminish internal weaknesses, and learn about and be prepared to respond to external threats and opportunities. Striving to enable everyone creates confidence, results, and pride. As noted by Chinese philosopher Lao Tzu, “But of a good leader, who talks little, when his work is done, his aim fulfilled, they will say, we did this ourselves.”

**The Focus of This Book: Managing and Leading**

The entry-level engineer or other technical person will, by definition, be well-prepared for and will spend a majority of his or her time producing, that is, carrying out the production function of the organization. An undergraduate education is typically a solid preparation for this function. The focus of this book is on managing and leading.

Your education may be preparing you, or may have prepared you, well for the managing and leading functions. For example, perhaps you are studying or have studied civil or environmental engineering in a department aligned with the Body of Knowledge (BOK) developed by the American Society of Civil Engineers (ASCE 2008), the BOK prepared by the American Academy of Environmental Engineers (AAEE 2009), or some similar BOK. As suggested by Appendix C in this book, current BOKs include managing and leading outcomes. If you are not in or did not
Leading Misconceptions

Leading, which has been contrasted with managing and producing, warrants further discussion because aspects of it are often misunderstood. One misconception is that leading implies holding a high position within an organization. For example, in a city, state, or federal unit of government, do you view the chief engineer and department heads as leaders whereas individuals further down the “food chain” as not being leaders? Or in a manufacturing firm, do you think of vice-president and up as leaders and those with lesser ranks as not being leaders? Perhaps, as suggested by Sanborn (2006), leading is perceived as enjoying these four P’s: position, power, prestige, and privilege. I reject this view, as clearly indicated by the previous discussion of the two organizational models. In my view and as reflected in this book, leading is a function that almost anyone can fulfill regardless of their position in the organizational hierarchy.

Another leading misconception is that one must be a charismatic extrovert in order to lead, that is, introverts need not apply. Not true. According to Jones (2006), Bill Gates, long-time Microsoft leader; Warren Buffet, Chairman and CEO of Berkshire Hathaway; and Steven Spielberg, film director and producer are all professed introverts and companies led by introverts do as well financially as those led by extroverts. Jim Collins, in his book *Good to Great* (Collins 2001), concludes this and dispels the notion that extroversion is needed to lead. Therefore, if you tend toward introversion—like me and the majority of engineers—that trait should not stop you from releasing the leader in you.

The third, and final misconception, is leaders are born, not made. You have probably heard expressions like “she is a born leader” and “his leading is natural.” Is that true? I reject the idea that birth defines leading ability and dedicate some of this book to helping you learn how to lead, as well as manage and produce. If leading KSAs can be learned, then a discussion of the elements of leading, of what can be learned, is warranted and follows.

Views of Others

Famed football coach Vince Lombardi believed leaders are made. He said: “Leaders aren’t born, they are made. And they are made just like anything else, through hard work.” John C. Maxwell, a student of leading, says “Leadership is not an exclusive club for those who are born with it. The traits that are the raw materials of leadership can be acquired. Link them up with desire and nothing can keep you from becoming a leader.”

THE SEVEN QUALITIES OF EFFECTIVE LEADERS

A review of books, papers, and articles on the topic and reflection on experience suggests seven important aspects of leading. These elements are discussed here for consideration by you, the student or entry-level practitioner. Think of these elements
as an answer to the question: What do you look for in someone you might follow? For brevity, the word “leader” is used to mean the leader in each of us or the leadership part of each of us. Leader and leading do not refer to positions in an organization; anyone can be a leader anywhere in a public, private, academic, volunteer, or other organization.

**Personal**

After one of my webinars, a participant shared this thought with me: “I learned a long time ago that you can be perceived as a leader by others and not realize it yourself. Becoming a leader is something you can do without anyone’s ‘permission.’ It is developed conscientiously through self-improvement. It’s amazing when you realize others perceive you as a leader.” If you possess, or work at possessing, the seven leadership qualities described here, others will perceive you as a leader. They will value you as an exceptional person. They will look to you when an unusual problem or opportunity arises.

**Honesty and Integrity**

The leader in each of us practices honesty and exhibits integrity, that is, tells the truth and keeps his/her word. On seeing this, some readers may be thinking, “oh sure, we’ve got to get this idealistic stuff out of the way. Please understand, I am not offering this first leadership essential in some sort of pie-in-sky, ivory tower, got-to-say-it manner. On the contrary, honesty and integrity are, in my view, the first—and the most important—of the leading elements.

Regarding honesty, “a survey of several thousand people around the world and several hundred case studies—found that honesty was the most frequently cited trait of a good leader” (Woolfe 2002). Leaders are granted the privilege of leading by those who are prepared to be led. Honesty and integrity on your part are crucial to earning and retaining the privilege to lead. You must get people to buy into you before they buy into your vision (Maxwell 1993).

Although honesty and integrity are often used in a vague and even interchangeable manner, they warrant precise definitions. Covey (1990) says “Honesty is telling the truth—in other words, conforming our words to reality. Integrity is informing reality to our words—in other words, keeping promises and fulfilling expectations.” Stated differently, honesty is retrospective and integrity is prospective; honesty is what you say about what you’ve done and integrity is what you do about what you’ve said. In high school, when you told your teacher that the family dog ate your homework, and that is exactly what happened, you exhibited honesty. Then, when you promised to redo the homework and hand it in at the next class, and did so, that was integrity.

**Vision: Reach and Teach**

Leaders know where their organization is going; they believe in it and much of what they say and do reflects and supports the vision. Each organization should have a multi-year strategic plan and an annual business or operating plan. The strategic plan
should contain and be based on brief, widely-understood mission and vision
statements.

The mission statement explains the purpose of the organization—why it exists, what
service or product it provides and to whom (Tompkins 1998). Tompkins offers this
example of a mission statement for a consulting firm: “To provide our clients with total
confidence in our solutions and to treat all employees with fairness and dignity.”

In contrast with an organization’s mission statement, its vision statement looks
boldly into the future. “Vision . . . is mental, cognitive—not reality, or even close to
reality, as we know it today. It is influenced, at least in part, by imagination, reflective
of actual or desired values, and focused on “what,” not “how.” Finally, a vision is
stimulating, energizing, engaging, and inclusive” (ASCE 2007). Consider the advice of
city planner and architect Daniel Burnham: “Make no little plans, they have no magic
to stir men’s blood. Make big plans, aim high in hope and work and let your
watchword be order and your beacon beauty.”

The vision statement declares, as specifically as possible, what the organization
intends to become. Like the mission statement, the vision statement must be clearly
and widely understood throughout the organization. Tompkins (1998) provides these
two examples of vision statements:

- For a consulting firm: “To be the best engineering-based consulting firm in
the world while providing all employees a rewarding and satisfying work
experience.”
- For an appliance manufacturer: “To be the world’s leading manufacturer of
diversified laundry equipment by continuously improving customer satisfac-
tion, employee motivation, and company profitability.”

ASCE’s Vision 2025 (ASCE 2007) provides another example of a vision. A com-
ppanion document (ASCE 2009) illustrates a “roadmap” for implementing that vision.
The ASCE – sponsored vision for civil engineering follows. “Entrusted by society to
create a sustainable world and enhance the quality of life, civil engineers serve com-
petently, collaboratively, and ethically as master:

- Planners, designers, constructors, and operators of society’s economic and
social engine – the built environment;
- Stewards of the natural environment and its resources;
- Innovators and integrators of ideas and technology across the public, private,
and academic sectors;
- Managers of risk and uncertainty caused by natural events, accidents, and other
threats; and
- Leaders in discussions and decisions shaping public environmental and infra-
structure policy.”

The Vision 2025 report explains the meaning of the word “master,” which is a key
adjective in the vision, as follows: “master means to possess widely recognized and
valued knowledge and skills and other attributes acquired as a result of education,
experience, and achievement. Individuals, within a profession, who have these
characteristics, are often willing and able to serve society by orchestrating solutions to society’s most pressing current needs while helping to create a more viable future.”

To illustrate the influence of visions, the China Civil Engineering Society translated Vision 2025 and then endorsed it in May 2010. Spain’s Association of Civil Engineers translated the two Vision 2025 reports into Spanish and, in June 2010, endorsed Vision 2025. Engineering societies in other countries have taken similar actions.

If the organization does not have a vision, a mission, and a plan, the leader takes action to get such statements articulated and a plan developed. But what if an individual’s values and goals are in serious conflict with an organization’s mission and vision? The answer is obvious—try to effect change and, if not successful, move on. Life is too short to dissipate yourself in a hostile environment or prostitute yourself by feigning allegiance to alien values.

The leader in you interprets opportunities and problems in the context of the vision and mission, always seeking ways to move the organization one more step in the direction of the vision. In the leader’s mind, a constructive tension exists between many of the common, day-to-day occurrences and the organization’s vision and mission. The tension pulls those occurrences in the direction of the vision and mission and is the force that enables the leader to take supportive steps. The leader in you seeks opportunities to communicate the vision recognizing that, as stated by Clark and Crossland (2002), “The difference between a vision and a hallucination is the number of people who see it.”

Phillips (1992) describes President Abraham Lincoln as a visionary. Lincoln-based principles about vision include the following, quoted directly from the book:

- Provide a clear, concise statement of the direction of your organization and justify the actions you take
- Everywhere you go, at every conceivable opportunity, reaffirm, reassert, and remind everyone of the basic principles upon which your organization was founded
- Because effective visions can’t be forced on the masses, set them in motion by means of persuasion
- When effecting renewal, call on the past, relate it to the present, and then use them both to provide a link to the future

**Historic Note**

During WWI, Herbert Hoover, engineer and later 31st U.S. President, was asked to lead an effort to save ten million people who were starving in Belgium. That country, which was heavily dependent on imports for food, had been overrun by the German army, which was intercepting imported food for its use. Hoover’s response to the invitation: He would accept no salary but must be given “absolute authority” to do the job. He clearly thought he knew the magnitude of the task and had a vision of how it would be accomplished. Robertson Smith, who worked with Hoover on the Belgium effort, said this
about Hoover’s vision: “There is something almost terribly personal about it, in [his] desire that things shall change, that order shall be brought out of an existing chaos.” Based on Hoover’s heartfelt, personal vision and lots of work, the Belgium people did not starve (Ruth 2004).

The leader in us is like a TV or radio station that cannot turn off its transmitter. We are always “broadcasting” the vision. Receptive individuals hear what we say about the vision and watch what we do to move, with them, step-by-step, toward the vision. Consider some ways to broadcast your vision:

- When you read a relevant newspaper article or professional paper connected to your vision, share it with key individuals
- As opportunities arise during project and other meetings, mention your vision
- Write a “white paper” that describes your vision and the benefits it would provide
- Find others who share your vision and collaborate with them
- Strive to get your vision reflected in your organization’s strategic plan
- Write an article about your vision for your organization’s e-newsletter or for presentation at a conference

In summary, the leader in you enables others to understand, value, and commit to the vision and mission of the organization and, as a result, direct their aspirations, talents, and skills toward carrying out the mission and achieving the vision.

Strategies and Tactics to Achieve the Vision

Visions, as engaging as they may be, are just dreams until they are converted to strategies and tactics that will help to achieve them. Engineers, architects, planners, and other technical professionals know how to create plans that bring their projects to fruition. Plans, that is, strategies and tactics, are also needed to bring visions to fruition. The leader in you does not wait for someone to tell you what to do, when to do it, and how to do it. You act because you view the future as something you and others can make happen, not something that happens to you.

Drawing again on the example of Abraham Lincoln, Phillips (1992) says that Lincoln had “an almost uncontrollable obsession” to achieve. Phillips sets forth these action principles, all quoted, at the conclusion of a chapter titled, “Set Goals and Be Results-Oriented”:

- Set specific short-term goals that can be focused on with intent and immediacy by subordinates
- Sometimes it is better to plow around obstacles rather than to waste time going through them
- Your war will not be won by strategy alone, but more by hard, desperate fighting
Your task will neither be done nor attempted unless you watch it every day and hour, and force it.

Remember that half-finished work generally proves to be labor lost

Consistent with the preceding, the leader in you sets goals and establishes strategies and tactics to achieve them.

Personal

I spoke with engineer Bill Ratliff who served as a Texas state legislator and Lt. Governor. He chaired committees and took on tasks in the legislature, such as education budgeting, clearly outside of his expertise. He gradually earned the reputation as “expert.” As he explained, he just applied logic which is a characteristic of engineers and other technical personnel. Like Bill Ratliff, we engineers and other technical practitioners have the ability to deal with complex situations, like moving toward and achieving a goal, a series of goals, and, eventually, a vision.

Always a Student

Leaders develop and maintain, through formal study, self-study, and experience, their unique set of knowledge and skills. Maintaining one’s expertise is a leadership element that is particularly important in a technical organization because rapid changes in science and technology drive the services and products the organization offers and produces.

Competency in knowledge and skills is crucial to an organization for three reasons. First, it contributes to what the organization can do or offer in serving its clients, owners, customers, and constituents. Second, maintaining currency at the individual level sets a positive example for others in the organization, earns respect from them, and encourages them to develop and maintain their expertise. Third, and finally, by being an expert, a person is much more likely to value expertise, people who possess it, and the wisdom of drawing on the proper mix of expertise in meeting needs of internal and external clients, owners, and customers.

Certainly the organization must support financially and in other ways the development and maintenance of individual skills and knowledge. However, the primary responsibility for maintaining expertise lies with the individual. The topic of managing personal professional assets is discussed in detail in Chapter 2.

The leader in you should also be a perpetual student of non-technical topics—of areas of concern and relevance outside of your area of technical expertise. Expertise implies depth of knowledge, in contrast with breadth of knowledge and understanding of context, which are also necessary. Harry S Truman, the 33rd U.S. President, advocated and exemplified gaining breadth of knowledge through reading. He said: “Readers of good books, particularly books of biography and history, are preparing themselves for leadership. Not all readers become leaders. But all leaders must become readers” (Poen 1982).
Personal

Near the end of my graduate studies, my grandmother, who never had an unpleasant word for me and had left school after the fifth grade, said “Stuart, what a shame! You are 27 years old and not working.” I was so embarrassed! However, this and other events, led me to recognize that I was the studious type—not necessarily smart—and that I must seek employment and other activities that would enable me to contribute by continuing to be a student. And I have done that for decades and feel fortunate. The “always a student” advice works for me and may work for you. Consider one mechanism I’ve frequently used to “make the time” to study. Commit to something for which you will have to learn more. Examples: Sign-up to give a brown bag presentation in your office one month from now on a newly-developed technology, submit an abstract to present a paper at next year’s geotechnical conference, or join a committee of professional or business society. When we do this, we are relying on a basic human characteristic: We do not want to embarrass ourselves. Works for me!

The notion of a leader who has extensive and largely sufficient knowledge based on education and experience and who uses that knowledge to direct the efforts of narrowly and sufficiently trained subordinates is dimming. The modern leader must continually seek and probe—and expect others to do the same. Rather than claiming to know in a static and superior sense, leaders increasingly focus on knowing how to learn and enabling others to learn as well. Continuous learning will increasingly characterize the world of work.

The perpetual student concept, so important to today’s and tomorrow’s leaders, is a common thread woven through history. Ancient works of fiction and nonfiction portray the heroes and the elite as relentless pursuers of knowledge and ideas—even when the resulting revelations threaten the seeker. For example, although Socrates probably protested too much, his claim that he did not know the truth but instead diligently searched for it can serve as a model for leaders. Directed discussion, used by Socrates and described by Plato, would seem to be the preferred modus operandi of viable organizations. Socrates convincingly expressed his faith in inquiry and discovery when he said (Plato 1981): “… but I would contend at all costs both in word and deed as far as I could, that we will be better men, braver and less idle, if we believe that one must search for the things that one does not know, rather than if we believe that it is not possible to find out what we do know and that we must not look for it.”

Change will increasingly be the only certainty. Accordingly, leaders must create and support an intellectual environment in which discussion is directed toward identifying, interpreting, planning for, and in some cases, influencing the direction and shape of change. Given the increasing complexity of the world, no one person can possess sufficient knowledge to accommodate change. Interdisciplinary teams employing Socratic-style directed discussions are a promising alternative.

However, unlike Socrates’ era when information was minimal, data now abound—usually to excess—and must enter into an organization’s dialogues. Used in a modern
organization, the Socratic method promises to elicit informed and relative contributions from many experts and other individuals, build the confidence of participants, sharpen critical thinking, encourage synthesis, and occasionally lead to serendipity. On the negative side, directed dialogue requires time and patience which are always precious resources in dynamic, action-oriented organizations. Dialogue may be difficult for the leader in some of us because the process may lead to challenges to our dearly-held notions and operating principles. Paradigm paralysis may afflict us. A leader’s search for knowledge must be credible—it cannot be conditioned on the expected positive or negative impact of the findings. The truth must be determined and dealt with. The leader in you inquires continuously and is a perpetual student in keeping with the Arabian proverb: “Learning is a treasury whose keys are queries.”

Personal

At one point in my career, I interviewed prospective engineering faculty members. I always asked this question: What are you studying? My reason: I did not want anyone in our classrooms who was not a perpetual student. During an even earlier period in my career, I interviewed prospective engineers for departments in a government agency and in an engineering-architectural firm. I did not routinely ask them that question. If I could do it over, I would ask each of them that question. My reason: I wouldn’t want any professional serving our clients, owners, or customers who is not a perpetual student. By the way, if you are a perpetual student, that is, a nerd, geek, dweeb, or, as we used to say, an egghead or bookworm, you are in good company. Besides Harry Truman, history tells us that other studious types who led included George Washington, Thomas Jefferson, John Adams, Abraham Lincoln, Theodore Roosevelt, and Herbert Hoover (Phillips 1997; Ruth 2004).

Courageous

The fifth quality of the leader in us is courage. We see lots of physical courage: Mountain climbing, Olympics competition, and bungee jumping come to mind. These are commendable. However, the leader in us must pursue different kinds of courage. Writer and humorist Mark Twain wrote: “It is curious that physical courage should be so common in the world and moral courage should be so rare.”

Leading requires courage to hold people accountable for carrying out their responsibilities and keeping their promises, to confront individuals exhibiting unacceptable behavior, to walk away from a project-client-owner-customer on ethical grounds, to speak up when someone is being treated unjustly, to aim high and risk apparent great failure, to apologize and ask for a second chance, and to persist when all others have given up. But, what constitutes courage and courageous people?

Aristotle (1987) offers a thoughtful and demanding perspective on courage. Aristotle defines courage as a precarious, difficult-to-prescribe balance between causes, motives, means, timing, and confidence. He says: “The man, then, who faces and who fears the
right things and from the right motive, in the right way and at the right time, and who feels confidence under the corresponding conditions, is brave; for the brave man feels and acts according to the merits of the case and in whatever way the rule directs.”

Aristotle goes on to say that courage is a mean between cowardice and rashness, confidence and fear. In summary, he defines courage as a fully informed, carefully-considered willingness to die for a noble cause. Aristotle refutes the notion that courage is reactive or instinctive. You might be tempted to say that Aristotle was not totally serious about his definitions of courage and courageous people—at least with respect to the “willingness to die” aspect. After all, he must have intended death as a metaphor for a willingness to incur great loss. Perhaps this interpretation is acceptable, at least for purposes of this book.

Aristotle outlines, in systematic and exhaustive fashion, five kinds of false courage. These might be referred to as lesser degrees of courage. They encompass much of what passes for courage in our society and help, by elimination, to define bonafide courage.

- The first type of courage is coercion courage or what Aristotle refers to as “the courage of the citizen-soldier.” The possessor faces significant risks, but he or she has no choice. Leaders simply have to do many things—some of which are quite unpleasant and risky. Aristotle’s coercion courage concept cautions the leader to maintain perspective and not to view these as courageous acts worthy of praise. These acts are part of the job—they come with the territory.

- What might be called high information or calculated courage is the second type. Aristotle uses the example of the professional soldier who seems brave in battle, but in fact entered the fray with far superior information and other resources that virtually guaranteed victory. The modern leader may be tempted to feign courage because he or she often has exclusive access to vital information or wields superior power by virtue of position.

- The third type of courage is passion courage. These reactionary acts conflict with the choice and motive elements clearly evident in Aristotle’s model of courage. While the emotional outburst or sharp retort is often viewed as courage—as in “you sure told him/her”—these acts are often done without thought. Although passionate reactions may seem to immediately please onlookers, calm and reason in difficult circumstances may require more courage and lead to long-term benefits for all antagonists.

- Sanguine, to use Aristotle’s word, or what might be called overly optimistic courage, is the fourth type of counterfeit courage. A string of business, government, academic, or other successes can lead to unrealistic optimism or even complacency, which may be viewed as courage. The U.S. global dominance in economic and military affairs during the four-decade post-World War II period is an illustration of Aristotle’s sanguine courage. The modern leader must be alert and view expectations of continued success with suspicion. An earlier atmosphere of courage that enables an organization to achieve high levels of performance may gradually and unnoticeably give way to complacency.

- Aristotle’s fifth and last type of false courage is the ignorance variety. As he bluntly says, “people who are ignorant of the danger also appear brave.” As we
become an increasingly information-rich world, our private, public, academic, and volunteer organizations must devote appropriate resources to continuously sifting through new knowledge to identify and assess opportunities and threats.

Informed by Aristotle’s ideas, the leader in you is more likely to recognize your and others’ bravado. There will always be some pretense of bravery—particularly by people in high and prestigious positions. Recognizing this, the leader in you should place a premium on his or her acts and the acts of others that, in the face of risk and calamity, are carefully considered and indicate a willingness to sacrifice for the corporate or community cause. Courageous acts don’t have to be extreme acts. When leaders take extreme positions, they may be less successful in defending a principle, advancing a cause, or achieving a worthy goal than when they assume courageous, but somewhat more moderate postures. The leader in you recognizes various types of false courage and seeks instead a courage that balances causes, motives, means, timing, and confidence.

**Calm in a Crisis and Chaos**

Whenever competent and committed people are involved in group efforts, often in competition with other organizations, difficult interpersonal and other serious conflicts and situations are inevitable. Confronted, usually unexpectedly, with such crises, the leader instills calm, seeks understanding, and does not make premature judgments. The leader should “Seek first to understand, then to be understood” (Covey 1990).

We’ve all heard the expression, “this is not a problem, this is an opportunity.” The leader in us actually believes this—at least most of the time. When faced with a crisis or chaos, we look for that opportunity. Alexander Graham Bell, the inventor, offered this observation: “When one door closes another door opens; but we often look so long and regretfully upon the closed door that we do not see the ones which open for us.”

Personal competency skills such as time management, listening, writing, speaking, delegating, and meeting facilitation are presented in Chapters 2, 3, and 4 of this book. These competencies enable you to effectively and efficiently carry out your day-to-day work. Of particular relevance here is that these skills are invaluable when faced with crises and chaos.

So much for getting your act together. The next way to prepare for handling crisis and chaos is to proactively seek a variety of personal and professional experiences. If you happen to be a civil engineer, please recognize that this profession is one of the few that provides many opportunities to have a career that includes employment in the government, business, and academic sectors. Travel is an excellent way to acquire personal and professional experiences.

**Personal**

During my first trip to Western Europe in the 1980s, I was astounded by the advanced level of recycling and the robust infrastructure. The fully integrated air-rail-bus-waterway transportation system amazed me. So did citizen concern...
with the environment. That and subsequent travel experiences influenced my thinking while working on various projects; I saw even more possibilities.

Actively participate in and sometimes lead ad hoc groups formed to carry out specific changes. These might be within your employer, in your professional society, or in your community. By working on these groups, you will rub shoulders with and learn much from individuals who know how to lead. Incidentally, this book’s last chapter continues this change theme by offering advice on how you can effect change.

Varied experiences give you a wealth of knowledge, experiences, and contacts to draw on when you encounter crisis or chaos. They reflect the philosophy of regularly getting out of your comfort zone. As a result, when faced with crisis or chaos, you are more likely to say: “This situation reminds me of . . .”—you get the idea!

Having defused and perhaps even resolved the most recent crisis, the leader—regardless of his or her administrative level in an organization—is usually thrust back into the midst of a general chaotic situation typical of the dynamic organization striving to succeed in an ever-changing world. Engineering and other technical organizations must contend with rapid advances in science and technology; new environmental, personnel, and other laws and regulations; the globalization of business; client and customer demands or dissatisfaction; new competitors or old competitors offering new services in new ways; unexpected business or other opportunities; and turnover of professional and other personnel. Typically, the changes cannot be predicted and defy quantification, but they must be continuously confronted. The leader in you is calm in crisis and chaos.

Creative, Innovative, Collaborative, and Synergistic

Leaders seek ways to utilize the right hemisphere of the brain to complement the left hemisphere. Stephen Covey (1990) notes that decades of research have resulted in brain dominance theory. Covey explains: Essentially, the left hemisphere is the more logical, verbal one and the right hemisphere the more intuitive, creative one. The left deals with words, the right with pictures; the left with parts and specifics, the right with wholes and the relationship between the parts. The left deals with analysis, which means to break apart; the right with synthesis, which means to put together. The left deals with sequential thinking; the right with simultaneous and holistic thinking. The left is time bound; the right is time free.

Clearly, leadership qualities of creativity, innovation, collaboration, and synergism are products of the whole brain. Because of the nature of their college education, engineers and some other technical personnel are likely to be dominated by the left hemisphere of the brain. Cultivation and development of the right hemisphere is, therefore, especially important for engineers and other similar professionals who want to be creative, innovative, collaborative, and synergistic. The section of Chapter 7 titled “Tools and Techniques for Stimulating Creative and Innovative Thinking” can help you further develop these qualities of effective leaders.

According to Covey (1990), leaders create things twice—first in their minds and then in physical reality. Leaders have strong visualization capabilities. Their mental
images are vivid and all-encompassing. What will the final structure, facility, system, product, process, organization, event, or thing look like? How will one feel to be in or around it? What will it smell like? How will it sound? The technical professional should resonate with the concept of creating things twice. This is the essence of first preparing plans and specifications—creating on paper—and then constructing, manufacturing, or otherwise implementing, that is, creating physically.

Covey argues that leaders apply the process of creating twice to all aspects of their lives. Somewhat ominously, Covey (1990) warns that “. . . there is a first creation to every part of our lives. We are either the second creation of our own proactive design, or we are the second creation of other people’s agendas, of circumstances, or of past habits.” Leaders view the future as something they make happen—not something that happens to them.

The leader in you leverages successes to produce even greater successes. The leader in you finds ways to invest money or other resources at the margin so as to yield larger returns at the margin (e.g., converting a successful project into a successful published professional paper). The leader in you is synergistic—seeking combinations such that the sum is greater than the parts. The leader in you searches for the silver lining in a black cloud. The leader in you believes—at least most of the time—that “this is not a problem, this is an opportunity.”

Personal

I worked on an urban flood control project that started out as a technically feasible, but costly, single-purpose stormwater detention pond that would be funded by one source and would have been used only a few times each year. It ended up, as a result of creativity, innovation, collaboration, and synergism, being a cost-effective, multi-purpose facility funded by several sources and now used every day.

THE ENGINEER AS BUILDER

Engineering is an old profession; its roots can be traced back to the beginning of recorded history when nomads first came together and formed communities along what are now the Nile River in Egypt, the Tigris and Euphrates Rivers in Iraq, the Indus River in India, and the Yellow River in China. With the creation of communities came the need to provide basic infrastructure such as housing, transportation, defense, irrigation, water supply, and wastewater disposal. The work of the engineer had begun.

Besides being one of the oldest professions, engineering is one of the broadest. For example, ABET, Inc. the inter-engineering organization that accredits undergraduate engineering programs, recognizes 27 types of engineering programs, ranging from Aerospace Engineering to Systems Engineering, for purposes of undergraduate engineering accreditation (ABET 2011). Within any of the engineering types, engineers carry out a broad spectrum of functions such as research and development; planning; design; construction and manufacturing; operations; teaching; marketing; and management.
Throughout engineering’s long history and within its great diversity, however, there is at least one widely-shared interest and function: building in the broadest sense. In the final analysis, whenever everything else is stripped away, the engineer is, at the core, a builder. Building is the glue that binds engineers together.

When civil engineers “build,” they usually call the process construction. When mechanical engineers “build,” they routinely refer to it as manufacturing. Whatever term you use, the ultimate end of the engineering process is to “build” something to meet human needs, usually something that never before existed. Examples include the water supply system “built” by the civil engineer, the energy-efficient and safe automobile “built” by the mechanical engineer, and the electrical power distribution system “built” by the electrical engineer. Some engineers “build” less concrete but nevertheless important things such as computer programs, better tools for performing engineering functions, and improved ways to organize engineering organizations.

“Builders” accrue great responsibility and liability as well as great satisfaction. U.S. President Herbert Hoover said (Fredrich 1989): “The great liability of the engineer compared to men of other professions is that his works are out in the open where all can see them. His acts, step-by-step, are in hard substance. He cannot bury his mistakes in the grave like the doctors. He cannot argue them into thin air and blame the judge like the lawyers. He cannot, like the architects, cover his failures with trees and vines. He cannot, like the politicians, screen his shortcomings by blaming his opponents and hope the people will forget. The engineer simply cannot deny he did it. If his works do not work, he is damned . . . On the other hand, unlike the doctor, his is not a life among the weak. Unlike the soldier, destruction is not his purpose. Unlike the lawyer, quarrels are not his daily bread. To the engineer falls the job of clothing the bare bones of science with life, comfort, and hope.”

As you begin your career, you will probably be increasingly cognizant of the diversity of engineers and the work they do. There is strength in diversity when that diversity is focused on a common and a meaningful interest. For engineering and other similar professions, that common bond is building for the benefit of society, that is “… clothing the bare bones of science with life, comfort, and hope.” Building for that purpose is indeed a high calling.

CONCLUDING THOUGHTS: COMMON SENSE, COMMON PRACTICE, AND GOOD HABITS

Some of the content of this book might be correctly referred to as “common sense.” An erroneous implication of this statement is the material is obvious and, therefore, does not warrant study or explicit disciplined application. However, experience teaches that which is common sense does not necessarily translate into common practice. Knowing something and using it are not the same. Knowledge is not power; knowledge applied is.

The student or entry-level engineer who is committed to high levels of achievement will take charge of his or her life. He or she will understand the need to translate common sense ideas and approaches become common practice through study and self-discipline. When common sense ideas and approaches become common practice, that is, normal or ideally habitual, the young person will be well on the way to realizing his or her potential in
the consulting business, industry, government, or academia. Or, as stated by author Og Mandino (1968): “In truth, the only difference between those who have failed and those who have succeeded lies in the difference of their habits. Good habits are the key to all success . . . I will form good habits and become their slave.”

Studies by neurobiologists and cognitive psychologists conclude that the unconscious mind controls as much as 95 percent of human behavior (Martin 2008). We are on automatic pilot almost all the time. Have you ever driven your car a few blocks, or even a few miles, and suddenly realized you couldn’t recall having done so? Your driving is largely habit and your unconscious mind was “at the wheel.” We use our conscious mind for new situations while our unconscious mind—our habits, good or bad—take care of routine activities. My point: If so much of what you do is habitual, then improving any aspect of your life means you need to change your habits.

Covey (1990) describes what he considers to be the seven habits of highly effective people. These habits, which have a common sense tone, are: 1) Be proactive; 2) Begin with the end in mind; 3) Put first things first; 4) Think win/win; 5) Seek first to understand, then to be understood; 6) Synergize; and 7) Sharpen the saw (i.e., renewal of your physical, spiritual, mental, and social/emotional dimensions).

Playing off of Covey’s ideas, Green (1995) presents the seven habits of highly ineffective people. They are: 1) Poor listening; 2) Negative thinking; 3) Disorganization; 4) Inappropriateness (i.e., there is a time and place for everything); 5) Decisions by default; 6) Randomization (i.e., performing tasks in random order rather than in logical sequence); and 7) Procrastination.

The opposing Covey-Green seven habits further emphasize the importance of good habits, as stressed by Mandino. You should decide what your most powerful habits are or will be. Engineering Your Future will help you learn about highly-effective managing and leading practices, some of which are common sense, so you can perhaps adopt many of them as habits. Let’s conclude this introductory chapter with the following highly-relevant thought:

I am your constant companion.
I am your greatest helper or your heaviest burden.
I will push you onward or drag you down to failure.
I am completely at your command.
Half the things you do, you might just as well turn over to me,
and I will be able to do them quickly and correctly.
I am easily managed; you must merely be firm with me.
Show me exactly how you want something done,
and after a few lessons I will do it automatically.
I am the servant of all great men.
And, alas, of all failures as well.
Those who are great, I have made great.
Those who are failures, I have made failures.
I am not a machine,
though I work with all the precision of a machine.
Plus, the intelligence of a man.
You may run me for profit, or run me for ruin;
it makes no difference to me.
Take me, train me, be firm with me,
and I will put the world at your feet.
Be easy with me, and I will destroy you. Who am I?
I am habit!

(Ed Hirsch, baseball coach)

CITED SOURCES

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EXERCISES

Note to Instructors: When this book is used as a course text, consider assigning Exercises 1.2, 1.3, 1.4, and/or 1.5 near the beginning of a semester or quarter so that students can work on them over a large portion of the semester or quarter. With this approach, students will be able to combine work on the exercises with material being presented in the course.

1.1 GOALS: The purpose of this exercise is to motivate you, the aspiring engineer or young practitioner, to think about your professional and other goals and how you plan to achieve them. The results of this exercise should be confidential, unless you want to share them with your instructor or other trusted persons. Suggested tasks are:

A. Write your goals, for 2 and 10 years from now, in each of the following areas:
   a) position (e.g., project engineer, project manager, instructor/professor, researcher, owner);
   b) annual salary and other income;
   c) function (e.g., design, marketing, construction, manufacturing, teaching, research, management);
   d) other (e.g., international travel; present a paper; serve as officer in professional, community, or other organization; start your own business; hold elective office; earn a PhD; take a year off).

B. For each of the four goals, identify one specific thing you will do within the next year to move toward the goal. Note: You are in effect “planning a trip.” How are you going to get to your destination? Do you have the necessary knowledge, skills, and attitudes or a way of obtaining them? Probably not, but you can obtain or develop them. Or are you going to let chance rule perhaps using the rationale that everything will come to you if you “just work hard?” If the chance route appeals to you, take a quick look at the contrary ideas presented at the beginning of Chapter 15.

1.2 ASSEMBLE PROJECT INFORMATION: This exercise’s purpose is to provide a profile for engineering or engineering-related project, unique to you, for subsequent use in one or more assignments. Suggested tasks are:

A. Select a technical “project” you worked on or are working on. Examples are:
   a project you did during co-op, something you worked on during a summer job, a volunteer effort with some technical content, a design project in one of your courses, or your capstone project. The project must have at least 15 different tasks or steps.
B. Prepare a memorandum that includes: a) A description of your relationship to the project. That is, when, how, and why are or were you involved? b) A list of project tasks, in approximate chronological order, recognizing that some tasks may overlap. Assign a letter or number to each task.

1.3 BOOK REVIEW: The purpose of this exercise is to provide you with an opportunity to study, in depth, one professional/business author of your choice, subject to instructor approval, and to critique the thesis of the book. In so doing, you will be further introduced to the broad range of leadership and management literature with the hope that you will continue to read critically in this area. Suggested tasks are:

A. Select one business/professional book that addresses some aspect of leadership and/or management. The book could be recent or it might be old or even what you or others consider a classic. Some sources are books listed in the Cited Sources and Annotated Bibliography sections of this book’s chapters, books reviewed in book sections of newspapers and magazines, books recommended by others, and those you find by searching under “leading,” “managing,” or similar words.

B. Request approval of the book from your instructor.

C. Read the book and prepare a review in which you do the following: a) cite your book (e.g., name, author, publisher, date), b) describe some of the key ideas and/or theses presented in the book, c) identify the evidence in support of the ideas/theses, and d) indicate whether or not you agree with the key ideas/theses. Refer to Chapter 3 of this book for writing guidance.

1.4 RESEARCH PAPER—INDIVIDUAL STUDENT VERSION: The intent of this exercise is to provide you with a means of studying, in depth, a leading/managing topic of largely of your choice. This can broaden and deepen your knowledge, increase your awareness of the leadership and management literature, and strengthen your research and writing abilities. Suggested tasks are:

A. Select a leading/managing topic. To get you started, but at the risk of unintentionally confining your thinking, an array of varied topics follows to stimulate your thinking: cost control in engineering-construction-manufacturing, creativity and innovation, decision making, design-build, dual ladder organizational structure, engineering and/or other licensure laws, ethics, failures and learning from them, globalization, history of some aspect of engineering or technology, lean construction or manufacturing, liability, partnering, quality control and quality assurance, reengineering, risk, robotics, sustainability, and teamwork.

B. Request approval of the topic from the instructor.

C. Research your topic by drawing on a variety of sources. Consider using one or more personal sources that you contact in person, by telephone, e-mail, or letter. If you use a personal contact, cite them at the end of your paper using this

D. Write the paper. Assume your reader is an engineering or other technical profession major who knows little about your topic. Use the writing section of Chapter 3 for guidance.

1.5 RESEARCH PAPER—TEAM VERSION: Similar to the preceding exercise, except that the topic is to be selected and researched with the paper being written by a team. The purpose of this exercise is, in addition to the purpose stated for the preceding exercise, to simulate the team-oriented manner in which engineering work is done in practice. A possible approach for this exercise is to select a country and research the following aspects of engineering in the selected country: a) overview of country (e.g., location, size, population, topography, economy), b) engineering education, c) engineering licensing, d) engineering professional organizations, e) area(s) of science and technology for which the country is considered a leader, f) image and/or social status of engineers, and g) any other aspect of engineering that interests one or more members of the team. In addition to providing an instructive team experience, this approach could heighten student awareness of international similarities and differences in the approaches to engineering education and practice as well as variations in the status of engineers and the engineering profession recognizing that today’s engineering students are very likely to work in a global engineering and business setting.

1.6 YOUR LEADER: The purpose of this exercise is to increase your sensitivity to the presence and influence of individuals who lead. As with Exercise 1.1, the results of this exercise should be confidential, unless you want to share them with your instructor or other trusted persons. Suggested tasks are:

A. Some of us are privileged to work for, or associate with, individuals who lead. Such situations are uplifting and instructional. Think of someone who led you or your group in a new direction, who enabled you or your group to see new possibilities and then achieve them.

B. Write about the experience noting, in particular, the qualities of the person who led. Compare them to the seven qualities of effective leaders presented in this chapter.