Leadership by Engineers and Scientists

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Professional Skills Needed to Succeed in a Changing World

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WILEY

AIChE
The Global Home of Chemical Engineers

A Joint Publication of the American Institute of Chemical Engineers and
John Wiley & Sons, Inc.

Published by John Wiley & Sons, Inc., Hoboken, New Jersey.

Registered Office
John Wiley & Sons, Inc., 111 River Street, Hoboken, NJ 07030, USA

Editorial Office
111 River Street, Hoboken, NJ 07030, USA

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Library of Congress Cataloging-in-Publication Data

Names: Hess, Dennis W., author.
Title: Leadership by engineers and scientists : professional skills needed to succeed in a changing world / Dennis W. Hess.
Description: First edition. | Hoboken, New Jersey : John Wiley & Sons, 2018. | Includes bibliographical references and index. |
Identifiers: LCCN 2017056788 (print) | LCCN 2018004834 (ebook) | ISBN 9781119436584 (pdf) | ISBN 9781119436560 (epub) | ISBN 9781119436591 (cloth)
Subjects: LCSH: Leadership. | Engineers–Vocational guidance. | Science–Vocational guidance.
Classification: LCC HD57.7 (ebook) | LCC HD57.7 .H467 2018 (print) | DDC 658.4/092–dc23
LC record available at https://lccn.loc.gov/2017056788

Cover design by Wiley
Cover image: © DrHitch/Shutterstock

Set in 10/12pt Warnock by SPi Global, Pondicherry, India

Printed in the United States of America

10 9 8 7 6 5 4 3 2 1

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Foreword by C. Judson King

Engineering is the one major profession for which the primary accredited degree in the United States is still at the bachelor's level. The result is a crowded curriculum in which there is barely room for anything beyond the required science, mathematics, engineering principles, and capstone design courses. Yet there are other attributes that engineers need to possess in order to be successful throughout their careers.

Communication skills – speaking and writing – have been recognized for decades as vital abilities for engineers. Many universities have instituted special courses or components of courses on these subjects for engineering students at the school, college, or departmental level. Engineering ethics has been similarly recognized, but is a less common component of engineering curricula. In industry, engineers commonly work as part of groups, with other engineers and often with persons from other disciplinary or professional backgrounds. Leadership and teamwork skills are important in structured group work, and become continually more important as an engineer moves along a career and reaches levels of ever greater responsibility. Leadership abilities are keys to success, but they have not traditionally had much place in engineering curricula.

Movie buffs may recall the 1955 film, The Long Gray Line, in which Tyrone Power plays Marty Maher, the long-time swimming instructor at West Point, the United States Military Academy. As a Signal Corps Army officer, my father was an Instructor of Electricity and Chemistry at West Point during my earliest years, and so it was decided that I should learn swimming from none other than Marty himself. Marty's rather idiosyncratic instructional technique consisted of placing the pupil in a cork life jacket suspended from a ropes-and-pulley apparatus that would be moved from the edge to the center of the pool and then lowered into the water so that the pupil could learn simply by doing what came naturally. In my case, being aged 4 or so at the time, what came naturally seems to have been abject terror and much screaming.

Most engineers first encounter team leadership in the same unprepared fashion of sudden total immersion, but without the life jacket. Doing what comes naturally is often the wrong approach for leadership, and bruises, discouragement, and even sustained hard feelings among colleagues can be the result. Some people are natural leaders, but most are not. And yet, as Dennis Hess demonstrates ably in this book, there are many aspects of leadership that can readily be learned and which will go a long way to help engineers avoid mistakes and succeed in career paths that are necessarily built on leadership skills.

I have known Dennis Hess for forty years, since he arrived at Berkeley as an Assistant Professor following his time with Fairchild Semiconductor. Dennis is himself a capable leader. As Dean, I had the pleasure of starting him off administratively as Assistant Dean in Berkeley's College of Chemistry, and he has now gone on to such things as being President of the Electrochemical Society and Director of Georgia Tech's NSF Materials Research Science and Engineering Center for New Electronic Materials. We are fortunate that he has turned the contents of his unique course on technical leadership into this book, which should help its readers to be understanding and effective leaders while minimizing scarring pitfalls as they proceed along their careers.

Berkeley, CA

Foreword by Rick Zalesky

In my 37 years working in the Chevron Downstream business, my first conversation with a new young scientist or engineer always went something like this, "if you are going to be successful in your job, you need to understand why things work the way they work." Generally they just smiled and said thank you for the tip. More than once however, I received a note, sometimes years later, saying "now I understand what you meant!" When I first started sharing this "wisdom" I was referring to refinery processes and equipment troubleshooting; if they did not understand what was supposed to happen, then they had no chance to diagnose a problem and recommend ways to solve it. Over time, I came to realize this was even more vital in their roles as leaders.

When Dennis first invited me to give a guest lecture for his Georgia Tech chemical engineering class on leadership, I was quite intrigued. In my day nothing like this was part of any science or engineering curriculum. I had to learn it over time; largely through experience and reflection on what seemed to work well and what did not. About a decade into my career, Chevron allowed me to attend a number of excellent leadership trainings courses. What struck me after the lecture was that the students would be starting their careers with a set of skills it took me years to develop.

What Dennis has been providing his students in his leadership course is captured perfectly in this new book. He covers all the critical skills, but even more importantly he shares how to put them into practice.

It is often said that leadership is a team sport. While this is most certainly true, a critical attribute of the sport known as leadership is how leaders support their teams. One of my mentors told be something I never forgot. He said, "Always remember you need the team in order to be successful in your job, however the reverse is rarely true!"

Enjoy!

Atlanta, GA

Preface

This book is intended to promote awareness of and approaches to effective technical leadership by technically trained individuals. Scientists and engineers undergo extensive education and training in the fundamentals associated with their fields. As part of this education, they solve numerous problems using the skills and knowledge they have acquired; in addition, they are given somewhat limited exposure to working in teams. However, virtually no education or insight into effective and ineffective leadership skills are offered within core or even elective courses. After graduation, scientists and engineers work almost solely in teams or groups where a leader is appointed. In this structure, they employ their skills to address technical problems that may or may not have viable solutions or even directions, thereby demanding vision-generation, goal-setting, consensus-building, decision-making, and communication. Success in these activities and responsibilities begins with the leader.

On teams, the gap between using fundamental knowledge to solve problems and progress toward or completion of a task invariably involves effective leadership that facilitates cooperation, synergy, and creativity within an extremely diverse group of individuals. Although such abilities are typically not developed in formal degree programs, graduates are expected to have the appropriate "soft, professional, or people skills" to successfully lead a team or organization. Many of the limitations and frustrations generally experienced by new leaders are related to the difficulties in inspiring, influencing, and guiding team members to decisions that move projects forward.

Numerous books are available that address leadership theories and studies for use in business degree programs or self-study; only a few address technical leadership and are written from the viewpoint of technically trained leaders. Rather, nearly all existing books identify and discuss specific leadership traits which must be developed and practiced in order to successfully navigate leadership roles. Examples of well-known leaders' approaches to achieving high performance are described to exemplify

desired behavior or illustrate poor behavior, although these examples are typically Presidents, CEOs, or other high level administrators who have little or no technical training. Discussion of and the manner by which scientists and engineers might deal with specific leadership scenarios commonly encountered in early to mid-career positions is lacking in almost every case.

This book was developed to supply assistance to scientists and engineers as they consider or begin their role as technical leaders with small groups or teams. It is an outgrowth of technical leadership courses that I have taught to undergraduate and graduate students in the School of Chemical & Biomolecular Engineering (ChBE) at the Georgia Institute of Technology. These courses arose from many years of teaching-required safety courses to ChBE majors where information on ethics, professionalism, and decision-making was presented to describe and discuss the causes and implications of various incidents (e.g. Bophal, Flixborough, Piper Alpha, T2). These topics facilitated discussion of the fact that numerous situations occur in science and engineering research, development, and production where no "correct" answer exists, but decisions must be made and directions established with considerably less than complete and generally with conflicting information. This is the domain encompassed by the technical leader and addressed in this book.

The content and topic sequence of the book draw on the analysis and critical thinking skills of engineers/scientists to address specific situational or contextual leadership scenarios that are encountered in small teams, but also at higher managerial levels, where egos, personal biases, and emotions can and do dictate behavior. After some background regarding what a leader is and is not, why engineers and scientists are excellent candidates for leadership positions, and limitations of a technical background insofar as leadership behavior is concerned, ineffective habits or characteristics of "leaders" are described so that readers can identify aspects of their own personality or behavior that detract from their ultimate capabilities. Ethics and professionalism are discussed briefly to describe their critical role in leadership functions. Effective leader behavior and characteristics required to maintain personal sanity and be successful (time management, personal values, development of credibility and trust) are described to place in context a variety of scenarios that will serve as illustrations.

After this prelude to leadership, specific topical areas that relate to responsibilities, professional skills and behaviors, and situations encountered frequently by technical leaders are discussed. Initially, discussion of how to use questions to effectively lead and influence others is described. Questioning is a continuing theme throughout this book, since this type of approach generally leads to open discussions and effective exchange of

information. Such outcomes are in stark contrast to the resistance and accompanying cessation of communication that frequently results when orders or statements are offered. Subsequent topics covered in the remaining chapters include developing a vision, building a team, running an effective meeting, decision-making, managing change, managing conflict, communication, and presenting difficult messages to others.

Within each topical area, numerous homework problems are given; some of these can be used as discussion questions for class or small group meetings. In addition, discussion questions and vignettes (mini case studies) are presented in shaded boxes throughout the text; some of these include suggested approaches that offer ways that the situation might be addressed. These scenarios are presented to develop awareness of and practice dealing with problems that have only better or poorer approaches rather than right or wrong answers.

Problems with no "correct" (or even good) answers are often uncomfortable to technically educated and focused individuals. The questions can be effectively discussed in a group/class setting with pros and cons of possible approaches debated and consequences of specific decisions described. These questions or scenarios can be used for self-study, homework, class/group discussion either in a separate leadership course, as examples in courses where team projects are employed, or in workshops. Such activities develop critical thinking skills via active learning by using inquiry-based or problem-based approaches. In this mode, the instructor serves as a facilitator or a naysayer as needed to supply perspective to open-ended questions or complex situations where actions must be proposed or conclusions drawn with considerably less than complete information. The variety of scenarios posed offers situational leadership practice for current or aspiring technical leaders; these exercises aid the development of professional skills and thereby help prepare students and early career engineers and scientists for leadership roles.

Acknowledgments

As with any textbook or professional development book, the content has been developed over time from interactions with a large number of colleagues and acquaintances. I owe a great debt to all of them. Unfortunately, there are too many to identify each by name. However, there are a few groups and individuals to whom I owe the most. The students who have been subjected to my attempts to "teach" leadership deserve special thanks. Their discussions, questions, comments, concerns, and enthusiasm have constantly improved my approaches and kept me motivated and humble. I have appreciated the collegiality and professionalism of colleagues at Fairchild Semiconductor, the University of California Berkeley, Lehigh University, and the Georgia Institute of Technology. I would like to thank Professor C. Judson King, who, while Dean of the College of Chemistry at U. C. Berkeley, convinced me to begin administrative roles when I was in the Chemical Engineering Department. Jud was an outstanding role model who made success as Department Chair, Dean, Provost, and ultimately Vice President for Research of the University of California System, look so easy that many of us foolishly thought that we could also do these jobs. I have also benefitted greatly from the lectures that Rick Zalesky has given in the leadership courses that were the precursors to this book. I especially want to thank a number of my colleagues at Georgia Tech, Professors David Sholl, Ron Rousseau, Chris Jones, Chuck Eckert, G. Wayne Clough, Charles Liotta, Pradeep Agrawal, Michael Filler, Julie Champion, and Jacqueline Mohalley-Snedeker for their extensive encouragement, advice, suggestions, and feedback on content and initial drafts of chapters contained in this book. Their insight and attention to detail and their willingness to serve as sounding boards for this project are sincerely appreciated; the content and quality of the book have been improved substantially by their contributions.

I greatly appreciate the assistance and encouragement of AIChE Executive Director June Wispelwey, who felt that the content of this book would be of

value to Society members as well as engineers and scientists in general, and initiated the process of evaluation and approval. Kate McKay, AIChE Books consultant, deserves considerable credit for efficiently shepherding me through the application process. In addition, members of the AIChE New Books Subcommittee supplied many helpful comments on the book proposal that greatly aided effective presentation of leadership approaches.

I have benefitted immensely from the publishing team at Wiley who oversaw this effort, guided me as I undertook and ultimately completed the project, and made certain that the final product met their high standards. In particular, Michael Leventhal, Editor and Assistant, supplied information and assistance on the book title, cover selection, and marketing and ensured that the publication process was organized and coordinated. Beryl Mesiadhas, Project Editor, provided guidance, structure, and answered many questions regarding submission details and permissions. Amudhapriya Sivamurthy, Production Editor, directed me through the final stages of copyediting and page proofs. Her patience and precision in addressing my numerous questions is greatly appreciated.

Finally, I want to thank Patty Hess, my wife of 49 years. Through much patience, guidance, and personal examples, she demonstrated how leaders can display emotional intelligence and empathy. Despite her best attempts, I am still learning these skills; apparently, I am improving! I have learned more from her counsel and example than from numerous books that I have read on these topics. She has put up with and even accepted the many years I have spent sitting in front of a computer screen as a practicing academic, and most recently, formulating this book. I am extremely grateful for her love and support and that she chose to spend her life with me.

Part I

Introduction to Technical Leadership

Why Take Time Away from the Study and Practice of Technical Problem Solving?

Exceptional performance in an engineering or scientific position and career requires detailed knowledge of the fundamentals of the specific field and related areas, and the ability to apply that knowledge to solve problems. However, these capabilities represent necessary but not sufficient conditions for career success. Less than 50% of an engineer's or scientist's time in any technical position will generally be spent on science- or engineering-focused tasks. This percentage always decreases with responsibility level and experience; in high level leadership or management positions, less than 20% is typical. Much of the day-to-day time invested by practicing engineers or scientists irrespective of their specific vocation, involves interactions with other individuals and groups of individuals within or outside the organization, where directions, goals, and performance are discussed and decisions made. It is therefore critical to develop leadership and decision-making skills, to communicate decisions and their implications clearly, and to ensure that these tasks are performed in an ethical and professional manner. That is, "… an engineer is hired for his/her technical skills, fired for poor people skills, and promoted for leadership and management skills" [1]. Despite the essential nature of these skills to career success, little emphasis is afforded them in core or even elective courses in science or engineering curricula.

The need for skill development in leadership can be envisioned easily. Below are three examples of situation types encountered frequently by technical leaders for which they have received no training and often have little awareness.

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- Two of your team members are simply incompatible. They argue about trivial as well as significant issues, make derogatory remarks about each other to other team members, and their behavior is degrading collegiality and team productivity. As team leader, how do you resolve this issue?
- One of your team members is rude, arrogant, and disruptive at team meetings. Other team members avoid this individual and refuse to interact. Due to the specific technical background and expertise, the individual is critical to the success of two of your projects. How do you handle this situation?
- A decision must be made regarding the purchase of a new spectrometer for use in your analytical department. The department members are split regarding which manufacturer and model should be ordered, and the discussions have become extremely heated and emotional. As team leader, how do you make this decision, and how do you deal with the individuals whose recommendation you did not take?

If these examples make you uncomfortable, wonder how you might address such issues, and begin to question if you want to ever be a team leader, then you need to keep reading.

Technical leadership effectiveness has been described through the relationship among various interpersonal effectiveness traits for engineers [2]; this view has also been applied to science and mathematics backgrounds [3]. The elements of interpersonal effectiveness are defined as [2]:

- **Ability** to solve problems, make decisions, communicate with and engage others
- **Awareness** of themselves, others, circumstances
- **Commitment** to responsibility, ethical behavior

The need for these interpersonal proficiencies are evident from even brief consideration of the situations described above. The importance of developing "soft" or "professional" skills has been the subject of recent articles for scientists [4, 5] and engineers [6], that illustrate what skills are needed; the articles offer brief descriptions of how these skill sets can be developed in students and early career professionals.

Corporations and academic institutions must identify and develop leaders who in addition to having engineering and scientific competency, can establish and promote a vision, build and run teams, make timely and effective decisions, communicate clearly, ensure high performance levels, and manage change. Individuals generally achieve the latter six proficiencies by trial-and-error or observation after completion of their degree(s). In their employment environment, they encounter many

examples of leadership successes and failures. Being competent engineers/scientists, they analyze these situations either after their own initial success or failure or after observation of others displaying successful or unsuccessful attempts at these efforts; such "data" lead to a realization of how the situation could have been handled better. As Mark Twain, Will Rogers, or Rita Mae Brown (depending upon which search engine is used) noted:

> Good judgement is the result of experience and experience the result of bad judgement.

These approaches to developing leadership skills are effective but linear and thus time intensive, since the number of different scenarios that can be encountered is infinite. A situational or contextual leadership approach is taken in this book, where specific situations are posed and/or discussed in light of the uniqueness of that particular scenario. Analogous to solving technical problems, the similarity among certain types of situations should shorten the time frame needed to develop technical leadership awareness and skills through identification, discussion, and recognition of how various commonly encountered situations might be handled. Such knowledge will allow engineers or scientists to progress rapidly up the learning curve in their "new" role of leading others.

Engineering and science students are taught how to address problems while increasing their understanding of the field by solving numerous problem types in homework sets or exams. The methods developed can then be used to attack new problems previously unknown to the students. After graduation, the students are expected to use their problem-solving skills to address more open-ended problems with a sufficient number of boundary conditions that an exact solution is unlikely or impossible. Rather, an "approximate or optimum" solution is needed, as experienced in process or product design problems. The intent of this book is to introduce the reader to open-ended (situational or contextual) problems focused on technical and nontechnical colleagues, boss, or subordinate behavior and interactions that defy simple, clear, or exact solutions. By offering examples of dilemmas in technical leadership along with selected analyses of possible ways to address or consider such issues, aspiring or current leaders can build awareness and develop approaches to address future variations on these themes or new situations. In addition, many decisions must be made with less than adequate data or information, a situation that is not viewed favorably by engineers and scientists. When the situation to be resolved is dependent upon individual or

group (personal) reactions and behavior, the resulting responses are often disconcerting to those who expect both system and individual behavior to be reproducible and predictable. Instead of this anticipated, or at least hoped-for behavior, the approach needed to resolve problems and successfully lead others depends upon the specific people and personalities involved, the culture within the organization, and the time frame within which a decision is required. Because the leader has very limited or no control of these issues, frustration is a frequent outcome. An effective leader recognizes that the problem and frustration encountered may not be due to incompetence or mediocre performance, or to the unpredictable or illogical behavior of others; rather, the issues encountered may be due to the fact that the leader's and team members' perceptions of the situation differ because of either misunderstanding or to disparities in values, motivation, experiences, and priorities.

This book is intended for technically trained individuals who (i) are considering, anticipating, or have recently been promoted into formal leadership positions; (ii) wish to have a "snapshot" of the types of issues they will face in such positions; and more importantly, (iii) wish to know how they might deal with common situations encountered that involve personal, social, political, and economic aspects. The starting point in dealing with many leadership situations is for the leader to understand and control himself/herself. As a result, numerous discussion and homework questions focus on introspection to gain knowledge of and insight into who the reader (leader) is. The specific topics or chapters contained in this book will also be helpful to those who are currently struggling to function effectively in leadership positions and to those non-technically trained individuals who have been given the task of leading or managing engineers and scientists (assuming that is possible). Within each chapter, there are discussion questions and frequently a vignette; these scenarios are set apart from the rest of the text by shaded text boxes. In the case of the vignettes that appear at the beginning of chapters, suggested ways to approach the dilemma described are offered at the end of the chapter.

It is also hoped that the concepts and information contained in this book will make those who are following leaders better "followers" since they will derive improved appreciation for the issues and complexities involved. Such appreciation should improve the behavior displayed when functioning on teams. Finally, since employees with leadership potential and "soft" or professional skills are strongly desired by every organization, it is hoped that the contents of this book will be helpful to individuals who are undergoing interviews and job searches where candidates' abilities to demonstrate these skills are probed.

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1

Examples of Routine Problems and Decisions Faced by Technical Leaders

If you have an engineering or science degree(s), you have been trained to apply fundamental principles to solve problems and make decisions based on carefully generated data, calculations, and their interpretation. As you have no doubt learned by this stage in your life and career, people are not data, nor do they **appear** to function in a well-defined and idealized manner. During your formal education, you have seen a number of open-ended technical problems. But, these problems have not incorporated the most diverse situations that you will encounter in your technical career: Those that involve beliefs, values, biases, and emotions of individuals. Such issues are generally far more difficult to resolve due to the personal nature and sometimes seeming unpredictability of the people involved.

Before launching into a discussion of technical leadership fundamentals and the unique viewpoints and characteristics that technically trained individuals bring to leadership positions, it will be helpful to consider a few of the routine or day-to-day "sensitive" issues that many leaders face when they are responsible for group members' actions, productivity, and accomplishments. Ways to think about and approach such undefined "people" problems are presented for five cases in this brief chapter. These cases offer examples that can serve as an orientation to other situations common to technical leadership that are introduced throughout the book. You will gain the most insight and understanding from this chapter if you take a few minutes to think carefully about how you might handle each vignette posed prior to reading "the answer." I state this as "the answer" because all answers offered are ambiguous and have multiple possible paths to follow. The context within which a leader must function for a specific issue typically determines the most appropriate approach. In fact, the same leadership dilemma may have a different "best approach" when the team or organization changes due to the variation of people, circumstances, culture, and deadlines associated with each team or organization.

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Published 2018 by John Wiley & Sons, Inc.

This is a common characteristic of nearly all leadership situations and decisions, which frequently results in frustration for early career leaders. You will find that most approaches suggested involve asking questions to lead the individual with whom the leader is dealing (or even the leader) through a process that helps them recognize their assumptions/actions/behavior/consequences. This "questioning" approach to leadership promotes interdependence among team members and ensures that everyone feels part of the approaches developed and decision-making process; further details describing characteristics of a questioning team culture along with approaches to establish and promote this type of culture are offered in Chapter 7. After considering the examples below, you will better appreciate the reasons for the ranking of attributes that employers seek on a candidate's resume [1]. In order, the top five attributes in 2016 were leadership, ability to work in a team, written communication skills, problem-solving skills, and verbal communication skills.

1) As a result of a team leader retirement, you have been given your first leadership/managerial position for a group of engineers and scientists who have been working together successfully and productively for more than 10 years. During the first few months of this new assignment, the attitude of a number of the team members appears to be one of distrust for you and your leadership style. It is apparent that the previous smooth-running operation is degrading and you have been asked by your boss if there is a problem. How do you respond to your boss and how do you deal with the difficult interactions with your team members?
2) As a result of your efforts to address issues within your new team, the team members have once again begun functioning effectively and efficiently. Due to a mistake in assessing the number of new technical personnel needed, an additional engineer was hired and has been assigned to your team. Sean is a very impressive new graduate from a highly ranked school. However, you quickly observe that whenever Sean asks a question or offers a dissenting opinion in team meetings, his remarks elicit demeaning and sometimes rude comments from several of the members. The normally collegial group seems to be polarizing into two segments as a result of this behavior. How do you regain group collegiality and professionalism?
3) Each month your team members are required to present 5-min synopses of their recent accomplishments and outline their plans for the next month, paying particular attention to current or anticipated concerns. This allows feedback and constructive criticism of the directions taken and the results obtained. Beatrice gives very detailed informative

presentations, but the presentation always runs more than 10 min. A number of team members are annoyed by this behavior because, as a result, the meetings run late and more importantly, they feel that Beatrice is receiving more than her fair share of attention, opportunity, and recognition. How can you resolve this issue?

4) As a recently hired employee, you attend team meetings and participate in the discussion and evaluation of results generated by different team members. On one occasion, one of the highly respected senior team members justifies his opinion on a discussion topic by stating a "fact" that is clearly technically incorrect. How do you as one of the most recent additions to the organization, address this issue?
5) A senior scientist with an international reputation and high visibility always arrives 10–15 min after your regularly scheduled team meeting has begun. In addition, this person typically spends most of the meeting time checking and responding to email. This behavior disrupts the meeting and morale is suffering because other team members have individually told you that they feel this person is arrogant, not engaged, and receives special treatment. How do you as the team leader, handle this situation?

1.1 Possible Approaches to Deal with Representative Leadership Dilemmas

The following discussions and possible approaches to dealing with the dilemmas posed above are the result of many years of experience (and mistakes made) by the author. My perspective on these representative issues has arisen from a large number of sources: Personal experience in a variety of professional positions; discussions with colleagues regarding their trials and tribulations as leaders; concerns expressed by students or former students who have encountered unexpected behavior from others while performing their professional duties; observations of other leaders' experiences; and reading accounts of problems that made headlines in industry, academia, national laboratories, and personal interactions. As noted previously, there are no "correct" answers to such situations, but various approaches can be considered; the optimum approach depends upon the specific people, organization, and time available for resolution.

1) *First leadership assignment after previous leader retirement:* First, an unbiased assessment of your leadership style and current team directions is needed. A detailed (soul searched) self-evaluation regarding how you began this team leadership effort and whether you gave the impression that you were going to, or in fact, did immediately

implement changes in culture, priorities, or rewards should be performed. In addition, you should request impressions and pose questions concerning your attitude and actions as you began this position from a trusted mentor or someone else outside the team. If you feel that one of the team members would be willing speak with you frankly one-on-one and address your questions so that you can gain insight into the impressions you have given the group, this will be very useful. You also need to determine if your behavior during team or individual meetings would have given the impression that you were closed to considering alternative ways of viewing the tasks your team undertakes and/or have taken a dictatorial approach to leading. You should also consider the possibility that some (or all) members of the team are resistant to change (even if it is for the better) and they have not yet decided if they can trust you or if you have established credibility with them. An additional possibility is that one or more of the team members felt that they should have been selected as group leader; rather, an individual outside the team (you) was selected. With this information in hand, you can decide if you have caused the dysfunction within the team by your actions, if you have not yet proved that you deserve their trust, or if one or more members feel slighted by your appointment. This conclusion will allow you to plan how to proceed. If you have caused the dysfunction, then you need to apologize to the team and indicate how you will rectify the situation. If you have not yet established trust, then you will have to show by your actions both who you are and that you are true to the value/belief system you claim to embrace; this may take some time, so patience is a virtue. If you were selected for the position when others feel that they were more qualified or appropriate, then you will need to prove by your actions and attitude that you are qualified and are a team player in all that you do. You should share your thoughts about what you believe is the problem with your boss and indicate how you will approach a resolution. You will then receive additional input and suggestions from him/her to be factored into how you proceed.

2) *Sean difficulties:* Since there are some team members who appear to interact well with Sean (at least one segment of the team behaves professionally), you should speak with one or more of them to obtain their evaluation of what is taking place in team meetings and why. As the leader, you need to assess from your own observation of behavior whether Sean is giving the impression that he is condescending with his questions/remarks. This may be due to his tone of voice, body language, or attitude. In such cases, you need to speak with Sean one-on-one to let him know how he is coming across to the team and ask questions that lead him into ways in which he might display more

appropriate behavior. You can then also suggest conduct wherein he can be viewed as more collegial and flexible. Of course, this assumes that he is not aware of the impression he is giving. If he is simply arrogant, then you need to indicate what effect he is having on the morale and collegiality and why it is important for him to develop positive interactions with other team members, to ensure productivity and thus meet team goals/vision. You should monitor his progress to confirm that he is committed to change and that his efforts are effective. If he is not willing to work toward that goal, then you may need to inform him that you will not tolerate such behavior within your team; consequences need to be stated in this case. If neither you nor other team members perceive problems with Sean's behavior, then you need to discuss the response that is occurring with the team member (or members) who appears to be the primary proponent of deriding Sean. Ask why this type of response has arisen and what he/she intends to accomplish by such behavior. Provided that the response is deemed truthful, this will allow an assessment of the concern eliciting inappropriate conduct and the development of a plan to address these issues. One or both parties may need behavior modification and this will require that they are motivated to change and willing to chart a plan to correct their actions. When all parties are aware that you are making a sincere effort to reconcile the differences, you may get assistance from others to improve the situation. That is, if peer pressure can be brought to bear to alter behavior, this may help resolve the problem.

3) *Beatrice presentations:* In a one-on-one meeting, the leader should ask Beatrice why she plans a presentation that is twice the allotted time. If she thinks that the presentation is only 5 min in length, or she does not know how to reduce the length and still present the important results, then her presentation skills need refining and likely your assistance and guidance. If she shows an "attitude" about this, i.e. my work is so significant that I deserve to take more time, then she needs to know the effect her behavior is having on team dynamics and that personal advertisement and kudos is not the purpose of this particular meeting. After this discussion the leader needs to keep track of how the next few presentations go; she may need a reminder and some stated consequences if the situation does not improve. An alternative way of handling this after your discussion is to schedule her presentation last, and when the time for the meeting has expired, the team is dismissed or individuals can leave if they need to do so. Of course, this will only work if all other presenters stay on time. If this type of approach allows Beatrice to continue functioning in a way that is disrespectful to other group members, then this is probably not the way

to proceed. However, you may need to try this tact to observe how the plan plays out. If other team members "tune out" when Beatrice begins speaking because they interpret your change in schedule for her presentations to indicate minimal importance of her efforts, then they are acting unprofessional and/or rude which may require clarification for your actions and/or intervention by you.

4) *Senior group member technically incorrect:* The most diplomatic way to handle this is to wait until after the meeting is over and then go to the senior group member's office and ask for clarification. This one-on-one discussion will allow the person to save face within his peer group and hopefully defuse defensive postures. Tell the person that you could not follow their logic and explanation and ask them to help you understand. With any luck, they will see their mistake. If you are not that lucky, then you need to keep asking questions regarding the details of what the senior person is saying to lead them through their misconception or false logic. If a decision is being made at the meeting where the incorrect information is offered, and the decision will change based on this false information, then you should approach the situation in a similar way at that time; this must be done carefully. That is, begin asking questions for clarification that leads the person through the false logic or incorrect "facts" so that they have the opportunity to correct themselves. This is the least threatening way to proceed in order to reduce the likelihood that egos will take over the discussion and eliminate productivity. If the senior individual remains insistent that they are correct either at your individual meeting or the team meeting, then you should point out the facts clearly with detailed justification via previous studies/references. If the incorrect "facts" will have no bearing on anything that the group is doing, it is possible that they may be ignored. However, having incorrect information entered into team members' memory or minutes to the meeting could be problematic at a later time, so it is best to correct this situation.
5) *Senior scientist late arrival:* Since this is chronic behavior, you need to have a one-on-one discussion with the senior scientist where you ask the reason for the constant late arrival at a regularly scheduled meeting. You should point out the effect that this has on the morale and effectiveness of the meetings and the message this sends to younger team (and more experienced) members. You should also ask why this individual feels compelled to spend the meeting time working on email. Point out that it is imperative for maximum productivity toward reaching the goals set that everyone contribute to the results and directions being discussed. You could also indicate that this person's extensive experience is greatly needed to reach viable conclusions and make decisions (i.e. appeal to his/her ego). Questions regarding why

there is an apparent lack of interest in the meeting content and discussion should be posed. Of course, there is no guarantee that this person will "see the light" and change their late arrival practice or stop giving the impression that this is a waste of time. If the behavior is annoying, but there are major contributions to the meeting by the senior scientist, you may wish to play down or ignore this conduct. If this is the approach you choose, you should speak with the team members who have complained to you to let them know where you stand on this issue and encourage them to not be put off by this behavior but to recognize how important the contributions are to the organization. If the senior scientist behavior is sufficiently disruptive that the attitude is poisoning the entire group, then you have a difficult decision to make. The question (but not the answer) is simple: Is the team and/or organization better with or without this individual? These are the types of decisions that an effective leader is expected and paid to make and requires great fortitude and a commitment to do the right thing for their team and organization.

Reference

1 Job outlook 2016. Attributes employers want to see on new college graduates' resumes, National Association of Colleges and Employers.

2

Technical Leadership Fundamentals

The key to successful leadership is influence, not authority
Ken Blanchard

An effective leader will make it a priority to help his or her people produce good results in two ways: making sure people know what their goals are and doing everything possible to support, encourage, and coach them to accomplish those goals
Ken Blanchard

The best executive is the one who has sense enough to pick good men to do what he wants done, and self-restraint to keep from meddling with them while they do it
Theodore Roosevelt

Management is doing things right; leadership is doing the right things
Peter Drucker

Leadership comes in small acts as well as bold strokes
Carly Fiorina

A leader is best when people barely know he exists, when his work is done, his aim fulfilled, they will say, we did it ourselves
Lao Tzu

Leadership has been defined as the ability to hide your panic from others
Lao Tzu

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

You have given a specific task that is part of a larger project, to one of your team members. Despite significant time and suggestions from you and other team members, he has still not made progress toward the goal nor has he figured out why his attempts have been unsuccessful. During your meeting with him to understand what is limiting his ability to complete the task, he tells you that he has been struggling with this project, has lost enthusiasm and motivation, and feels that he is unable to complete the assignment. How do you deal with this team member? What options do you have to move the task and thus the overall project forward? [Suggested approaches at end of chapter].

Leaders come in different sizes, shapes, and personalities. We have all seen examples of effective and ineffective leadership, but why are some leaders more effective than others? Insight into this question can be gleaned from definitions of leadership:

> Leadership is a process by which a person influences others to accomplish an objective and directs the organization in a way that makes it more cohesive and coherent [1].
>
> A process whereby an individual influences a group of individuals to achieve a common goal [2].

The common term between these as well as many other leadership definitions is "influences." This verb is used rather than coerces, tells, orders, controls, dictates, or instructs for good reason. All definitions imply that leadership is about people and interactions. Of course, there are particular traits or characteristics that leaders must possess or develop, but successful implementation requires effective personal interactions. The importance of personal interactions in technical leadership is sometimes unappreciated by technically trained individuals, since their focus is on facts and analytical approaches. In fact, engineers and scientists are responsible for developing existing and future technologies that avoid personal exchanges, e.g. internet purchases, personal assistants, self-serve or automated checkout, unmanned delivery vehicles.

In addition, it is important to recognize that influence can and does take place up (boss), down (subordinates), and laterally (peers) within an organizational structure and is distinctly different from power or control. In fact, an effective leader influences everyone around him/her in an attempt to improve all aspects of the organization. Such influential

behavior should extend outside the organization to the profession in which the leader is employed so that all members of the profession and society benefit.

One of the most insightful quotes regarding leadership as it pertains both to those who may question if they are "leader material" and to indicate what is expected of leaders, originated with John Quincy Adams, the 6th US president:

> If your actions inspire others to dream more, learn more, do more, and become more, you are a leader.

The context of this statement is of particular importance, since it does not refer to organizational structure or titles. You can **and should strive to** be a leader irrespective of your position in the food chain or your current duties. A leader title does not identify a functional leader; rather, the appropriate behavior and actions earmark a leader. Furthermore, this quote appropriately supplies the primary focus for leader efforts: **Others**, i.e. those individuals with whom the leader interacts.

2.1 Leaders Versus Managers

Effective leaders and managers share some of the same traits and deal with analogous people issues. However, their duties, responsibilities, and attitudes are not the same. Typically, leaders promote a vision, inspire others, and encourage appropriate risk-taking. They seek difficult or grand challenge problems to undertake and depend upon creativity, insight, and resilience to develop new approaches and directions for their teams and organizations. They mentor and develop those reporting to them. Their visions do not always materialize, but they learn quickly from their mistakes. Managers oversee current activities and processes, and ensure that tasks are completed, standards met, and manufacturing protocols followed and controlled for specific processes/products. They generally avoid risk since risk implies the possibility of uncontrolled structure and results. A leader can be and sometimes does function as a manager and vice versa, but this is seldom the case, because several of the personality traits or characteristics that make them successful as either a leader or a manager are distinct. Although both roles are necessary in an organization, they are often assigned to different individuals.

Discussion Questions

- What are three primary personal traits/characteristics exhibited by:
  - Leaders
  - Managers
  - Mentors.
- Which of the following will be the most successful/effective technical leader:
  - One who believes people are the only important resource?
  - A technical expert in the field being pursued?
  - An energetic hard-driver who expects 110% from everyone?
  - A big-picture charismatic who wins over everyone at meetings/social events?

2.2 Engineers and Scientists as Leaders

The gold standard by which engineer and scientist quality is evaluated is technical competency and ability to solve problems. Technically trained individuals therefore bring an extremely impressive skill set to leadership positions. For instance, they know how to solve problems, how to break complex issues into smaller parts, and how to plan and carry out activities. They can clearly articulate problem statements, devise studies, evaluate results, draw conclusions, and quantitatively measure effects of variables. They are well-organized, methodical, and rational, and they question everything; in fact, they typically enjoy playing a devil's advocate role. They are motivated and know how to stay up-to-date on new scientific and technical developments via life-long learning. Finally, they have experience leading technical projects as a result of their design or laboratory courses, internships, co-ops, or research, development, or manufacturing duties.

Engineers and scientists are generally promoted into or aspire toward formal leadership or management opportunities because of the success(es) they have had in technical positions. However, as mentioned previously, scientific and technical competency is a necessary, but not sufficient, skill set for technical leadership success. What is generally missing in the background of engineers and scientists is extensive experience leading large or small groups, communicating clearly, making decisions in a timely manner, building consensus, establishing personal relationships, organizing others, and handling conflict among people who have a multitude of viewpoints, backgrounds, and experiences, and are (often) highly opinionated.

A typical frustration for new technical leaders/managers is that they are suddenly responsible for various activities (e.g. productivity, timing of project completion) for which they have no direct control. Instead of depending upon their own abilities, they must now depend upon others to accomplish goals or meet deadlines. Achievement of objectives requires that they establish an environment that allows or empowers those who report to them to accomplish the goals; such activities are not included in their technical preparation. The "new" technical leader typically does not want to relinquish control and resists delegating; these traits manifest themselves by preferences to perform the technical tasks themselves and impatience with others who are now assigned the task and do not perform it in the way the leader expects. Equally difficult is the need to deal with uncertainty and incomplete information when making decisions. These issues require that technical leaders avoid reliance **only** on their technical prowess and insistence on identifying the correct technical solution over an unspecified time frame. Seldom is there a "correct" solution when subordinate, peer, or supervisor idiosyncrasies; time deadlines; ethical issues; and cost limitations are considered. The situations encountered are complex with numerous interacting causes and effects due to technical and people issues; frustration is therefore a frequent outcome. Despite such competing priorities, decisions are required. In addition, leaders must enhance their people skills, promote people interactions, deal with others' problems, listen more than they speak, and perhaps most importantly, take pride in and energy from facilitating others' development, achievements, and successes.

Technically trained individuals often find it difficult to deal with people who do not understand engineering and science. This is particularly problematic when a technical leader reports to or interacts with someone without a strong (or any) technical background. These individuals may not fully understand what engineers or scientists do and may view it as "magic," incomprehensible, or simply detail oriented, while the technical leader feels that the nontechnically trained individual is clueless; neither viewpoint is correct or appropriate. This type of disconnect requires patience and careful explanations by the technical leader. Indeed, an extreme example of a conversation between two individuals, one of whom has a technical background while the other has a management background, has been offered in The Balloonist and the Engineer [3]:

> Realizing he was lost, a balloonist dropped down to ask directions. "Excuse me, but I'm a little off course" he shouted. "I promised to meet a friend an hour ago, I don't know where I am."

A woman hollered back: "You're in a hot air balloon hovering approximately 30 feet above the ground. You're at exactly 40 degrees, 22 minutes, and 21 seconds North latitude and 70 degrees, 30 minutes, and 33 seconds West longitude."

"Amazing," the balloonist replied. "You must be an engineer!"

"I am," she replied, "How did you know?"

"Well," answered the balloonist, "everything you told me is technically correct, but I can't use your information. I'm still lost and you haven't been much help at all. If anything, you've delayed my trip."

The woman thought for a moment, then replied: "You must be in management."

"I am," replied the balloonist, "but how did you know?"

"Well," said the woman, "you don't know where you are or where you're going. You've risen to your position due to a large quantity of hot air. You made a promise that you have no idea how to keep, and you expect people beneath you to solve your problems."

"In fact," she said, "you're in exactly the same position you were before we met, but somehow it's now my fault."

Many technically trained individuals are or aspire to be perfectionists and so have trouble accepting their own (or others') mistakes. They carry precision and detail to an extreme where others feel they are obsessive, "nit-picking," and pedantic. They sometimes have trouble identifying the most important aspects of an issue due to their general and broad interest in gaining understanding, and so appear to ramble in their discussions. Such behavior arises because they look at every aspect of an issue and strive for clarity at all levels, when a simple answer would suffice for everyone but the technically trained person. A colleague of mine once commented that he hates to ask Joe for the time of day, because his response will always include the history of the watch. Technical leaders must be aware that some of the personality traits that have made them successful in their technical field may hinder them greatly in a leadership role, where a number of their interactions are with people who have more diverse backgrounds and are not driven by the need to understand technical details and background.

Technical leaders also expect that everyone makes decisions and establishes their views and priorities based on logic and facts, which is seldom the case. They expect that others' comments/remarks are literally correct. Finally, technical leaders often discount emotion in the decision-making process, but this is the way many individuals (even technically trained ones) make decisions.

Sandia Laboratories Internal Contest: Complete the Sentence: "You know you're an engineer when …"

Two of the runners up responses were:

"… your spouse/significant other won't let you dress yourself."
"… you create a spreadsheet to evaluate dating prospects."

The WINNER was:

"… you're lying in the hospital bed asking the nurse how the light on your finger is measuring the oxygen level (and then you hold your breath to test it)."

From Sandia Lab News, March 4, 2016.

Technical leaders are problem solvers, and so they often interrupt others when these individuals are explaining their problems, frustrations, and concerns. In this operating mode the leader displays an attempt to help them solve their problems. This behavior is interpreted as rude, uncaring, negative, and disrespectful despite contrary intentions. Listening is not a skill many engineers and scientists have perfected. Technically trained leaders look at "all sides" of a new idea or direction and often hesitate to make timely decisions; they see concerns in everything since they are motivated by identifying problems to solve. This is generally viewed as pessimistic or playing "devil's advocate" by people not trained technically (e.g. those in business, finance, social sciences, or humanities). The technical leader must overcome this perception and convey a positive attitude and approach, perhaps by focusing on and describing what potential successful outcomes a new approach or direction might offer to the team or organization.

2.3 Leader Attributes/Characteristics

Effective leaders display specific traits, possess certain values, and show personal character by their actions; ineffective leaders also display distinctive but typically destructive behaviors that limit their effectiveness. The various attributes of such leaders have been described previously. In fact, many of these key leader characteristics were offered several millennia ago by King Solomon, who ruled Israel from ~970 to 931 BC. Specifically:

Humility: "When pride comes, then comes disgrace, but with humility comes wisdom" (Proverbs (NIV) 11:2).

Takes advice: "Pride only breeds quarrels, but wisdom is found in those who take advice" (Proverbs (NIV) 13:10).
Strong in adversity: "If you falter in times of trouble, how small is your strength" (Proverbs (NIV) 24:10).
Good listener: "Even a fool is thought wise if he keeps silent, and discerning if he holds his tongue" (Proverbs (NIV) 17:28).

The description of a good listener is frequently ascribed to the restatement by Mark Twain:

> It is better to keep your mouth closed and let people think you a fool than to open it and remove all doubt.

2.4 Ineffective Leadership Traits

Although it is important to recognize traits associated with successful leaders, it is often helpful to first identify behaviors or beliefs associated with ineffective or feckless leaders. Recognition of the destructive habits we display enhances awareness of our behavior. This leads to directed development of positive traits as we desire change and act on this desire. Specifically, destructive or ineffective leaders:

- Are prideful, arrogant, unapproachable, "perfect"
- Are inflexible and myopic
- Expect the impossible from their team
- Have a negative attitude
- Seek power
- Are prejudiced
- Change direction frequently
- Discourage risk
- Micromanage to an excessive extent
- Lack respect for employees' time by overworking them
- Ignore conflict
- Hide or downplay difficulties anticipated in the directions being pursued
- Believe that money motivates
- Are convinced some people cannot be motivated.

If leaders exhibit any of these behaviors/attitudes, effective leadership is inhibited. It is especially important to consider the effect and implications of such ineffective behavior; likely responses to the destructive behaviors listed above from those individuals being led are offered within the next paragraphs.

When a leader is prideful, arrogant, appears to be uncaring or unapproachable, and feels they are perfect, he/she does not admit they are wrong. Since they blame others for mistakes, take credit for successes, and sometimes demean others, employee morale drops and frustration and dissatisfaction increase. These results are consistent with a common axiom:

> People do not quit jobs, they quit managers.

Technically trained individuals are frequently overconfident in their abilities and feel that their interpretation of situations and problems is correct since they are trained to be self-sufficient. They therefore depend only on themselves for answers and discount opposing views, criticism, and opinions. Inflexibility or myopia inhibits the opportunity to take advantage of novel or alternative directions and see situations clearly through the eyes of others. This leads to frustration, loss of drive and motivation, and perhaps hopelessness in followers because the leader appears to have made the choice or decision and so is resistant to reconsideration. Establishment of high standards and expectations is a necessary part of being a leader. When the impossible is expected, perhaps due to limited people or material resources or an inappropriate time frame, failure is assured, which eliminates the possibility of success and leads to frustration. A strong leader sets lofty but potentially achievable goals and is willing to alter these as more information or unanticipated boundary conditions are uncovered.

Leaders must have a positive attitude that builds up the team and organization; continuous complaining or negativity breeds dissatisfaction, even when not warranted. A negative attitude reduces enthusiasm, promotes or fosters cynicism, causes others to feel down or even depressed, and conveys the expectation of failure and a feeling of hopelessness. Such environments lead to an unwillingness to attempt difficult assignments because failure appears to be nearly certain; when the employee subsequently fails, the negativity is confirmed and may be propagated into a general attitude toward future assignments. Technically trained individuals sometimes display this attitude inadvertently, because they are anticipating problems that might surface; this can cause non-technically trained people to view the proposal or direction negatively.

As noted previously, high achieving leaders virtually never use coercion or threats, but influence, guide, and coach others to success. If leaders do not show respect for and fairness to those around them, they cannot expect to be treated with respect; when this environment exists, frustration, discontent, and low morale are prominent. Frustration is also the outcome when leaders change direction frequently. Establishing

priorities and directions for teams or organizations requires significant effort, planning, and discussion. When a leader is indecisive and unable to make important decisions, trust, credibility, and perceived competence suffer. The team or organization may also lose because the "window of opportunity" is missed. Effective leaders recognize the pros and cons of dealing with risk and uncertainty. Risks must be taken if substantial advances and major successes are to be achieved. If the leader consistently "plays it safe," employees will follow suit, be unimaginative and unwilling to take chances, and thereby relegate future accomplishments to at best, minor achievements.

An effective leader seldom micromanages since this approach conveys the impression that the leader does not trust the employee or feels that he/she is not competent. This tactic also encourages employees to avoid undertaking tasks because they feel that they must await leader input and directions; that is, they hesitate to act or progress since leader behavior indicates that instructions will be given. Such impressions discourage creativity, initiative, and acceptance of responsibility. In situations where micromanaging is needed, it is performed only to the extent necessary to coach the employee and reach the goals set. If an employee is capable of self-direction and high performance, then he/she should be given the responsibility and authority to carry out assignments; this encourages the employee to take responsibility and reasonable risks. Inexperienced employees need more guidance and training to be successful. No job should require 24/7 dedication on an extended basis. Although this type of effort may be needed at certain times in projects, expectation of this level of commitment on a regular basis leads to low morale, dissatisfaction, and burn-out. If constant "fire-fighting" or redirection is the approach du jour, then leadership and planning are absent. When the leader has assembled the correct team members, and challenges them according to their capabilities and strengths, micromanaging is seldom necessary; employees will be self-motivated.

Most individuals dislike conflict and so prefer to avoid it. Avoiding the conflict or problem is ineffective because decisions must be made and actions taken to move a team or organization forward. Not making a decision or ignoring conflict implies that the leader wishes to maintain the status quo. In general, this approach increases the likelihood that the problem or conflict will increase in magnitude until a breaking point is reached; full recovery to an acceptable operating point at this stage may not be possible. Furthermore, a leader that operates in this manner is weak and unwilling to perform his/her duties.

Effective leaders communicate concerns and difficulties that might be encountered when undertaking complex or challenging tasks or projects. Rather than downplay or hiding the severity of problems that may be encountered, candid acknowledgement and discussion of such issues is

critical. The honesty, courage, and confidence displayed by such discussions build trust and credibility for the leader and engages/encourages team members to seek solutions.

A successful leader compensates his/her employees fairly. If a fair wage is not in place, the likelihood of job offer acceptance and the ability to retain high quality employees both decrease as does overall job satisfaction. However, salary is seldom the primary reason for unhappiness in the workplace. Other issues such as lack of collegiality, professionalism, and ethics; minimal challenge or project significance; continuing changes in direction or focus; dislike of or lack of respect for leaders or managers; and lack of recognition have considerably higher impact in establishing low morale, frustration, and ultimately employee resignations. Motivation is always needed for effective and efficient operation of a team or organization. The claim that an individual is not motivated is nonsense; **everyone** is motivated. But, some team members may not be motivated by the current incentives, duties, and goals involved. In such instances, the leader should discuss with this individual how they feel they can best contribute to the vision and goals established; perhaps the leader can then redirect assignments. In extreme cases, an employee may not even be motivated by the necessity to work; he/she would prefer to spend time traveling, fishing, playing tennis or golf, or relaxing; this is their motivation. In such instances, drastic measures may be required. That is, if resistance to performing tasks that contribute to team progress and success is evident and correction is not forthcoming, the leader must discuss this with the individual and may need to initiate termination proceedings. Finally, even when motivation in a technical position is high, leaders must ensure that they do not demotivate by exhibiting any or all of the ineffective leader traits listed above.

Aspiring or current leaders should evaluate their behavior and attitudes with respect to those on this list to identify which of their behaviors need modification. Recognition of shortcomings can then be followed by charting a path to bring about the necessary changes.

2.5 Behaviors or Strategies Used by Effective Leaders

Effective leadership behavior will now be contrasted to the negative, ineffective behaviors already discussed. The following strategies and approaches describe ways to promote collegial interactions, build trust and credibility, and develop a positive culture among members of a team or organization [4–6]; after the list, a number of paragraphs are devoted to detailing the specifics involved in model leader behavior along with consequences that can be expected. The need for these strategies will be evident as specific leadership scenarios are considered in various

examples, problems, and questions posed throughout the rest of this book. Specifically, successful and effective leaders:

- Display confidence, courage, optimism, passion, responsibility, and accountability
- Are available and approachable
- Show kindness, consideration, respect, and appreciation for others
- Take advantage of insight/knowledge gained from successes and failures
- Clearly define and communicate objectives and goals
- Ask for assistance and additional resources when needed
- Offer advice, evaluate performance, develop employees professionally and personally, and help employees work through problems
- Acknowledge effort and achievement routinely
- Criticize diplomatically without blame or anger
- Admit when they are wrong and correct the situation
- Are transparent, authentic, professional, unbiased, and ethical
- Keep an open mind for alternative/creative views or approaches and seek participation from team members in decisions, **i.e. they listen**
- Ask numerous questions to gain understanding and show involvement; they listen carefully to the responses to show their interest in team member opinions and ideas.

Leaders set a positive example by showing confidence, courage, optimism, passion, perseverance, vision, and self-control. These traits are essential when difficult decisions must be made and especially when a decision proves incorrect. Leaders have a positive attitude but recognize that success requires time and effort and thus determination and resilience. However, they are truthful in that they make clear what current difficulties exist and must be overcome and support creative nontraditional approaches by those who report to them. They continually seek to improve their own performance and abilities, lead by example, and show that they are willing to change when necessary. They demonstrate responsibility and accountability to achieve the vision and mission of the organization. Leaders make themselves available to others, especially their team members. They convey the feeling that any problem, concern, question, or suggestion can be proffered and discussed with no judgement from the leader. When employees hesitate to bring up issues that concern them, it is likely because the leader is viewed as judgmental, perhaps harsh, and not open to different views/opinions.

Leaders are kind, considerate, and respectful in their interactions with others, even or perhaps especially, when they disagree with views or opinions expressed by those individuals. That is, they are humble and function as servant leaders wherein they put others' (organization, team, employees) needs ahead of their own.

Leaders take advantage of the history of the organization's and their team's successes and failures to gain insight and knowledge, which allows them to adapt their approach(es) or directions and thereby improve their and the team's effectiveness. They learn from and count on experience to develop perspective and good judgement. Effective leaders recognize that a postmortem on failures is critical because it frequently reveals mistakes or incorrect assumptions. However, a postmortem on successes can also be fruitful. That is, asking why or how a certain process or procedure succeeded sometimes identifies specific approaches that can be applied to other endeavors. This methodology imparts an optimistic mindset and enhances team confidence.

In order to facilitate success, leaders clearly define and communicate objectives and goals, which establish expectations and enable employees to succeed. They recognize that each member of the organization must contribute, albeit often in quite different ways, if success is to be achieved. When necessary, they ask for assistance and additional resources from superiors to ensure that goals can be met.

Leaders offer advice, evaluate performance, assist employee professional growth and development, and help employees anticipate and work through problems whenever needed. That is, since annual performance appraisals are seldom sufficient for efficient improvement, input and perhaps informal evaluations should be provided on a regular (even weekly) basis. Opportunities to attend professional development workshops, programs, or training sessions to enhance or build technical and soft skills should be offered to employees. Leaders must acknowledge effort and achievement and show appreciation by complimenting more often than they criticize. They show empathy (listen to and acknowledge others' feelings) to demonstrate support; such emotional intelligence will be discussed later in this chapter. Leaders coach and develop the talent of those reporting to them and offer opportunities to practice leadership. They identify employees with the appropriate drive, enthusiasm, and personal character traits that earmark effective leaders and mentor/guide them to prepare subordinates for increased responsibility. In some instances, leaders groom their own replacement. This type of effort represents professional development at its best.

Effective leaders criticize when necessary, but they do so diplomatically without blame or anger; this allows learning and personal improvement to take place. Reasons behind performance problems should be the focus of discussions with employees to demonstrate that the leader wants resolution and understanding, not someone to blame. The success associated with the correction is evident when employees feel responsible and accountable for their actions and accomplishments and strive to enhance their own and others' performance.

Leaders must indicate and demonstrate clearly their values and beliefs. They must be transparent, authentic, consistent, professional, unbiased, and ethical. Constant and fair expectations from and treatment of team members are critical to avoid demotivation due to certain individuals shouldering more than their share of responsibility. Only when these traits and behaviors are displayed and adhered to, can meaningful relationships be established and flourish; mutual respect is thereby developed.

Successful leaders are receptive to alternative or creative views and approaches. They listen to feedback and opinions, and are willing to change and take a (calculated) risk on challenging problems; such actions emphasize openness to others' ideas and a desire to achieve success in the best way possible. They are humble and admit that they do not have all the answers; they therefore seek extensive input and engage everyone in decisions and direction-setting to ensure that team members' contributions and participation are solicited and recognized.

Asking questions frequently uncovers a number of issues and different views of existing problems and often identifies or anticipates previously undetected problems. Successful leaders ask numerous questions to engage and promote dialogue with employees. For instance, they query subordinates (and bosses) about the most important limitations they are encountering in performing their tasks and what could be done about this; they ask for suggestions for team or organization improvement. Such questions engage the employees in conversation and discussion, confirm that the employee is a full participant in the team, supply motivation for employees to undertake risks and new directions and equally important, allow the leader to obtain opinions and input. Details concerning a questioning approach to leadership will be presented in Chapter 7. Most importantly, leaders **listen** carefully to responses to gain insight and knowledge, demonstrate their interest in and concern for employees, avoid judging the validity of the responses, and indicate their own interest in feedback and improvement. As a result, personal relationships between the leader and the led are typically enriched. In some cases, the employee may want time to consider more carefully the questions prior to offering his/her responses. The leader should not rush this conversation if he/she wants thoughtful replies; future discussions may therefore be warranted.

Showing appreciation for the input received is important because this indicates that value is being placed on the conversation by the leader. When the leader acts on or subsequently addresses the responses obtained (even if the leader explains why this is not the direction that will be pursued), employees' engagement increases because they feel that they are having an effect on the team/organization and their views are being taken seriously. One of the worst mistakes a leader can make is to not follow up with the person who supplied the input/suggestions,

because this gives the impression that the leader was insincere; credibility and trust are therefore lost.

Of particular interest when posing questions to employees regarding the current operation and directions within the team, is the identification of activities or procedures that should be eliminated or redefined either because they no longer contribute to the goal(s) set, or they appear to be leading nowhere. Ineffective leaders generally identify new directions/projects more readily than they identify tasks to discard since significant effort may have been dedicated to these activities. As a result, elimination of projects/efforts requires a leader with considerable courage and confidence. However, when time and resources are used to carry out efforts that are no longer important or are not productive, efficiency and achievement suffer. Unfortunately, the responsibility to eliminate unproductive or no longer appropriate tasks is frequently neglected; effective leaders recognize this fact and take action.

A group of contributors that is often overlooked when soliciting information and attempting to identify concerns or potential problems is staff members. Operators, technicians, mechanics, shop workers, and administrative assistants typically have extensive experience and have encountered a wide variety of mistakes and glitches in processes or equipment, and in operational procedures. Such insight is invaluable; even if these individuals do not understand the scientific or engineering fundamentals involved, they understand what process or procedural upsets have occurred and usually how the problem was or could be alleviated. Furthermore, they are the ones closest to the process(es) and tasks being performed and so are keenly aware of deviations from the standard procedures, behaviors, and results.

2.6 Practice Makes Perfect

Mastering any subject requires considerable effort. Some individuals possess an innate talent for certain areas and appear to accomplish their goals with little effort. If the truth were known, this is hardly ever the case, despite appearances. Most, if not all of us, have expended considerable energy and dedication to obtain one (or multiple) degree(s) in engineering or science. The word "considerable" has been quantified to some extent for success or stellar achievement in a variety of fields (e.g. sports, music, acting, writing), and has become known as the 10 000 h rule [7]; that is, effort level does matter and 10 000 h has been suggested as the necessary value. Like other endeavors, leadership can be learned and improved [8]; this is not a trait or characteristic that appears only because you have been born possessing the trait. Practice is needed to gain experience, know-how, and perspective, although 10 000 h is probably closer to

what is needed for middle to upper level technical leadership/administration. Practice can be attained by seeking leadership opportunities (e.g. volunteer in community activities, request responsibilities from bosses), observing respected leaders, listening to podcasts by accomplished leaders, and studying in books or courses. Insight and information gained can then be applied to modify behavior; repetition, iteration, self-evaluation, and feedback from colleagues and mentors are critical because they lead to continued improvement. As with any goal, a target and short-term aspirations are needed. Examples may include an enhanced feeling of confidence when undertaking a new task, the calm manner by which one handles conflict or adversity, or the feeling of accomplishment (rather than simply relief) when your team completes a difficult assignment. Course homework and exams were stressful, but they forced growth and improvement; so too will practicing leadership.

2.7 Listening

One leader trait that generally receives little attention is listening. We often equate leadership with aggressive behavior wherein a vision or direction is pronounced and others are expected to follow it religiously. Alternative approaches are not tolerated. This type of leader is seldom effective and worse yet, sows discord, creates anxiety among the team members, and ignores novel alternative directions. Listening is an important part of communicating; unless the message being presented is heard and understood, miscommunication or no communication has occurred. Technical leaders must convince their bosses and employees that their unique ideas and directions are worth pursuing. Therefore, they must understand the problems they are addressing, appreciate the motivation behind the effort, and determine how to best gain acceptance by those above and below them in, and perhaps outside, the organization. Such issues are best addressed by listening to and understanding the needs and directions of those who will fund and/or use the technology being developed. This is particularly important if new ideas or directions are being presented to nontechnically trained individuals. A "build it and they will come" approach is rarely successful although such outcomes do occur.

Effective listening is often referred to as "active" listening, a critical skill for which most technically trained individuals need improvement. It is generally difficult to listen effectively or actively when derogatory comments or complaints are being offered; typically, a defensive posture is the response to such situations. However, this is the most informative and valuable time to listen because such conversations frequently identify improvements for or at least misconceptions of a leader; these concerns can be dealt with after they have been recognized. An effective leader

does not interrupt others to tell them how to solve their problem, but allows them to explain and then guides them, often with insightful questions, to allow them to discover their own answers. Fortunately, there are guiding principles to achieve and develop listening skills [9, 10]. Specifically, an "active" listener:

- Pays attention; is not on his/her smartphone or laptop
- Makes eye contact
- Accepts the viewpoint expressed as authentic/genuine
- Is open to alternative viewpoints
- Listens to understand, not judge, prejudge, or reply
- Recognizes speaker body language, facial expressions, and tone of voice to enhance information being conveyed
- Does not interrupt or correct the message
- Gives verbal and nonverbal feedback (asks questions for clarification and summarizes what was said, offers supportive feedback or constructive criticism, and displays appropriate body language, e.g. nods head to express agreement/approval/understanding)
- Is not distracted by poor presentation skills, odd behavior, or anger, but focuses on the message being conveyed.

Evaluating oneself against these criteria during presentations and conversations will identify areas where improvement is needed. Equally important is the professional attitude and engagement that is displayed by practicing these traits. The listener, both shows respect and deserves respect in return, which is important when constructive criticism is offered. Such behavior is an example of emotional intelligence, a topic that will be discussed in more detail later in this chapter.

Discussion Questions

- Why should someone follow you? If you have followers, will they continue to follow you after they learn about the "real you"?
- As you advance in your technical career, do the leader traits that are required change? That is, you need technical skills, interpersonal skills, and administrative and goal-setting skills. Does the relative importance of these change as your responsibilities change? Compare the necessary traits for group/team supervisors with division managers with corporate executives (e.g. VP, CEO).
- Identify reasons why technically trained leaders or managers sometimes fail to perform at the level required for further advancement. Which reasons are likely due to the leaders' technical training and characteristics? Which of the reasons can be developed to improve leadership abilities?

2.8 Mentoring or Coaching

Technical leaders should identify and take advantage of mentors or coaches to assist their development and obtain advice throughout their careers. The distinction between mentoring and coaching is subtle and relates to the specific emphasis: Development of an individual (mentoring) versus the development and the improvement of skills and performance of an individual (coaching). Clearly, these activities are closely related, and I will therefore use these terms interchangeably. Although there will be a number of suggestions and exhortations for leaders to request advice, feedback, and recommendations from mentors throughout this book, that is not the purpose of this section. Rather, the focus in this section is on the leader serving as an effective mentor to those individuals who report to him or her and perhaps to some peers.

In a mentor or coach role, the leader supplies insight, perspective, encouragement, and reason; he/she advises, serves as a sounding board, and offers constructive criticism when needed. A mentor should be supportive; calm; a good listener; and display integrity, confidence, accountability, and a positive attitude. That is, he/she should be a role model for the person being mentored and thereby facilitate their professional and personal development. Mentors help others identify their unique abilities and limitations, while facilitating achievement of the mentee's full capabilities; in this way mentors assist others in recognizing what they can become. The effectiveness of these efforts is often promoted when the mentor describes his/her own struggles, experiences, and mistakes. This shows the mentee that vulnerability is not a negative trait, that he/she is not the first to undergo and recover from bad situations, and that success is possible despite setbacks and difficulties.

An effective way to mentor is to first ask the individual to perform a self-evaluation. Discussion of the responses to questions asked in the evaluation generally identifies issues of importance for professional development and often uncovers other less obvious situations that require attention or are crucial to the individual's personal or professional development. An example of a self-evaluation form is presented in Appendix A. The various categories probe the individual's abilities and comfort with their technical knowledge base and skill level, communication skills, work ethic and effectiveness, independence, teamwork, leadership efforts, goals (short and long term), and areas for improvement. After the areas for improvement are identified, prioritization should take place with respect to personal and professional aspirations. Subsequent discussions with the individual allow plans and approaches to be formulated to address the pertinent issues; these steps support and aid the individual in reaching the goals set. This assessment should be

performed at least once a year, and preferably every 6 months. During these discussions, progress toward improvement and the general goals set can be assessed and any changes, corrective actions, or new opportunities examined.

An exceptionally important leader obligation is to identify, mentor, and develop new or aspiring leaders. Mentors should encourage individuals whom they feel have the personality, drive, aptitude, and people skills to undertake leadership duties. These (potential) next generation leaders must be guided and made aware of how to further develop their existing skill set; in many situations, specific components need to be added to the current set in preparation for leadership roles. Remember that everyone should function as a leader within their own set of responsibilities; initially this will likely be in a minor role, but one in which experience and awareness are built. As noted previously, such behavior does not require a leader title, but a concerted effort to inspire others to dream more, learn more, do more, and become more. One way to accomplish this is to pose a direct question to those who report to you: "What have you done over the past month to hone and further develop your leadership skills?" This will allow a discussion of who and what a leader is, and point out small actions that the individual may not equate with leadership (e.g. offer insight to someone new to a particular process, product, or project, supply perspective regarding team strengths/weaknesses). It will also give you the opportunity to suggest roles or tasks that permit the individual to practice leadership. For instance, they could get involved in the governance of professional societies (local or national), serve on committees within the organization, or coordinate internal or external meetings. The encouragement you supply can also open the door for the subordinate to identify and then request appropriate assignments. In addition, the individual can share concerns or misgivings about their leadership potential and indicate their level of interest in such positions.

It is critical that the mentor or leader perform his/her own self-assessment using the rubric in Appendix A, since their personal responses to this series of questions and issues can be equally enlightening for the development of the mentor/leader as well as those being led. Effective leadership **begins** with self-reflection, self-awareness, and self-assessment. If a leader does not recognize his/her abilities and shortcomings, he/she can either underestimate or overestimate their capabilities. Self-awareness also identifies personal biases, likely developed through life experiences, that can color the way situations are perceived or decisions are made. Through self-evaluation and self-assessment, leaders can inhibit drawing erroneous conclusions due to previously unrecognized prejudices. Such evaluations also identify the positive and negative passions that we have and thus the way in which we respond to situations.

In order to improve their effectiveness, leaders must listen to and act on feedback and input from bosses, peers, subordinates, and mentors and be willing to change. Change requires the formulation of both short- and long-term goals and an associated plan. The goal(s) and plan developed, which are often referred to as an individual development plan, are particularly important because they allow the creation of a realistic approach to achieve the stated goals along with periodic evaluation of progress. Appropriate issues or concerns, as well as the feasibility of the goals set, should be discussed in detail with the leader's mentor or supervisor. The feedback and perhaps additional suggestions obtained supply perspective and alternative views of leader aspirations.

2.9 Leadership Styles

Many leadership styles exist. An effective leader varies his/her leadership style to meet the requirements of the organization, team, or individual at a particular point in time for a specific project or situation. As will be discussed in Chapter 9, teams can change membership when a new or different problem is assigned; in addition, members may be assigned to multiple teams. The new or alternative team will have different personalities and perhaps even a different culture depending upon the individuals who make up the team. As a result, an altered leadership style relative to that needed for the previous team may be required to effectively guide the new team. This situation and the associated approach can be difficult for technical leaders who often seek a static methodology that will lead to the "correct" answer as efficiently as possible. Despite the fact that there are different styles needed as a function of time and organization/team/project disposition, some leadership styles are more effective than others.

Numerous studies have identified and categorized leadership styles, and the resulting styles have been described by a variety of different names or titles. In one study of many different organizations, Rooke and Torbert defined seven categories or styles that characterize approaches to leadership; these styles are described briefly below, since each has shown different levels of success [11]. Further discussion of leader styles and methodologies will be described more broadly when approaches to team building and oversight are considered in Chapter 9.

The **opportunist** is egocentric and manipulative and operates by exploiting, controlling, and ridiculing others. He/she is not interested in taking feedback and so retaliates when challenged and blames others. This type of leadership destroys trust and the leader is often removed quickly from the leadership position.

The **diplomat** wishes to please others and so is collaborative and friendly. Although this leader displays good self-control and performs assigned duties well, he/she wants to be accepted by others and thus tries to avoid conflict and change which results in ineffective leadership and frequently dissatisfaction in employees.

Logical and secure, the **expert** is typically a technically trained individual who has been moved into a leadership position and is a vital contributor to the technology involved. Decisions, directions, and views are established according to the engineering/scientific details of the project. This individual is opinionated, often does not seek collaboration, and may not be in tune with or even aware of others' feelings or viewpoints.

The **achiever** creates a positive, challenging, and supportive work environment and so effectively influences others, thereby ensuring high productivity. These characteristics are essentially those of a manager, so the achiever is sensitive to relationships and balances short- and long-term objectives well. Many of these traits are in conflict with those of the expert which can limit the overall creativity possible.

Unconventional and nonconforming, the **individualist** appreciates alternative ways of viewing problems and therefore offers creative/unique approaches and solutions. When rules appear irrelevant, the individualist ignores them, which earns him/her the title of "wild card" and this behavior invariably frustrates colleagues, subordinates, and supervisors.

The **strategist** is visionary and able to deal with conflict and change, thereby offering transformative solutions to problems. Such approaches can promote collaborations and interactions across or even outside the organization.

The final leadership designation by Rooke and Torbert is **alchemist**, not to be confused with the scientific definition of this category. This individual is interested in broader societal issues, connections, and transformations and can reinvent himself/herself as well as the organization. This type of leader is quite flexible and so deals effectively with multiple complex issues, managerial levels, and goals.

As expected, most leaders show characteristics of several of these styles, although they are associated primarily with one. Leaders can transition from one style to another provided that they (i) are motivated to change in order to qualify for a new position, (ii) recognize that they may be more effective if they lead in a different way, or (iii) undergo training to improve interpersonal or new technical skills. The most effective teams in this study [11] had achiever cultures with other personality styles included, but always with shared leadership. Shared leadership may in fact become inverted leadership in that the "appointed leader" may briefly turn over the reins to another team member or members

under circumstances or specific demands where that individual(s) is (are) more qualified to move the project forward. This requires a leader who is confident in his/her abilities and contributions, and has the best interests of the team and organization at heart. These attributes will be discussed further when team building is described (Chapter 9).

Social convention posits that an effective leader is an extrovert, since a strong personality is believed to be needed to guide and influence others and display charisma. However, in some situations, introverts have been extraordinarily successful leaders [12]. When followers are proactive and assume the initiative for team progress, introverted leaders are frequently most effective since they allow the team to drive the process while ensuring focus on the goals. As mentioned previously, the appropriate leader style depends critically on the team to be led. Such required variations in approach are antithetical to many technically trained individuals because they seek the correct answer; as a result, frustration builds. In addition, a particular leader style often benefits from adopting certain characteristics of other styles, since every team has a unique set of personality types each of which demands specific approaches to achieve success.

Nontechnically trained individuals sometimes find it difficult to assess whether their technically trained associates are introverts or extroverts. A quote that I find helpful in this regard has been offered by Ronald Shewchuk at Air Liquide:

> … the difference between an Introverted Engineer and an Extroverted Engineer (is) Introverted Engineer looks at His shoes when he's talking to you. (An) Extroverted Engineer looks at Your shoes when he's talking to you.

Although this may appear to be an extreme example based only on humor, such perceptions of technically trained individuals are not unusual.

Irrespective of the leadership style employed, it should be clear that leaders must possess a varied skill set. Many of these skills have been formulated into a schematic that indicates the scope of behaviors/attributes necessary for effective leaders [13]. In addition to these "soft skills," there are a number of additional competencies and behaviors required for technical leaders; see Figure 2.1. The central or primary proficiencies are displayed in the inner circle. These abilities, traits, or attitudes have been developed mostly during formal education and training. Without technical competency and up-to-date scientific and engineering knowledge, it will be difficult to gain and maintain respect, trust, and credibility by a team that performs technical tasks (e.g. research, development, manufacturing, education). These attributes also allow the leader to

Figure 2.1 Skill set possessed by successful technical leaders. *Source:* Adapted from Farr et al. [13].

relate more easily and successfully to the problems encountered by team members, to respond to new directions and advances in technical or scientific fields, and offer assistance as needed. Since technical information changes rapidly, lifetime or continuous learning is critical to ensure professional development.

Motivating others requires a vision and mission (these topics will be discussed further in Chapters 8 and 9) that challenge, engage, and energize team or organization members. Few behaviors entice followers more than a passion for the subject, project, or vision. This characteristic cannot be "faked." If true drive and enthusiasm are absent, this deficiency will be evident to team members, and their motivation and desire to undertake the project and maintain the determination needed for completion will be reduced and likely will be insufficient for success. The leader must serve as a cheerleader and advocate and constantly reiterate the underlying purpose of the team or organization as well as the significance of the effort, to facilitate motivation.

The outer or surrounding behaviors designated in Figure 2.1 identify many of the activities and characteristics necessary to implement the vision and mission and guide an effective and successful team or organization; they represent the professional skill set required to be an effective

leader. Two of these behaviors, e.g. influences others and shows resilience, have been discussed briefly; further discussion of these along with detailed examination of the remaining ones will appear in subsequent chapters. Analogous to enhancement of the technical skill set, continuous learning and practice are necessary to further develop soft or professional skills. An effective leader sets goals for himself/herself to improve these attributes, which may require participation in workshops, working closely with mentors or experienced leaders, taking courses, and extensive reading/studying. These efforts demonstrate that improvement is a priority for him/her and thereby should be emulated by team members. It is important to recognize that as technical leaders rise in the organization, some of the focus on technical skills and accomplishments will give way to more administrative/corporate duties, but appreciation for and understanding of the technical issues should never wane, since this is the basis for maintaining respect and credibility from technical colleagues and subordinates.

2.10 Fixed Versus Growth Mindset

Leaders must instill a mindset in those around them that improvement and achievement are possible for the team or organization and especially for each member. Individuals, leaders included, sometimes feel that they have been given certain talents, a particular personality, and a specific intelligence level. As a result, they believe they are inherently limited in their abilities and capabilities and therefore lack the incentive and drive to improve. Carol Dweck describes this attitude as a fixed mindset [14]. When operating in this mode, the individual avoids challenges, obstacles, and criticism which severely limits creativity and risk-taking, inhibits success, and often leads to feelings of dejection and hopelessness. Dweck contrasts this attitude with a growth mindset, where individuals seek and accept challenges, persevere in the face of obstacles, and use criticism to improve; that is, they are driven to learn and are optimistic. These people believe that hard work is a major contributor to their abilities and accomplishments, and if sufficient effort is expended, they can enhance their talents, personality, and intelligence, and ultimately find success in their endeavors. Such positive attitudes not only assist their personal and professional development and likelihood of success, but they also pervade and alter the outlook and motivation of colleagues, collaborators, supervisors, and followers. Therefore, leader demonstration of a growth mindset along with implementation within his/her team significantly promotes effective and efficient team and organization operation. This approach also demonstrates that the leader believes that each team member is capable of improved accomplishments and performance.

2.11 Servant/Shared Leadership

Leaders depend upon the people they supervise to accomplish tasks and generate new ideas and directions. Successful leaders therefore invest considerable time and energy in these people. The leader's responsibilities to the individuals are diverse, but include availability of the resources (people and facilities) needed to accomplish the assigned task(s); identification of significant and challenging problems to address; assignment of authority and responsibility; and development of employee skills, talents, and performance [15–17]. Many effective leaders exercise these responsibilities by delegating, empowering, offering advice, and putting others' needs before their own; that is, they practice servant leadership. They continually ask themselves questions such as: How can I better assist and develop the people with whom I interact? This approach engenders trust and loyalty, and improves performance because it focuses on the well-being of the individuals and ensures that they are engaged in their duties and organization. This shared style is in contrast to more traditional/historical leadership structures wherein the leader's position in the organizational chart determines who has and thus wields the power or control. The reported successful outcomes of employing servant leadership indicate that this is a productive and satisfying model to adopt. Leaders and organizations often do not practice this approach as diligently as they should because this is not a short-term process or fix. Rather, it requires leaders with patience, who are interested in building a culture where values as well as interest in and empathy for others are paramount.

Covey [18] contrasts win–win, win–lose, lose–win, and lose–lose situations on the basis of the leader's courage of his/her convictions and consideration for others as shown in Figure 2.2. In order for leaders to have a positive impact and successfully move individuals or organizations forward, both parties must feel that they are considered in and benefit from the decisions and directions selected; the ideal scenario is therefore a win–win situation. If the leader has both a low level of confidence or courage insofar as clarifying and adhering to his/her stance on issues and directions and has low consideration or concern for others, a lose–lose conclusion results. That is, the leader must be open to a variety of suggestions or directions that perhaps were not envisioned initially. He/she must also be able to calmly and succinctly express arguments against a proposal from an individual in such a way that further discussion and refinement of the original proposal are promoted. Without this, neither side will win because limitations or ineffective approaches will be accepted, resulting in lost time and effort. If consideration for others is high while courage of his/her convictions is low, or if consideration of others is low while courage of his/her convictions is high, then an I lose/you win or a you lose/I win scenario results. These outcomes generate

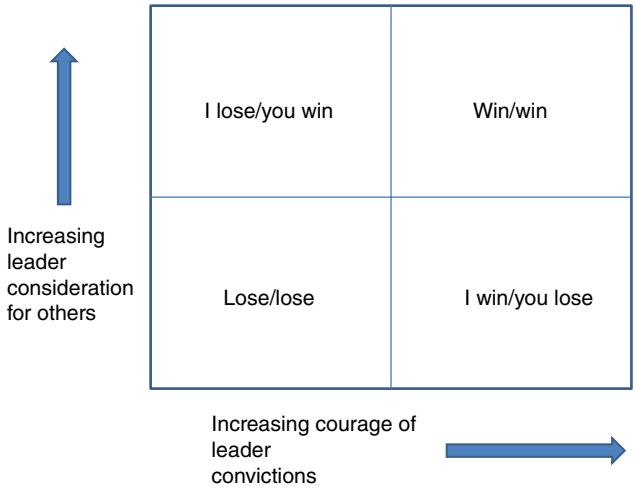

Figure 2.2 Trade-off between courage of one's convictions and consideration for others' views and opinions. *Source:* Adapted from Covey [18].

dissatisfaction for one of the parties and thus are not ideal. Only when both personal courage and conviction for others are high can the two parties hope to reach an agreeable solution and thereby accept the outcome and feel appeased. Achievement of this particular outcome requires considerable effort and openness from both parties. In addition, both sides must desire the formulation of a scenario that both can accept. When this occurs, positive energy and trust between both sides is evident. How can this seemingly impossible result be attained?

First, leaders must understand themselves and appreciate their own conscience, values, and independent will [18]. Unless the leader understands clearly who he/she is, what priorities and values dominate behavior, and the specific situations that cause stress and anxiety, they will be unable to control themselves, and thus have little hope of effectively leading others. Equally important is the need to recognize, empathize with, and address the unique character traits and needs of others. That is, leaders have to move from being completely independent (a state to which all technically trained individuals aspire) to being interdependent [18] so that they can learn from and take advantage of different opinions and viewpoints. This transformation from egotist to collaborator to empathizer is leadership maturation.

Most successful scientists and engineers have learned to appreciate and value (but not necessarily accept) different technical viewpoints when solving problems; this ability must be transferred to interpersonal interactions with regard to decision-making and team or organization directions.

Only by relying on integrity and maturity in our dealings with others, and rejecting the perception that either you or the other person must lose in a disagreement, can we realize what Covey refers to as abundance mentality. This concept posits that an abundance of recognition, achievement, and successes are available to each of us. Many individuals feel that if someone else receives accolades or recognition, this inhibits or detracts from their ability or opportunity to attain these goals/rewards. When this attitude is prevalent, we are unable to fully appreciate others and share in their accomplishments, thereby impeding effective leadership. A leader must promote, encourage, and acknowledge those around him/her to establish the environment for motivated, engaged, and fulfilled employees.

Before leaving the topic of shared leadership, it is important to mention that it is sometimes necessary for a leader to make authoritative decisions. When a technical leader feels that the consensus reached is not in the best interest of the team or organization, it may be time for a dictatorial override. That is, the leader may need to take control and impose his/her will for the betterment of everyone. For instance, the leader may feel that the direction that a project is taking is not consistent with the goals set, despite the general interest in this specific effort. In this situation, it is his/her duty to take on the decision and responsibility directly. This should not be the typical operating procedure, but may be warranted when the needs of the organization would not be met by the desired resource allocation. For example, extensive additional data or related studies might be of interest to the team members, but results from such studies would not affect the conclusions and decision already reached. When a leader override approach is taken, explanations for this behavior mode must be offered so that all team members understand the reasons for the decision, that the leader has considered carefully the alternative viewpoints, and has made the decision for the betterment of the team or organization.

Discussion Question
• What obstacles can you suggest that preclude applying and/or achieving a WIN–WIN paradigm in technical leadership roles? How might you overcome these obstacles?

2.12 Values

The values and beliefs that a leader subscribes to and demonstrates are critical since they represent the basis/core of who the leader is, their most significant principles, and how he/she views situations and

life [19, 20]. Values guide right versus wrong decisions and approaches to dilemmas. The values and principles displayed by individuals and organizations are essential to demonstrate integrity and to convince followers to commit to the goals and vision espoused. A leader must understand what motivates, impedes, annoys, and exhilarates him/her because this determines the responses offered, decisions made, and actions taken. Otherwise, effectiveness will be difficult to achieve, since the actions can demonstrate an agenda that may not be clear even to the leader. Furthermore, changing our destructive values, beliefs, or behavior must begin with identification. Each of us must recognize our motives, emotions, and "hot buttons" in order to anticipate how we react in certain situations; if this is not the case, our actions or reactions may be inappropriate, thereby damaging our reputation and eroding trust and credibility. When trust or credibility is lost, we cannot be effective in leading, guiding, or coaching others. Therefore, leadership begins with identification of the leader's values and beliefs. A simple way to approach identification of the values which are most and least important to us is to consider an extensive list from which are selected the values that we will not sacrifice under any circumstances along with ones that are inconsequential to us. Such a list can be found in Appendix B, which has been reproduced from Ref. [21]. Using this list, Homework Question #7 at the end of this chapter guides the reader in recognizing what values drive his/her behavior and decisions. We can often further define our unique personality traits and values and become self-aware, by assessment tests such as Briggs–Myers personality evaluation [22], the Kolbe A^{TM} Index or Instinct Test [23], the 360 Degree Leadership Assessment [24], and the Big Five personality traits [25]. Results can offer insight into the personal issues that make us who we are as well as identify the innate interactions and reactions that need attention in order to enact change in our behavior and attitudes. We cannot allow the specific situation or context to define us and elicit an inappropriate response that will reduce effectiveness. Knowledge of the value system to which we subscribe is critical when difficult decisions are required, uncertainty is prevalent, and visions are formulated; examples will be offered in subsequent chapters. An effective leader knows both his/her current values, passions, priorities, and motivations, and recognizes who he/she wants to become. Equally important is the enjoyment of and appreciation for establishing a path to enact this transition.

Even after the leader has identified the values/beliefs that characterize him/her, actions must be in harmony with the claimed values. In addition, these values or beliefs cannot be automatically imposed on others. Rather, a vision must be devised that is consistent to the extent possible,

with the values of the team or organization, i.e. a leader must understand, appreciate, and acknowledge the organization and other team members' needs and priorities in order to formulate a vision that is appropriate; details of vision formulation will be discussed in Chapter 8. Surveys indicate that people can only effectively commit to organizational and leader values when those are consistent with their personal values; without this equivalence, integrity is lacking. Psychologists refer to this as cognitive dissonance wherein stress or anxiety results when an individual/group/organization with specific but contradictory values/beliefs, makes a decision or acts in a way that conflicts with one of these views. Organizations and individuals can clearly promote their values, but if their actions are not congruent with these stated values, credibility and trust suffer. Only when we deal with others as our true selves (i.e. we are authentic), with our values and beliefs clearly established and displayed by our words and actions, will we be effective leaders (and organizations). This recognition is succinctly described by Ralph Waldo Emerson:

> Your actions speak so loudly I cannot hear what you are saying.

2.13 Emotional Intelligence

Related to servant leadership and effective people interactions is the concept of emotional intelligence, sometimes referred to as EI or EQ [26–29]. All of us can cite examples of individuals with high intelligence quotient (IQ) or with most impressive technical skills who are ineffective leaders. A better gauge of leadership success has been professed to be EI or EQ, which can be defined as [26]:

> Emotional intelligence (EI) or emotional quotient (EQ) is the capacity of individuals to recognize their own, and other people's, emotions to discriminate between different feelings and label them appropriately and to use emotional information to guide thinking and behavior.

Although specific definitions vary with the source, the concepts are the same in that the important factors involve controlling your own and acknowledging or understanding others' emotions. In addition to their use of IQ, leaders should develop or enhance their EI in order to improve their ability to deal effectively with conflict and decision-making, establish credibility and trust, and thereby achieve win–win outcomes.

EI depends upon the cultivation of several personal attributes [26]: self-awareness, self-management, social awareness, and relationship management. As discussed previously, leaders must be self-aware, and thus know and understand their strengths, weaknesses, and emotional responses to stimuli. In addition to knowing who we are, or who we think we are, we must be cognizant of who others think we are; such awareness assists our efforts to understand and interpret remarks or responses that others make regarding our actions or behavior. This critical self-evaluation is the starting point for effective leadership skill development. Knowledge and appreciation of your values, priorities, and the actions/behaviors that engage your emotions allow you to better deal with stressful situations and interact appropriately with others. Equally important is the ability to genuinely relate to difficulties that others are experiencing so that you can show empathy to them which will further develop your EI, and thereby assist the identification of suitable approaches or win–win solutions to problems. Self-management is critical in order to control spontaneous responses and behaviors, make difficult decisions, manage conflict, adjust appropriately when circumstances change (adaptability), and recover quickly when mistakes or wrong decisions are made (resilience). Leaders must be comfortable in social venues, recognize the emotional state of others, and be able to assess the dynamics controlling group, team, or organization behavior. Group behavior or response is sometimes nonverbal or even misdirected. It is important that the leader pick up on these cues to maintain group focus and move toward a resolution; otherwise, the interactions can become emotional or divisive. Finally, since personal interactions depend upon the emotional state, personal viewpoints, and motivations of each individual, effective leaders develop and maintain good relationships, are humble, communicate clearly their concern for and interest in others, and are team players. They demonstrate empathy, compassion, and respect for others. Such behavior leads to improved employee and colleague satisfaction and attitudes. More will be said about these issues when the topics of decision-making and running meetings are discussed in Chapter 10.

When EI is absent in leaders, they often display anger and frustration. Such reactions lead to loss of focus on the goal(s) to be achieved and generate divisiveness and lack of respect and commitment within the team/organization. Typically such behavior results from an inability to cope with stress, unwillingness or inability to consider alternative or conflicting views, or poor interpersonal skills. A leader must be open-minded with regard to views or suggestions that are antithetical to those currently held; the attitudes of "we've always done it that way" or "I have

already considered all reasonable approaches," only frustrates and quells motivation in others, inhibits achievement of win–win scenarios, and labels the leader as egotistical, arrogant, and rigid.

2.14 Stress

Stress is a condition that all of us experience but few appreciate. Travis Bradbury points out [30] that some level of stress is necessary for effective and efficient performance. Without some stress to cause us to react or engage, boredom or even depression can result. As stress builds, motivation and action increase and attention to the issues to be resolved improves. If too high a stress level is encountered, anxiety and even emotional breakdown can appear. Therefore, a leader (and followers) must recognize when his/her stress level is rising and especially when the level exceeds what can be handled effectively. Before reaching the "point of no return" where reactions and emotions control behavior and actions are taken or statements are made that will be regretted later, it may be necessary to diplomatically excuse yourself from the situation so that you can regroup and think rationally and calmly. At the very least, when this overstressed state of mind has been reached, the leader should remember the adage,

> If you can't say anything nice about someone, say nothing at all.

Adherence to this simple rule of thumb often keeps the situation from getting worse.

Leaders must self-evaluate to ensure that they know their motives, strengths, and weaknesses, which leads to self-awareness and so recognition of how and why they react badly to certain types of stress; this includes knowledge of what events (or people) provoke them into taking a defensive stance or triggering anger. This is one reason why emotional intelligence is an important characteristic of effective leaders. A leader must be aware of physical (e.g. headaches, sweaty palms) and emotional (anxiety, feeling out of control) signs that indicate stress relief is needed. A successful leader learns to use stress to his/her advantage (i.e. to motivate), and to deal with stress levels that can cause inappropriate behavior. The most difficult part of this is to control emotions while experiencing the stress. Like most control problems, this requires that we keep our reactions to stress within a certain operating window. When this is not possible, then shutting down the system (i.e. leaving the premises) may be necessary until a reset to the control point has been achieved.

Much has been written regarding how to reduce and better handle stress, since mental and physical health as well as job performance, often degrade when stress levels are too high. Since extensive information on this topic is available (see for example, Refs. [31–34]), this subject will not be belabored here. Generically, a healthy diet, sufficient sleep, and regular exercise are obvious approaches to alleviate stress. However, since stress is pervasive in leadership positions, it is helpful to consider briefly specific ways to deal with stress and thereby minimize its effects. Outside the work environment, participation in activities such as exercise, sports, hobbies, coffee/tea with friends, or caring for a pet typically lower stress levels. Mindfulness, where awareness of ourselves, surroundings, and experiences is heightened, has led to reduced stress levels; meditation appears to be the precursor to this approach. Some organizations make available courses on mindfulness to their employees wherein they learn to focus on the situation-at-hand while disregarding the history, worry, or judgement they bring to each situation. Within the work setting, short-term approaches with more immediate results are desirable. For instance, deep breathing has a positive effect on blood pressure and stress. Taking a break to talk with colleagues or staff about work-related or non-work-related interests can be helpful. That is, individuals (e.g. mentors or colleagues) who can serve as a support group when needed are invaluable.

By admitting to and accepting mistakes that we make without becoming overly critical of our abilities or actions, stress levels can be reduced. Specifically, we sometimes need to give ourselves some latitude and recognize that we are not exempt from wrong decisions or deeds; this is what an effective leader is expected to do for others, so it is reasonable to view our own discretions in a similar way. Similarly, we should resist trying to live up to unrealistic expectations of others; this represents a frequent cause of stress. Reliance on a trusted mentor or colleague to assist in the assessment of the reasonableness of criticism is a good approach. Related to acceptance of our own mistakes is an additional approach to lower stress that has a multitude of other benefits: Maintain a positive attitude. Allowing negative thoughts and attitudes to control us generally increases stress and brings on a feeling of hopelessness. Recognition that we are in the position that we are in because we clearly have been successful and accomplished in our life and career frequently offers a different view of the current state of affairs and helps us deal with unpleasant and frustrating circumstances. This outlook reinvigorates our attitude and resolve and encourages us to embark on normal or even extraordinary tasks.

Short- or medium-term methods or remedies for stress relief as described above are helpful, especially when dealing with day-to-day

situations. However, long-term stress requires careful analysis of the fundamental cause of the stress in order to devise and implement a plan for stress reduction. If an unreasonable number of duties, responsibilities, and too lofty personal or professional goals are the cause, then better time management (Chapter 4), prioritization, and more realistic expectations should be effected. If the cause is conflict with bosses or co-workers, then candid discussions with these individuals or with trusted mentors may be beneficial (Chapter 11). A positive attitude (and "thick skin") can also lower stress levels under these conditions. That is, if we recognize (or assume) that the occurrence that triggered our reaction/emotion was not intentional or planned, but that a poor choice of words, or inadvertent situation transpired, we can frequently move past the stress and be rational. Even if this assumption later proves incorrect, we will have the opportunity to re-evaluate what happened in a sensible manner and subsequently act when in a more composed state of mind.

Depending upon the severity of the stress and the prognosis for alleviation, a change of venue such as a different assignment, leave of absence, or in extreme cases, alternative employment, may be necessary. Although we often try to separate our personal life from our professional life, these entities are seldom separable. Stress generated either at home or at work affects our frame of mind and behavior in both locations, which requires identification of the source of the stress followed by action.

One of the most difficult situations that a leader encounters in the work environment is when bad news (e.g. reduction in work force, insufficient funds for an ongoing project, insensitive comments from team members or bosses) is suddenly delivered. The first response to the resulting stress must be to remain calm and not react. This response precludes inappropriate reactions, sets an example of professionalism for other team members, and often avoids escalation of the problem. Such behavior is facilitated by understanding yourself and recognizing how you can most readily deal with stressful situations. Confidence is critical in such instances because this trait helps the leader remember that they have been in stressful situations before and have survived. The leader needs to recognize that if they maintain focus, the situation can be handled by planning a reasonable path forward. By remaining positive about the situation at hand, the leader indicates to others that the incident or situation can be addressed and thus inhibits the possibility that panic will consume everyone and divert progress. One way to approach this is for the leader to draw on his/her support system (e.g. mentors, colleagues); these individuals can supply perspective that either the leader lacks or has overlooked due to the stress that is being experienced. This approach will have an additional positive effect: Relationships with mentors and colleagues will be strengthened.

Discussion Question

- At a meeting of managers and engineers, the Department Head was being asked for approval of several ongoing and start-up projects. One of the projects had a problem with compressor vibrations that resulted in continuing seal breaks and recurring shutdowns of several days each, with losses of ~$1M per day. Although a solution to this problem had been defined, the Department Head clearly displayed his lack of interest in this issue, offered no insightful comments or suggestions, but refused to approve the change. After discussion had started on the next project, a late-arriving manager joined the meeting; the initial project was reintroduced to allow her to be brought up to speed. When she indicated that the first project was a good one, the Department Head agreed and gave approval.

  How would you describe the Department Head's behavior? Why do you suppose he made the original decision? What might have caused the change in attitude toward this project? What might the meeting attendees have done to affect the initial outcome?

2.15 Summary

This chapter has described an extensive array of skills and attitudes that technical leaders must possess and convey in order to be effective. Much of the background and skill set presented will be discussed in more detail in subsequent chapters. Specifically, various situational leadership tasks and responsibilities that are encountered frequently will be discussed and the abilities and attitudes noted in this chapter will be brought to bear on these issues. Examples are presented as Vignettes or Discussion Questions (in shaded boxes) and some are contained in homework problems that are also suitable for extensive discussion and debate. However, prior to dealing further with approaches and specific situations, it is important that ethics and professionalism be discussed. These traits and behaviors are essential for effective and authentic leaders, because their values and beliefs determine who they are and thus how they and their groups and organizations will respond to difficult personal interactions and ultimately what technical decisions are made. Subsequent chapters will offer detailed discussion of various situations commonly encountered by leaders. Recognition and consideration of some of the wide variety of circumstances possible is intended to raise awareness of problems and responsibilities of technical leaders and offer ways of thinking

about the confluence of "soft" (nontechnical) or professional concerns and technical issues. Many of the Vignettes, Discussion Questions, and homework questions can be viewed as "mini" case studies where appropriate approaches to dealing with problems that have no "correct" solution are discussed and thus can be added to the repertoire of challenges that can be addressed by engineers and scientists.

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You should ask the employee why his motivation has diminished. Are there personal issues that are taking focus from his work assignments? If so, is there anything that you or the organization can do to assist? Does he need more training or guidance in the area he is working? Is the assignment not of interest to him? If the assignment is of little interest, a discussion regarding what his interests are and how they could be used to move the project forward is appropriate. Are there new directions that could be pursued where both the employee needs and the project demands could be satisfied? Has he interacted closely with other team members to obtain additional assistance or ideas? As the team leader, you need to remind the employee of his responsibility to project completion because he is a member of the team. If he is unwilling to commit to engagement in the project, then he needs to either resign or request re-assignment. In the latter case, there may or may not be opportunities available, so termination could be the result.

Homework Questions

1 What are your long-term (>10 years) plans/goals?

2 What life- or career-changing events or experiences have led to your current situation or goals?

3 What obstacles have you overcome to get to this point in your life/career?

4 What obstacles are currently impeding the accomplishment of your goals?

5 Who have been your primary mentors? What did you learn from them?

6 What do you want your legacy to be (i.e. what do you want to be remembered for) to your (a) profession and (b) family and friends?

7 Look at the list of values given in Appendix B which is from C. Roberts at http://www.selfcounseling.com/help/personalsuccess/personalvalues.html
   a Which five values are most important to you?
   b Which five values are least important to you?

c What other (not listed) values are important for you personally, and especially for you in a technical career or leadership position?

8 Which destructive/ineffective habits of a leader described in this chapter are characteristic of you?
- **a** Explain what you can do to overcome each of these habits.
- **b** Are there other destructive or ineffective habits that you have experienced or observed?

9 Do you believe that leaders are born or made/developed? Explain.

10 Describe a situation where you reacted negatively or in anger.
- **a** What caused this reaction?
- **b** How should you have reacted in this situation? Why did you not react this way?
- **c** Are there situations or frustrations that you are currently experiencing or that you anticipate in the near future where you may react badly? How can you ensure that you will react appropriately?

11 Identify a mistake that you have made that had significant consequences. (a) How did you respond when the fact of your mistake was made known? (b) Was your reaction one that engendered trust and credibility from those around you? Why or why not? (c) Was there a better way to respond? Why did you not respond in this way?

12 It is imperative that you as a person and as a leader, understand your priorities, values, fears, and who you are. To assist this understanding and knowledge, answer the following questions. (a) Indicate what would constitute a major success for you within (i) the next month and (ii) the next 5 years. (b) Indicate what would constitute a major failure within (i) the next month and (ii) the next 5 years. (c) Do the answers to these questions assist in determining how and why you might react in stressful situations? Explain.

13 Have you taken advantage of or sought opportunities in your professional or personal life to practice leadership within a small or large group?
- **a** If you have not, what has kept you from seeking such activities?
- **b** If you have, what were your successes and failures?

c What traits are needed for you to be more effective in future leadership efforts?

14 Think about the various people with whom you have interacted closely during your education or work experience(s).
- **a** Who is the most effective leader/manager that you have known personally?
- **b** What was their background or "path" that led them to become a leader?
- **c** What primary characteristics did they possess that made them so effective?
- **d** Were certain characteristics missing that limited their ability to progress further?

15 Consider two broad types of leaders: Assertive or task-master and people-oriented. (a) What are the positive and negative implications/results of being an assertive task-master insofar as team productivity is concerned? (b) What are the positive and negative implications/results of being a people-oriented leader insofar as team productivity is concerned? (c) What conclusions can you draw from such considerations?

16 Of the various people with whom you have interacted, who was the worst/poorest leader/manager that you have encountered?
- **a** What traits made them ineffective?
- **b** Why do you suppose they behaved this way?

17 Describe an interaction you experienced recently where you achieved a win–win situation. Describe an interaction you experienced recently that resulted in a lose–lose situation. What was the fundamental difference between these two scenarios? How could you have turned the lose–lose scenario into one that was win–win?

18 Do you have aspirations to be a technical leader/manager at a middle administrative level (e.g. Division Head, Academic Department Head) or higher (e.g. Dean, Provost, VP, CEO) at some point in your career?
- **a** Why do you aspire to this goal or why do you want to avoid such positions?
- **b** What do you expect will be the rewards of such a position?
- **c** What do you expect will be the most frustrating part of such a position?

19 Has the strong presence of social media necessitated a change in the way leaders behave or function? Are the personal characteristics required for effective leaders different relative to those before social media? Explain.

20 Imagine that one of your colleagues is nominating you for an award for technical leadership. Her nomination letter states that you are truly a servant leader. What evidence can you offer to justify her statement?

3

Ethics and Professionalism

Relativity applies to physics, not ethics

Albert Einstein

Ethics must begin at the top of an organization. It is a leadership issue and the chief executive must set the example.

Edward Hennessy

A graduate student and his advisor (Professor Susan) discussed preliminary results with another professor (Professor Alice) at their institution. Since the initial results suggested that a significant advance in the field may have been identified with their unique approach, the goal in this discussion was to establish a collaboration between the research groups to take advantage of these results. Professor Alice subsequently shared the results with a friend of hers, Professor Jim, who was employed at another university. The discussion led to a joint project on this topic between Professors Alice and Jim, and within a few months, a high impact publication resulted prior to the establishment of a collaboration between Professors Susan and Alice. How should this situation have been handled by Professors Alice and Jim? What should Professor Susan do at this point in time? [Suggested approaches at end of chapter].

Leaders must demonstrate specific characteristics if loyalty and commitment from followers is to be achieved and maintained. In order of importance, the four primary traits expected of leaders according to several surveys [1] are honesty (ethical), forward-looking (vision), inspiring, and competent. Honesty or ethical behavior is at the top of the list, because this

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

creates trust throughout the organization, promotes buy-in of the goals and vision professed by the leader, and sets an example of the behavior expected from everyone. Equally important is the fact that engineers and scientists are required to make a number of decisions regarding how a process or product is designed and performs as well as product impact on the organization, the technical field, and society. The fundamental scientific and engineering training that these individuals have received qualifies them to make rational and appropriate technical decisions. In addition to the technical issues, there are invariably ethical and legal issues that must be considered because they are an integral part of these decisions. For instance, individuals employed in technical fields must address issues such as public and corporate safety, bribery and fraud, whistleblowing, fair treatment, environmental protection, confidentiality, and conflicts of interest. Leaders must recognize that such topics are analogous to other "people" issues in that ethical problems have no unique or "correct" solution; only better, poorer, or incorrect (the later implies unethical, unprofessional, and illegal) approaches. Engineers and scientists must rely on technical and moral assessment of a particular situation to identify the "best" solution, since complexities and trade-offs between technical and moral issues are ubiquitous. This is particularly true when considering topics such as safety of a product or process and how this should be balanced with cost, reliability, legal issues, and responsibilities to upper management, consumers, the environment, and plant personnel. For example, "dual use" technologies that can be exploited for beneficial as well as harmful purposes should be considered in light of benefits, risks, and potential destructive applications. Freeman Dyson stressed the need for ethical evaluation when investigating scientific advances or technologies:

> The progress of science is destined to bring enormous confusion and misery to mankind unless it is accompanied by progress in ethics.

The approaches used to address ethical dilemmas and make leadership decisions are analogous to those used in process or product design, where many conflicting issues must be considered simultaneously and an optimum solution formulated and implemented. The discussion in this chapter is brief since the focus of this book is not ethics and professionalism. A separate chapter is included in order to heighten the awareness of the role of ethical and professional leadership in engineering and science, since these traits are critical to the short- and long-term success of leaders and leadership within a group or organization. More detailed discussion of ethics and professionalism for engineers and scientists can be found in a variety of sources [2–11].

3.1 Ethics

Ethics is defined (dictionary) as:

> the study of standards of right and wrong; that part of philosophy dealing with moral conduct, duty, and judgment.

Engineering (or scientific) ethics can be defined as [4]:

> the study of the decisions, policies, and values that are morally desirable in engineering (or scientific) practice and research.

The need for ethical behavior is conveyed and guidance provided to engineers and scientists by two primary means. First, mentors, advisors, and colleagues provide examples of and a positive environment and basis for ethical and professional behavior and attitudes. Leaders not only look to such individuals as paragons, but must in turn serve as examples for those with whom they interact and lead. This method of promoting ethical and professional behavior was described clearly by Norman Augustine when he discussed leader qualities [12]:

> … they were people of great character and high ethical standards. They worked hard. They were selfless – they did not think about themselves and their careers, but of the mission to be accomplished. They looked out for others, and treated everybody alike. Most importantly, as actions speak louder than words, they set a personal example.
>
> … are employees going to follow somebody they don't trust? In a dictatorship, you can force people to do what you want done, but that's not leadership. Smart people come into an organization, look around, see that those in authority don't cut corners or behave unethically, and think 'that's how you do it around here.'

Second, a code of ethics offers a framework for ethical judgment wherein values and standards for behavior within that profession are described; several Codes of Ethics are presented in Appendix C. Codes of ethics are sometimes designated as codes of conduct because actions taken as a result of specific values (ethics) fall within the realm of ethical behavior and professionalism. Since the codes do not, because they cannot, detail every situation that might be encountered, they must rely on professional and moral judgment. These codes are generally established by professional societies and are subject to change. Changes occur as the Societies' perception of the role of their profession in society is updated, altered, or

after new ethical or professional situations are encountered. Each engineering and scientific society has formulated their own code of ethics, which show somewhat minor variation in their tenets because they describe the considerations, attitudes, and behaviors expected for members to appropriately practice their profession (Appendix C). These codes typically include an overarching statement such as: "Hold paramount the safety, health and welfare of the public and protect the environment in performance of their professional duties" [8], which indicates clearly the breadth of responsibilities assigned to engineers and scientists. This type of statement is in consonance with a medical doctor's intent to "do no harm." In addition, engineers and scientists have a responsibility to their profession and society to "do good" [7]. This must be a pervasive attitude and goal for professionals and is reminiscent of a slogan that was historically used by DuPont: "Better things for better living … through chemistry."

Why do we sometimes not function according to generally accepted ethical or moral standards? Typically this is not due to a lack of knowledge, lack of understanding of right versus wrong, or to unfamiliarity with our professional Code of Ethics. Rather, we often are concerned that we will not achieve what is expected of us or will not obtain what we feel we are entitled to. In other words, we are seeking something or looking out for ourselves, a natural tendency that takes great restraint to resist. What we frequently fail to recognize is that our unethical conduct affects others negatively and inappropriately, and this may not come to light until long after our actions, when the consequences of our behavior become apparent. It is fair to say that a leader's true character and integrity are most clearly displayed when they have to deal with a personal or professional crisis. Such crises offer the opportunity to serve as a personal and/or professional role model for other engineers and scientists, and for the general populace. In addition, this is often the time at which the most rapid growth in and development of leadership abilities and insight takes place, despite the unpleasantness of the situation.

3.2 Professionalism

Professionalism refers to the ethical behavior, responsibility, engagement, commitment, competence, respect, and loyalty displayed by individuals who are performing the duties associated with their occupation [9]. Professionals take pride in their work, set/meet high standards, show initiative, accept responsibility, promote/assist others, and strive for quality in all assignments. They are ethical, open to constructive

criticism, and team players. Classification as a professional implies that an engineer or scientist is characterized by his/her competence, positive attitude, and interactions with others. Such conduct results from the individual's core values from which this behavior derives.

Discussion Questions

- Can someone be a professional and not an effective leader?
- Can someone be an effective leader and not a professional?
- How can you enhance the professionalism of your group/team?

Many of the ethical and professional issues encountered by engineers and scientists, e.g. public and corporate safety, bribery and fraud, whistleblowing, fair treatment, environmental protection, and confidentiality are somewhat obvious, since the concerns are evident within the context of job-related duties. One ethical conundrum that sometimes requires careful reflection is conflict of interest (COI). Codes of Ethics specifically note that COI should be avoided. Various definitions exist for COI, but with respect to engineers and scientists, all definitions relate to competing interests between personal or professional gain and professional responsibilities to their employer and society. Acceptance of a bribe in return for selecting a specific vendor or receipt of funding if research results are interpreted in a particular way are clear COI violations. More insidious are situations such as (i) coverage of trip expenses, including elegant dinners and entertainment by, or gifts from, vendors with whom you are negotiating contracts or making decisions regarding adoption of their products; (ii) entering into contracts with companies for which you own equity or that employ family members; and (iii) existing or previous personal or professional friendships or disputes with individual(s) with whom you are entering into agreements. Even if your decisions are unaffected by these associations and incentives, the perception that your professional integrity may be compromised by these issues is sufficient to warrant concern. It is therefore critical that such relationships be disclosed to your employer to ensure that awareness of possible impropriety exists.

Discussion Questions

- A new production manager's approach to identifying, evaluating, and solving problems was strongly opposed by R&D personnel who had to interact with engineers in the manager's group. One of the engineers

had to present his results and directions for one of the projects to both the production and R&D scientists and engineers for final evaluation and assessment. The R&D staff took this opportunity to severely criticize and rudely question the engineer while indicating why this project was insignificant.

How should this situation have been handled by everyone involved, including the R&D and production staff, presenter, and his immediate supervisor?

- Department employees used crude and vulgar language/jokes during interactions with each other and this sometimes extended to others in the area. Eventually, this behavior began to be practiced by the Department Manager.

  Why might the Department Manager have behaved this way? How should this situation have been handled by (a) the Department Manager and (b) others who were subjected to this behavior?

3.3 Team or Organizational Culture

Culture can be defined as [13] "… the set of behaviors, values, artifacts, reward systems, and rituals that make up your organization." A few simple examples can drive home the meaning of this general statement:

- Are employees given responsibility **and** authority to make decisions?
- Are employee concerns addressed?
- Do leaders pose open-ended questions to obtain feedback and input?
- Are new ideas valued?
- Are procedures transparent?
- Is collaboration encouraged and rewarded?
- Are trust and respect evident throughout the team or organization?
- Is mentoring and professional development practiced?
- Is risk-taking encouraged?

Some disagreement exists regarding whether the behavior of individuals determines the culture, or whether the culture and environment establish behavior [14]; this philosophical distinction will not be explored here. However, as everyone who has visited a new or different organization can attest, a few hours of visitation generally supply an indication of the culture; employee satisfaction, enthusiasm, and collegiality offer insight into the type of culture that exists. A strong commitment to the organization usually results from a culture where values, beliefs, dignity, respect, and shared leadership are ubiquitous

among employees and are consistent with stated organizational policies and procedures. This can often be achieved by ensuring that employees feel that their opinion and input matters, which shows respect for others and thereby promotes full engagement in the group/organization. Appreciation for employee input and concerns can be made evident by establishing a "questioning culture" where the leader as well as the subordinates, continually ask questions that challenge the status quo, critically evaluate currently accepted ideas and directions, and seek opinions from all team members; details regarding this approach are presented in Chapter 7. When the overall team, group, or organization quality is improved because of the individuals who comprise it, the culture is healthy and enjoyable to all. Finally, the leader must demonstrate the stated culture in his/her actions if followers are to buy into the culture and thus show the desired behavior.

Changing team or organizational culture is extremely difficult, because the existing culture has been established by many individuals, circumstances, and policies over many years. This means that a change will also require significant time unless it is possible to hire a number of (new) team/organization members who have the attitudes and characteristics desired for the new culture. A leader should not consider embarking on a culture change until he/she understands the history of the current culture: how and why did it develop, what have been the defining issues, and what (seemingly) unassailable principles or traditions exist? That is, what is the context within which the leader is operating? Without this insight, changing culture or making decisions that require change will be difficult at best. Assimilation and discussion of this knowledge with trusted mentors or colleagues will assist the leader in ascertaining whether these cultural aspects originated to address a particular problem that no longer exits; this allows an approach to change. If the traditions are still relevant, but changes are desired, such discussions may indicate how the existing perceptions can be altered.

An additional issue that sometimes surfaces relates to a team or organization that is highly adaptable/resilient. Although these are desirable characteristics, a change in culture may be difficult to implement and sustain when the team is resilient, since they may view the change as unnecessary because they are broadly satisfied with the status quo and adjust when perturbations occur. That is, they never fully envelop the new culture and over some period of time, revert back to previous behavior and conditions. A permanent change in culture therefore requires patience and continual promotion of and suitable rewards within the new culture.

If a supportive and encouraging culture does not already exist and hiring is not currently feasible, there are ways to promote such a

culture by altering the manner in which interactions take place. When team or organization members are comfortable expressing their opinions and values without fear of criticism or of being ostracized (sometimes referred to as psychological safety), openness and respect are apparent. The result is a collegial and congenial team where everyone accepts ownership, accountability, and responsibility, all of which are needed to establish a culture of trust and credibility. Leaders must therefore make clear that they are open to new, perhaps unconventional, ideas for consideration and evaluation and that they value questions that force reconsideration of currently accepted norms. Although the culture may not change rapidly or substantially during the initial phases, this attitude moves everyone in a positive direction and likely leads to more satisfied and engaged employees.

Team and organizational culture develops and progresses as time passes. An excellent example of how leaders can alter culture by putting in place appropriate procedures, expectations, and goals for individual and team operation was demonstrated by DuPont in 1995. Vernon Bradley, a DuPont plant manager, combined the viewpoint expressed by Covey [15] regarding the maturation sequence of individuals from dependent to independent to interdependent with the desire to improve the effectiveness of the safety culture within DuPont; the goal was to achieve a sustainable safety culture with an injury rate approaching zero [16]. The progression of this effort, known as the DuPont Bradley Curve™ and shown in Figure 3.1, was designed to help organizations understand and benchmark their journey toward a world-class safety culture. It describes the change in attitude, responsibility, and interactions needed to continually reduce the injury rate and improve the safety performance in an organization. Bradley added a category to Covey's sequence to precede the dependent category; this addition was termed reactive. The reactive category is considered the lowest level of safety culture wherein the intent is merely to comply with regulations; the responsibility of ensuring compliance is relegated to the safety manager, who acts without technical personnel or managerial participation in ensuring adherence to safety protocols. Changes to safety practices are typically implemented after an incident because accidents "just happen." The next stage of safety culture (dependent) is realized when management of the organization and especially the team establishes well-defined procedures and training to protect workers, thereby demonstrating commitment to and insistence on safe practices. However, this can simply be a matter of following the rules or practices in order to "check the box" and thereby meet compliance requirements. At the independent stage, individuals display the

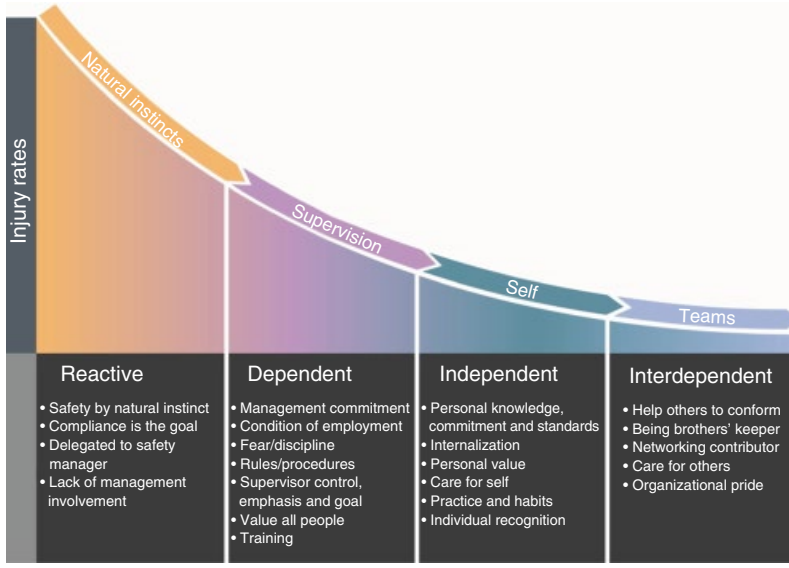

Figure 3.1 DuPont Bradley Curve™ that was formulated to assist organizations in their efforts to develop an effective safety culture. *Source:* Copyright 2016 E. I. du Pont de Nemours and Company ("DuPont"). All rights reserved. Reprinted with permission from DuPont.

personal knowledge, commitment, values, and habits needed to approach safe operation, which ensures their own well-being; in this category, the leadership recognizes and acknowledges these efforts to demonstrate support and belief in the philosophy espoused. The highest and most effective safety level that results in the lowest injury rate is reached when interdependence is achieved. In this mode, the employees look out for each other's safety due to the significance of the ultimate objectives set because these will benefit the employees, the organization, and society; success therefore results in a sense of pride. In principle, the DuPont Bradley Curve™ or model could be applied to a variety of technical goals (e.g. quality) that have multidimensional dependencies but require improvement in the effectiveness of the team or organizational intent.

Although a strong supportive culture is typically a considerable benefit within a team or organization, leaders must guard against the culture serving as a resistance to change. That is, statements such as "In our organization we do things this way," can dismiss or inhibit the expression of alternative views and procedures that may be advantageous to progress or problem solving. The leader should be open to change when improvement is needed or possible.

3.4 Character Ethics and Personality Ethics

The association of character with an individual alludes to personal traits and behavior. Dictionary definitions of character vary; two that are particularly helpful are:

> the mental and moral qualities distinctive to an individual
>
> the stable and distinctive qualities built into an individual's life which determine his or her response regardless of circumstances.

Our character is developed through experience that entails making and dealing with the consequences of difficult decisions or actions; this trait is therefore closely related to perspective. Individuals of character engender trust from others, a topic which will be discussed in Chapter 5. Invariably, those deemed to be of high character are ethical, compassionate, humble, and place others' needs before their own [17], analogous to the behavior of a servant leader. They are identified by their response to situations and events in which they find themselves; it is under trying circumstances that they exhibit character (or not). A person with a strong character recognizes his/her weaknesses and deals with them rather than ignoring or downplaying the weaknesses. This attitude allows them to relate well to others and show empathy and thereby heighten their leader effectiveness by building trust and credibility with team members.

Covey [18] draws a distinction between the character within us and our personality; the latter is what others see or we try to convey. Over the past 75 years, society has primarily promoted personal progress via personality ethics. That is, we facilitate human interaction by displaying the proper personality, public image, attitude, behavior, and communication skills. These traits can be attained by human and public relations techniques and/or a positive mental attitude. In extreme situations, intimidation has been used to gain the upper hand in interactions with others, but this is not an acceptable leadership approach. Previous generations (prior to 1940) relied more on character ethics, which is based on the premise that there are basic principles of effective living that include "integrity, humility, fidelity, temperance, courage, justice, patience, industry, simplicity, modesty, and the Golden Rule" [18]. It is only by adopting these traits as personal values that success and happiness are achieved. Despite the need for character ethics, it is important to note that the personality traits described in personality ethics are often required to succeed as a person and in a profession. However, if a leader's character is flawed, inconsistent, and insincere, others will eventually identify this behavior as manipulative and self-serving, which will lead to a lack of trust and credibility.

Discussion of Ethics Case

Read the Gilbane Gold case study https://www.engineering.com/Library/ArticlesPage/tabid/85/ArticleID/167/Gilbane-Gold.aspx and discuss:

- Ethical problems present in this dramatization and how they are related to technical issues.
- Tradeoffs between protection of human health and environment, capitalism, quality of life, personal values.

3.5 Summary

In order to be an effective leader, we must know our strengths and weaknesses and especially our values and beliefs. In particular, we must be genuine and act ethically and professionally if we hope to develop followers who respect and trust us. We should view ourselves as others see us and then change to address our weaknesses and faults, even when those are difficult pills to swallow. The first step in this process is to understand our motives, personality, and emotions which establish the way we behave when confronted with difficult people, issues, and decisions. Challenges and tasks that confront technical leaders will comprise most of the remainder of this book. Only by knowing ourselves can we, as technical leaders, be effective in addressing these open-ended scenarios that have undefined, although better versus poorer solutions. The expectations of ethical behavior within a group or organization will, in large part, be determined by the leadership, requiring that leaders serve as positive examples in all interactions within and outside the organization. Adherence to such standards will allow us to become the type of leader and person whom others wish to follow and we will therefore have enormous impact on our organization, family, and friends.

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This is a clear breach of ethics by Professor Alice. She should have first indicated to Professor Susan that she intended to discuss the results with Professor Jim. Of course, when Professor Susan first told Professor Alice about the results, she should have told Professor Alice that the preliminary results were proprietary and should not be discussed with anyone else. If Professor Alice's intent was to establish a three-way collaboration, then that should have been described to Professor Susan and Professor Alice should have asked her if this was acceptable. Communication among Professors Susan and Alice is critical to establish appropriate

ownership of the idea (and so intellectual property) and to define the roles of each professor if a project is to be undertaken. Such clarification should have preceded any discussion of the results with a third party; since that did not happen prior to description of the results to Professor Jim, the discussion should take place immediately. There may need to be discussions with and questions posed to a patent attorney to establish the rights, responsibilities, and ownership (i.e. IP) of all parties.

Homework Questions

1 Describe a situation or circumstance that demonstrated lack of technical leadership, professionalism, or ethics that you have encountered (personally or indirectly) over the past several years. These may well have been experienced in a co-op, internship, undergraduate or graduate research, or full-time employment position.
- **a** Indicate how that situation was handled or resolved.
- **b** Discuss alternative (preferably better) ways in which that situation might have been handled.

2 Tom Terrific graduated from Top Notch University and accepted a job at Plastics Are Us, a large chemicals manufacturing firm designing "green" processes for plastics manufacture. He quickly began contributing to the company's product lines and developed a novel process that rapidly found application in the high volume production of stretch wrap for food packaging; this effort evolved into a major business unit of the company. As Tom's accomplishments mounted and his reputation spread, he received a most attractive offer from a small firm, Upstart Plastics, that was developing specialty impact and weather resistant plastic cases to house high voltage electronic devices. Tom soon realized that with very slight changes, he would be able to adapt the process that he developed previously and apply it in his new position. He once again envisioned his value to the company skyrocketing.
- **a** If Tom uses the approach that he developed at Plastics Are Us, does this constitute an ethics violation and thus unprofessional conduct?
- **b** Explain/discuss the issues involved in this decision and how Tom should proceed.

3 Unprofessional conduct or unethical behavior in the performance of professional duties and responsibilities for engineers and scientists

occurs despite continued discussion and reports of these issues. Numerous reasons have been given for such behavior, including (i) career pressure, (ii) the ability to get away with wrongdoing with no consequences, (iii) cultural differences regarding the importance of ethical behavior, (iv) the inability to differentiate between ethical and unethical behavior, and (v) the feeling that I will be at a disadvantage if I behave ethically because others violate such precepts.

a Rank these possible excuses from most important [1] to least important [5] and explain why you ranked them as you did.

b What other reasons/factors can you offer that could account for unprofessional or unethical behavior? Do you feel that any of your additions are more important than the five listed above? Explain.

4 Howard Alper in his opinion paper (*Materials Today*, April 2008, p. 60) entitled, "How can research integrity be best achieved," offers a number of comments and some suggestions regarding how to enhance research integrity. His comments/discussion are equally appropriate if the reader replaces "research" every place that this word appears with the combination phrase "research, scientific, and technological." That is, misconduct is not limited to research in a society where science and technology are prevalent.

a The author cites several ways to prevent misconduct and promote research (to be read "research, scientific, and technological") integrity. Which of the ways that he suggests do you feel is the most important and hence most likely to be successful. Why?

b Who should be responsible for setting the standards, for overseeing, and for enforcing adherence to research, scientific, and technological integrity? Why?

c What should be the penalty or consequence(s) of research/scientific/technological misconduct in academia and in industry?

5 Caroline Baillie in her opinion paper (*Materials Today*, April 2009, p. 6) entitled, "Whose choice is it anyway," offers a view regarding decisions that a professional makes concerning how she/he can or should use their skills and to whom we should offer these skills in the workplace.

a The author did not want to write an article on the benefits of asbestos due to the safety concerns involved with that material. Do you feel that the benefits of a material or technology are unimportant when safety concerns exist? Justify/discuss your answer.

b The author commented that, "I resigned from the PR job without writing the piece." Do you agree with the author's following remark, "Resigning cost me nothing – I would get another job." Explain why you agree or disagree.

c Do you feel that if there are policies and practices in your company or university with which you disagree, e.g. safety concerns, ethical questions, technologies used for the purposes of war, etc., that you should not accept such a position or that you should resign if already employed? Explain.

6 Engineers, scientists, doctors, administrators, lawyers, etc., generally receive training in ethics. However, despite the knowledge imparted and information learned, the professionals in these fields often have difficulty making ethical decisions and practicing ethical behavior. Read the article entitled, "Does an 'A' in ethics have any value?" from the 6 February 2013 issue of *The Wall Street Journal*, and answer the following questions.

a Is there a relationship between good performance (e.g. an 'A') in an ethics class (or segment of a class where ethics is discussed) and ethical behavior? Explain.

b What (i) similarities and (ii) differences are there between the fundamental issues involved in practicing ethics or behaving ethically in a business career and in a science/engineering career? Explain.

c How can university, industrial, and government organizations improve the connection between the study of or training in ethics and the practice or implementation of ethical behavior in the large variety of situations encountered by professionals in these establishments?

7 Engineers and scientists have duties or responsibilities to their place of employment as well as to society. However, when these responsibilities are in conflict, decisions or choices must be made. Consider the following scenario and then answer the questions. As a result of much hard work and tenacity, you have developed a new process for the manufacture of a commercial plastic that is used in toys. The President and Vice President of Technology for your company, Toys For Infants (TFI), are ecstatic, since this process is more efficient, less expensive, and high yield than the current process. Management is already in the planning stages of a new plant with you as the General Manager. This will increase your value to the company, allow you to expand the savings for your children's college costs, place more funds into your retirement account, and buy that new sports car that you have been wanting.

Due to the change in process conditions, catalyst, and solvents in the new process, a small amount of a toxic impurity is incorporated into the finished plastic. The standard, accepted, and documented analytical test for this impurity does not detect the compound. As a result of your efforts to stay informed about advances in your field, you find out that a new analytical method for detecting this toxic compound has recently been commercialized. You send samples of your plastic to this company to assess their capabilities, and find that this new method indeed detects the toxic compound and that it is above the "safe ingestion limit" published for this compound; the standard routine test that has been used to date, still shows no detection of the compound.

a What, if anything, should you do with this information and how do you proceed with the project? Explain.

b Assume that you are either the VP of Technology or the President of TFI. When told about the new test, what would be your reaction and what instructions would you give to the "new General Manager"?

8 Wikipedia defines "dual-use technology" in the following way: "Dual-use is often used in politics and diplomacy to refer to technology which can be used for both peaceful and military aims. It often refers to the proliferation of nuclear weapons, but that of bioweapons is a major issue as well." Such issues were evident with renowned scientists such as Albert Einstein and Robert Oppenheimer who questioned the moral implications of nuclear weapons, despite the fact that both had been intimately involved in their scientific and technological development. Dual-use issues may also apply to other scientific and technological discoveries. For instance, consider a hypothetical new drug developed for the purpose of treating a specific disease such as leukemia that is inadvertently found to result in effective weight loss. A black market therefore develops; however, it is later discovered that individuals who do not have leukemia but take this drug develop horrific side effects which can result in death. A series of lawsuits results. Subsequently the drug is taken off the market even though it is extremely effective for treating leukemia.
Consider the broadest definition of dual-use technology and answer the following questions.

a Should ANY scientific or technological development be considered dual-use? Explain.

b Should the developer (individual, company, and/or government) be held responsible for illnesses or deaths resulting from inappropriate use of the chemical/process? Explain.

c Identify three different ways by which we might enhance/ensure professional responsibility and thus inhibit unprofessional conduct with respect to research in such dual-use areas. Discuss the pros and cons of each approach.

9 You have been hired under a 1-year contract by a ceramics company to work with an R&D group to design a new material that is both electrically and thermally conductive. The contract defines the specifications to be met within a 1-year time frame. Your supervisor within the company has been promised a promotion with significantly increased responsibility if the project is successful. Due to the extensive effort that has been required, the project is over budget at the 10-month mark with promising but not conclusive results. The results that meet the stated specifications are not reproducible. When you express concern to your supervisor about how to proceed, she indicates that you should report only the specific results that meet the specs and claim that you have honored the contract and met the requirements. How should you handle this situation?

10 Read an account of the Flixborough disaster/explosion that occurred in the United Kingdom in 1974; an extensive description can be found in *Transaction of the IChemE, Part B, Process Safety and Environmental Protection*, 82(B2), 105 (2004). There were a number of safety violations that played a role in this incident, but consider specifically the replacement of one of the series of gravity-fed reactors by a dog-leg pipe connecting reactors on either side. This design change was in opposition to the guidelines stated by the manufacturer of the reactor system. However, in order to minimize production delays, the appropriate guidelines and procedures were ignored. If you were the mechanical engineer in charge of system design and you were instructed by your supervisor to make the change and proceed with a restart of the process despite a violation of system design, how would you have reacted? What options do you have when placed in such a position?

11 Read the ACS COMMENT article entitled, "Creating safety cultures in academic institutions" by Robert H. Hill, Jr., that appeared in *Chemical and Engineering News*, 11 June 2012.

a Rank the seven essential elements Hill feels are needed to support a robust academic safety culture, with #1 being the most important, and #7 being the least important. Justify your ranking.

b Would your ranking be different if the same question were posed for industrial engineers or scientists? Explain.
c Explain why Hill claims that "Teaching safety is an ethical responsibility."

12 Read the article entitled, "Whistle-blower claims his accusations cost him his job" by E. S. Reich, which appeared in *Nature*, 8 June 2011. The issues raised in this article are not limited to those between a postdoctoral scholar and his/her advisor or even a graduate or undergraduate student and his/her research supervisor. Rather, the concepts are of equal importance to an individual who is performing an assignment during a summer job, co-op, or permanent industrial or academic position, when he/she disagrees with the instructions given by the supervisor for either technical or ethical reasons. Address the following questions.
a Do you feel that whistleblowing is a necessary/appropriate approach to expressing technical or ethical concerns? Explain.
b After reading the account in the *Nature* article, do you agree with the decision made by the university? Explain.
c After the whistleblower has raised pertinent issues, who should investigate the allegations and who should oversee this process? Who makes the final decision concerning the validity of these allegations and where necessary, determines the consequences to be levied? Explain.
d Since the allegations on both sides of situations involving technical or ethical issues such as those described in the article can have devastating effects on the careers of those involved, how might these situations be handled to minimize the escalation of negative and deleterious actions or comments?

13 Bill has been a close friend and colleague since you both joined the organization 10 years ago. Your families are close and regularly socialize. Three years ago, you were promoted into a very responsible managerial role, still within the Division where you and Bill work. As a result of changes that will take place at the organization in 6 months, you learn that the group that Bill is in will be downsized and his position eliminated; there is no plan to keep him with the organization. You discuss this with your boss and she indicates that this information cannot be disclosed; a formal announcement will made in several months.
a How do you handle your interactions with Bill prior to the announcement?

b What will be your response to Bill when he asks you if you knew about this change prior to the downsizing announcement?
c How will this affect your friendship? If you were Bill, how would you respond to this situation and what would you have expected from your friend?

14 When corporate profits, technology, and social responsibility intersect, company decisions are called into question. Consider the situation related to the drastic increase in the price of EpiPens, used by many individuals to save lives when someone experiences allergic reactions (see, for example, http://money.cnn.com/2016/09/20/news/companies/mylan-house-oversight-hearing/index.html).
a How might corporations, consumers, insurance companies, and technical leaders resolve such issues?
b What responsibilities do the various segments involved in this issue have?
c Who or what organization should make the final decision?
d What role does the technical leader play in such scenarios?

15 Artificial intelligence (AI) efforts have increased rapidly over the past several years. The connection between humans and machine intelligence has been discussed in a recent book: *The Mathematical Corporation: Where Machine Intelligence and Human Ingenuity Achieve the Impossible*, by J. Sullivan and A. Zutavern, Public Affairs, New York, 2017. Furthermore, AI will greatly impact individuals and society in many ways (*Science*, 357(6346), pp. 16–30 (2017)). If machines can learn, could we reach a point where we could not control the machines we have developed (of course, this has been the subject of many science fiction books and movies)? What are the ethical implications of such a situation and what responsibilities do engineers and scientists have in such scenarios?

16 As indicated in the text, Codes of Ethics periodically undergo change due to new situations that arise in the performance of professional duties. It is interesting to compare the AIChE Code of Ethics prior to 2003, with the current version as shown in Appendix C. Several of the fundamental canons listed in Appendix C were not present in the pre-2003 version. For instance, the following directives were added:
- Formally advise their employers or clients (and consider further disclosure, if warranted) if they perceive that a consequence of their duties will adversely affect the present or future health or safety of their colleagues or the public.

- Treat fairly and respectfully all colleagues and co-workers, recognizing their unique contributions and capabilities.
- Never tolerate harassment.

For each of these additions, propose one or more situations that could have occurred within the performance of an engineer's or scientists' professional life that might have warranted the addition of these canons.

17 Modification and updating of Codes of Ethics may be needed as a result of new technology developments.

a Has the extensive use of electronic communication raised additional concerns (relative to those espoused in current Codes) about ethical behavior and expectations in the technical community?

b Should tenets be added to the existing Codes of Ethics of professional societies to recognize such changes in the way technical professionals behave and operate? Explain and give specific examples.

4

Time Management

The essence of self-discipline is to do the important thing rather than the urgent thing.

Barry Werner

I am definitely going to take a course on time management … just as soon as I can work it into my schedule.

Louis E. Boone

How did it get so late so soon?

Dr. Seuss

Engineers and scientists generally approach problems and decisions by developing an understanding of all pertinent issues. Deadlines may not be of particular interest to them because solving problems is where their gratification lies. Because they are highly motivated, engaged, and accomplished, engineers and scientists seek and accept numerous challenges and invitations to undertake new projects and responsibilities. Although such opportunities are flattering and intellectually stimulating, 24 h/day availability remains the prevailing boundary condition. As a result, engineers and scientists sometimes commit "professional suicide" because the commitments made become overwhelming and nearly impossible to satisfy even if sleep is eliminated. A natural consequence of this situation is the generation of stress, anxiety, frustration, and perhaps compromised mental and physical health, all of which negatively impact performance and quality of life. Time management is therefore imperative. Of course, no one should accept all the opportunities that they encounter or find attractive, but we will say more about that later.

Efficiency and effectiveness require that proper use be made of the fixed amount of time available. This is especially true of leaders who are

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

responsible for both their duties and oversight of duties assigned to the individuals who report to them. Despite the importance of time management to deal with multiple demands, many technical leaders give little thought to whether their time is spent addressing important issues or simply those that are urgent; still worse is the fact that leaders often neglect their own personal (and sometimes professional) needs in favor of work-related duties. Numerous books, articles, and blogs have been written to describe time management techniques and strategies; a few of these are cited here [1–7]. In this chapter, factors that an effective leader must consider to manage his/her most limited resource – **time** – are discussed.

4.1 Time Allocation

Leaders must first recognize how their time is spent and be willing to alter their behavior as needed. This statement may appear obvious, but most technically trained individuals have never tracked how they use the hours in their week because they enjoy the intense effort that they expend doing their job and their intent is to achieve the best technical result possible. Although this goal is laudable, the outcome significance is often not justified by the effort. Tracking the time spent on specific tasks every 30 min for 1 week will indicate where time is being spent productively and where it is being wasted. When equal or even more time is being spent on unimportant rather than important tasks, the need for prioritization will be clear. After time usage is determined, evaluation of the accomplishments during the week should be assessed. This exercise offers additional insight into personal achievement: The most productive time(s) in your day are identified. These times can be used to undertake particularly difficult or intense tasks as the workweek is planned. For instance, you may find that early morning or late afternoon/evening, when other distractions are minimal, is the best time for you to devote to more creative activities such as devising novel project directions or writing proposals, manuscripts, and reports.

Covey [1] describes the need for prioritization in managing time. He breaks activities into those that are urgent, not urgent, important, and not important. This categorization and discussion in Ref. [1] has been used to formulate Table 4.1. When considering how our time is spent, the urgent and important activities must obviously be given priority, since these often determine the ability to accomplish tasks. That is, if equipment is nonfunctioning, facilities (e.g. cooling water, ventilation) are compromised; if a deadline is looming or a presentation is required within the next 24 h, these must receive attention immediately. However,

Table 4.1 Generic activity types, examples, and anticipated consequences of each when managing time.

Activity type	Examples	Consequences of focusing on this activity type
Urgent and important	Crises, deadlines, process or product problems	Crisis management, stress, burnout
Urgent and not important	Interruptions (e.g. visitors), some emails or phone calls, some meetings	Lack of discipline, irresponsible if devote considerable time
Not urgent and not important	Websurfing, hallway conversations, some emails and phone calls	Lack of discipline, irresponsible
Not urgent and important	Relationship building, vision generation, planning, goal setting, strategy formulation	Discipline, control, perspective, decreased number of crises

Source: Adapted from Covey [1].

effective leadership will be inhibited if urgent and important activities consume the majority of the available time. This is leadership/management by crisis, and indicates that adequate planning (e.g. maintenance, repair, problem anticipation, deadline planning) was absent. Such approaches to time management lead to demoralization, high stress, anxiety, and ultimately burnout for both the leader and the subordinates. That is, when operating in crisis leadership mode, a leader typically requests immediate responses and accomplishments from those reporting to him/her, requiring the subordinates to disregard the tasks that they have been assigned, to generate or supply information to the leader. Equally problematic is the fact that strategic efforts such as goal and vision development may have been ignored to make time to deal with crises, a tactic that can lead to disaster personally and professionally.

Certain activities are not particularly important, but require urgency. Some interruptions (e.g. phone calls, unscheduled visitors or meetings) are necessary as are immediate responses to some emails. The primary consideration is ensuring that despite the urgency, these activities do not become time consuming, thereby resulting in a feeling of frustration and lack of control. That is, these are short-term issues and extensive engagement with them is closely related to the crisis leadership mode described under activities that are urgent and important.

Activities that are not important and not urgent are often responsible for significant wasted time. Since many of the specific activities in this category (e.g. surfing the web, hallway conversations, phone calls or

emails[1] with a friend or colleague) are interesting and pleasant, substantial time investment (distractions) can occur readily with the justification that these fall within expanding leader interactions with and courtesy to others. While these activities can indeed be worthwhile and courtesy to others is essential, our tendency is to spend an inordinate amount of time on them because they are enjoyable and a break from our routine and perhaps less-pleasant tasks. When a sizable fraction of our available productive time is spent on these activities, overall productivity suffers and places more urgent activities in crisis mode because time has been squandered. The criticality of controlling the time we spend on activities such as email has been enhanced by the extreme and constant "connectiveness" we experience with such current technologies. In particular, the availability of being connected seems to suggest that we **should** be continually connected. Operation in this mode leads quickly to an inability to unwind and relax, which generates enhanced stress and a feeling of frustration. These devices have on/off capabilities that should be used on a regular basis.

A balance of productive versus less-productive time is required, which demands prioritization, decisions, and careful planning. Particular times during the day should be made available for email responses and social interactions so that they do not consume large parts of the day but are an active and important part of your schedule. This plan offers the advantage of a short break or "refresh" from intense effort that requires high levels of concentration and extensive time. Such planning efforts require that we establish and implement good habits that reflect a recognition of the distinction between important and unimportant tasks and employ the self-awareness and self-control necessary to adhere to these priorities.

As Covey stresses, activities that are not urgent but important should be the focus of our efforts, with time allotted for the other three types of activities. Items that are important but not urgent constitute the strategic aspects of an effective leader's time allocation; these efforts include planning, anticipating potential obstacles, goal-setting, and relationship development. Since the payback for these endeavors is typically long-term, they often receive inadequate focus. Because goals, vision, and personal interactions represent the future success (or failure) of individuals as well as organizations, considerable energy should be placed on activities that promote or define these efforts. Specific time(s) each week should be allocated to these activities so that the limited time available is not taken up by the urgent items that belong in the not important task category.

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1 Electronic communication has evolved rapidly and will continue to evolve. In this book I will use "email" as a convenient label for essentially all non-face-to-face communication.

Followers seek leaders who have a clearly articulated vision, display the perseverance to pursue that vision, and engage others to obtain their input and support. Covey labels this general process "begin with the end in mind," and devotes extensive discussion to the topic [8]. Furthermore, the objectives desired must encompass both professional and personal goals. Unless our goals and priorities are considered carefully, and a reasoned plan established, we may simply undertake a "random walk" with much effort expended, but little to no progress toward desired objectives. That is, someone can work hard and be busy (e.g. taking data, holding meetings, reading broadly) but not accomplish anything useful or obtain significant results. When this happens, the focus is likely on the activities themselves rather than on strategic objectives and goals. Technically trained individuals are particularly prone to this scenario, since they are driven to better understand the problem they are addressing; more data, more calculations, more model formulation is always better. Since these tasks are tangible and often more familiar to the technical leader, long-term planning and strategic goal-setting is delayed or ignored. It is particularly important that a leader guard against putting his/her employees in this situation with specific requests. For instance, to compensate for their hesitation to make a decision without all the facts, technical leaders sometimes call too many meetings and require or perform too much analysis ("analysis paralysis") resulting in insufficient action that inhibits progress toward the goal.

4.2 Planning and Organization

Planning is a critical exercise to optimize time use. As noted by Winston Churchill,

> No one ever plans to fail, they just fail to plan.

Leaders especially need to plan and use time effectively and efficiently to further develop their capabilities, skill sets, and achievements. In addition, they should facilitate maximum productivity and accomplishments of those reporting to them. Crisis leadership as deadlines approach or due to spontaneous and unexplained changes in direction on a regular basis leads to frustration, dissatisfaction, and confusion on the part of those performing the work. A variety of planning tools are available, including to-do lists, calendars (hard copy or electronic), charts, and electronic planners; the latter allows priorities and deadlines to be set and easily accessed. The planning method selected should be determined by answering a simple question: Which of these will I actually use to make my life and the lives of those around me, better?

Although planning in professional and personal venues is essential for technical leaders and followers, before discussing the implementation of plans, a caveat must be offered regarding realistic expectations with respect to these plans. All engineers and scientists have (hopefully) made detailed plans for their career and life. As with any tangible technical problem to be solved, these plans include a number of assumptions. Specifically, we assume that the opportunities that we desire will be available to us. Our expectation is that we simply need to search and ultimately identify these opportunities; if we are properly prepared, everything will fall into place. Unfortunately, this is generally a poor assumption. Like most events in life, we have absolutely no control over the opportunities that present themselves to us at any given time. Irrespective of how well-prepared we are for a certain type of position, if that opportunity is unavailable, we are unlikely to be able to create the position merely because we have the necessary background and expertise. The exception to this statement is entrepreneurial activities, but even in this case, the timing must be right to attract the necessary funding and realize the appropriate market demand. Recognition of this limitation is not meant to be discouraging, but rather realistic and forward-looking. That is, at all times, we should embrace continuous learning, improve technical competencies within and outside our focus areas, develop additional skill sets needed for our "ideal" position, and network at every occasion. When a new attractive opportunity does appear, whether or not it was initially sought, we will be prepared to undertake this new challenge with a positive attitude and approach.

After priorities and plans have been established and a time management structure put in place, the tasks must be accomplished. This requires that the leader decide how this will occur. Many new technical leaders rely solely on themselves for accomplishment since they are capable, driven, and agree with Charles-Guillaume Étienne:

> If you want something done right, do it yourself.

Time restrictions preclude this approach as new leaders soon learn. To avoid wasting time, leaders should first make a decision regarding whether the task should be performed. If not, then inform the requester that this is not appropriate/necessary, that the time frame requested is not reasonable, or that it is not best accomplished by you or your team; of course, justification will be needed. New technical leaders often feel that they should accept every task request they receive, even if they are not the best individual to assume this responsibility. Sometimes it is best to decline the opportunity, especially if completion of the task within the time frame needed is not possible without obviating other duties. If you

are not given the choice to decline, then reprioritization of the existing obligations may be needed. If the task is to be completed, then either you perform the task or delegate it.

Procrastination in undertaking or completing a task clearly inhibits progress and achievement and frequently increases stress level because we know that the tasks must be addressed. Why do we then delay performing a number of duties or assignments? This response may result from the individual (i) feeling overwhelmed by the effort that will be required, (ii) considering the task to be uninteresting or unnecessary, (iii) lacking the expertise to undertake the task, or (iv) recognizing that the task is difficult and the approach has flaws that may result in failure. These thoughts instill doubt and fear and cause us to abdicate our personal responsibilities. One way to move past this blockade is to devote or schedule a fixed (perhaps short) amount of time to get the task underway. Once the project has been initiated, the directions and path forward often become less onerous and threatening and smaller steps can be invoked to advance the effort. Confidence in our ability to perform the task is thus enhanced and the habit of procrastination broken. Another way to address procrastination is to step back from the task or problem to consider what part it plays in your overall goals and responsibilities. Placing the task in context can supply sufficient motivation to move forward. Such approaches involve managing our choices; rather than avoid the undertaking of a task, we proactively budget time to undertake and ultimately complete it and recognize its importance in the bigger picture. Irrespective of how procrastination is overcome, effective leaders quickly move the decision process to the point of either completion by himself/herself within a defined time frame, or assignment to someone else with clear instructions regarding the time frame and task purpose.

Technically trained leaders frequently have difficulty accurately estimating the time required to complete a task. The incorrect estimate can take one of two forms. Since they often feel that they understand the fundamental details of the problems to be solved and therefore how to solve the problem, technical individuals underestimate the time required. When their assumptions regarding the details prove incorrect, alternative approaches are implemented, leading to a prolonged time frame. Because technically trained individuals like to generate data, models, and understanding, they prefer to investigate technical problems extensively, exploring every main avenue and even side roads due to their interest in the nature of the situations being studied. Such attitudes can lead to an overestimation of the time required to ensure complete investigation of the possibilities. Experience is often the best teacher in overcoming these limitations, although a trusted mentor or advisor can also offer assistance.

With numerous duties on their plate, leaders undertake multitasking. Although this concept appears to be something that is quite obvious to and expected from a successful leader, multitasking can be detrimental. Clearly, progress must be made on several projects simultaneously. The effective leader learns quickly that if all projects are given equal priority, then all projects move slowly and may only reach completion asymptotically. It is usually best to maintain primary focus and concentration on one project to ensure completion in a suitable time frame. Although attention must be given to multiple tasks, too many projects underway simultaneously increases the stress level. In addition, frequent switching between projects can waste considerable time due to the need to reorient and recall previous efforts at each switch point. Completion of specific tasks in a timely manner while maintaining (limited) progress on others is accomplished by setting appropriate priorities and managing time effectively. This can be achieved by budgeting suitable time for each project and conscientiously adhering to the schedule. Self-discipline is critical for effective time management and completion of individual projects. However, being involved in multiple projects and activities does have a positive effect on the level of creativity displayed. Synergy and variety of effort increases the probability that novel solutions to several of these problems are realized. Sometimes this is labeled serendipity, but recognition of relationships among different fields or problems and alternative ways of viewing situations arise because of the large amount of information being processed. More details regarding creativity will be discussed in Chapter 6.

Another activity that can be considered both good and bad insofar as time allocation is concerned is collaboration [9, 10]. Shared leadership implies collaboration, close interaction, and interdependence to obtain and evaluate a variety of ideas, input, and concerns. Involvement of numerous individuals is required to achieve well-defined, detailed goals and objectives and in the formulation of viable approaches to achieve these goals. Some organizations have promoted such efforts by designing buildings and office space in such a way to ensure "chance" meetings and spontaneous discussions. For example, Mervin Kelly was initially a researcher and ultimately Chairman of the Board at AT&T Bell Labs. He assisted in the design of the research facility at Murray Hill, NJ, where eight researchers won Nobel Prizes. The building was designed with many long hallways that virtually guaranteed meetings with colleagues who were addressing related or unrelated problems, thereby promoting interaction/innovation [11]. Sadly, the AT&T Bell Laboratories described above is no longer in existence; however, their legacy offers insight into how to promote interaction among engineers and scientists.

In addition to architectural designs to promote collaboration, seemingly endless numbers of meetings are scheduled to bring together stakeholders with different backgrounds and experiences in particular focus areas for brainstorming sessions. How can such activities be deleterious? Productivity decreases if a significant amount of time is spent talking about and debating tasks/decisions with few if any concrete outcomes, because these efforts take time away from actually performing tasks. This is an example of ineffective time management. When too many individuals are involved in the decision-making process, the process slows substantially because attempts are typically made to placate everyone's major and minor concerns irrespective of whether these are critical to proper resolution of the issue. Priorities must be set and the leader must keep the group focused on the outcome so that important issues receive the emphasis, but less critical issues are recognized. Furthermore, there are some activities that are best carried out individually (e.g. detailed formulation and evaluation of a new process, calculations to estimate throughput, process modeling).

High performers are always in demand; their attendance is therefore requested at an extensive array of meetings, which takes time away from other activities and productivity. This can be a particular concern for younger group members/recent graduates who may be reluctant to say **no** to such requests. A quote that I find useful in this regard, although it is from an unknown source is:

> I can only please one person each day; today is not your day and tomorrow doesn't look good either.

Underrepresented minorities and women are often overloaded with committee and meeting requests because they can offer diverse views and approaches. A servant leader will ensure that committee assignments and meeting requests/contributions are distributed among team members to minimize overburdening any individual while soliciting full participation and input into the various team functions. The leader must be sensitive to and aware of members who feel overwhelmed and whose accomplishments are suffering due to extensive collaborative efforts. This activity must be considered part of their contribution to enhancing the overall performance and goals of the team or organization. When needed, leaders should serve as mentors to assist others in evaluating which opportunities are worth their time and effort; decisions must be made with respect to how different opportunities might affect the team member's professional and personal development while ensuring that significant contributions to colleagues, the team, and the organization are made.

4.3 Personal Time for Leaders

As mentioned previously, one of the more important items that leaders must consider in the realm of their time management, **is finding time for the leader**. During the quest to advance our careers, we often neglect establishing time for family, personal growth, and physical fitness. These activities fall in the *somewhat* urgent and definitely important category of activity types shown in Table 4.1. When attention to these items is lacking over long periods of time, leader development is repressed and his/her physical, emotional, and relationship health deteriorates. Although it may appear that the closer we get to 24/7 dedication to accomplishing work-related tasks the more successful we will be; this is generally not true. Overemphasis on work-related tasks can impede both personal and professional growth. Specifically, too high intensity for too long a period of time raises stress, generates fatigue, decreases efficiency, reduces overall job and personal satisfaction, can cause depression, and ultimately results in burnout. Short breaks from difficult and extended tasks to talk with colleagues or friends, spend more time with family, read a book on an unrelated topic, exercise, plan activities for personal growth, undertake a different task, or simply relax has an extremely positive effect on both physical and mental health. Sharing frustrations with mentors, colleagues, family members, and friends also lightens the load, often results in new ways of viewing or dealing with concerns, and improves personal interactions. When you leave the workplace, make certain that you unwind with family (including pets) and engage in other activities such as those listed above; working on a hobby; watching a play, theatre performance, or movie; or playing sports. These activities refresh your mind (and perhaps your body) and can improve your attitude, outlook, and motivation, especially when work-related demands are high. Furthermore, as leaders advance and assume more responsibility, such considerations become more critical; it is thus crucial that the habit of scheduling time for personal pursuits be employed during all career stages.

4.4 Summary

Time is a limited quantity for everyone, including leaders. Effective and efficient use of this resource is mandatory if the leader is to be successful. Since leaders must perform their own tasks and are responsible for accomplishments of those reporting to them, it is critical that wasted time and ineffectual requests to others are minimized. Leaders must

therefore know how their time is spent and especially ensure that urgent tasks are not given overriding emphasis. Important duties such as strategic planning, organizing, relationship-building, and goal-setting are often given limited emphasis since the outcomes are long-term; yet, these are the activities that ultimately determine personal and professional success. Due to the myriad responsibilities assigned to leaders, they can easily devote 24/7 to these efforts, resulting in fatigue, burnout, and anxiety. Leaders must allocate time for themselves to renew, refresh, energize, exercise, and develop new (as well as strengthen current) professional and personal relationships. Dedication to these activities is crucial for continued effective leadership and physical/mental health.

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Homework Questions

1. Describe an activity that falls within each of the Activity Types in Table 4.1 for which you devote:
   - **a** Too much time.
   - **b** Insufficient time.
   - **c** How can you alter your behavior or priorities to achieve more effective use of your time?

2. Keep a logbook detailing how you used your time in 30-min intervals, for a 5 consecutive work-day period.
   - **a** Were there periods where significant time was wasted? What caused the wasted time? How can such activities be better handled?
   - **b** Are there times during each day when you are particularly efficient and energetic? How could you best use these times to improve your productivity?

3. Every dedicated, motivated professional has a higher workload than he/she can handle effectively, and most continue to accept additional duties because they are driven, engaged, and responsible. The work to be accomplished can be assigned to various "categories" such as:
   - **a** What you like to do
   - **b** What you dislike doing
   - **c** What you can do quickly and easily
   - **d** What you find difficult to do and so requires considerable time.
     1) List these four categories in priority order from the one that you are most likely to undertake (#1) to the one that you are least likely (#4) to undertake insofar as the way you budget your time is concerned. *Note:* you should not list them in the order you THINK they should be considered, but in the order that you ACTUALLY employ.
     2) Is the priority order listed in (i) the one that you should employ if you are to be most effective in your career (and life)? If not, why not? What should be the criteria upon which your decisions regarding how to spend your time are based? Explain.

4. Think of a time when you had several deadlines the same week.
   - **a** How did you handle this situation? Did you complete one and then begin the next or keep all moving forward?
   - **b** Did you learn anything about how you can best complete multiple deadlines in close proximity?

5 How do you decide when to handle or address a problem or issue yourself versus delegate it to someone else? What are the advantages and disadvantages of both approaches?

6 One of your employees has difficulty initiating any new project assigned to her.
   a What might be the cause(s) of such hesitation/procrastination?
   b How can you help her overcome these issues and thus become a more productive individual?

5

Building Trust and Credibility

When you explain to people what you're trying to do, as opposed to just making demands or delegating tasks, you can build instant trust, even if it's just for that short time you're on the phone.

Simon Sinek

The glue that holds all relationships together – including the relationship between the leader and the led is trust, and trust is based on integrity.

Brian Tracy

The trust of the people in the leaders reflects the confidence of the leaders in the people.

Paulo Freire

The more you are willing to accept responsibility for your actions, the more credibility you will have.

Brian Koslow

Claiming that you are what you are not will obscure the strengths you do have while destroying your credibility.

Tom Hayes

A team has collectively decided that they no longer trust their leader. Many of the team members are considering leaving the team and the organization. Identify several behaviors that the leader might have displayed that would have lead to this outcome. What actions could the team take to address this situation? What can the team leader do to regain the trust that has been lost? [Suggested approaches at end of chapter]

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

For followers to commit to the vision and directions described by a leader, they must first trust the leader and believe that he/she is credible, since relationships represent the essence of leadership. Furthermore, employees will not display trust toward the organization unless they trust their leader(s). Trust and credibility require that a leader knows himself or herself and therefore demonstrates responsibility for his or her actions and reactions in specific situations. The two concepts are intertwined as is evident from dictionary definitions of these characteristics:

Trust: "Belief that someone or something is reliable, good, honest, and effective."
Credibility: "Quality of being trusted or believed-in."

These characteristics are the foundation for effective leadership [1–3]. Without them, performance, collegiality, loyalty, respect, cooperation, communication, and team satisfaction will be strained and may be absent. When trust is lacking, employees are frequently disengaged from the goals/vision and even from the organization/team. Trust is a two-way street. A leader must first trust his/her employees; employees cannot trust him/her if they feel that they are not trusted. Achievement of mutual trust is a process that requires time, patience, open/truthful communication, transparency, vulnerability, fairness, and is established through responsible, calm, predictable, and consistent behavior. Leaders must be genuine or authentic to be effective and engender trust; the importance of this attribute in nearly every aspect of leadership has received recent attention [4]. Leaders must demonstrate that they do not allow their own interests to determine priorities and decision-making. When such behavior occurs, subordinates feel they have no substantive part in the operation of the group/organization and morale and engagement suffer. Kouzes and Posner [1] discuss the fact that trustworthy and credible leaders do not ask those reporting to them to do anything that they would not be willing to do. They also stress the importance of keeping promises; they "abbreviate" this as DWYSYWD (do what you say you will do); effective leaders view this as their personal responsibility. Leaders must "walk the talk" in that they must display the traits and behavior that they pronounce and expect from those reporting to them. That is, leaders' actions must be consistent with their stated values, beliefs, and promises, which is what their followers expect. Inconsistency calls into question the integrity, honesty, and fortitude of the leader. When the leader is or is believed to be deceitful, restoration of trust and credibility requires extensive effort, and may never be fully regained.

Credibility and trust are often heightened when the leader is viewed as a member of the team and not simply the boss. That is, the leader

should be considered "human" in that he/she has undergone and overcome struggles and challenging assignments, and has still succeeded; in this way, the leader serves as a role model for those reporting to him/her. By relating examples of such difficulties and experiences in their career (and life) they offer examples and optimism that team members can resolve and recover from their problems. Frequently, such discussions and shared experiences strengthen relationships and promote open discussion.

Discussion Questions

- When building trust and credibility, discuss the relative importance of:
  a) Technical competency and accomplishments
  b) People skills
  c) Suggest scenarios where one might be more important than the other versus when they would be equally important.
- When an engineer or scientist is successful in their position, does the end justify the means insofar as their trust and credibility are concerned? What behavior would you deem unacceptable from a leader who has generated extensive visibility, accomplishments, and recognition for the group and/or organization?

Trusted and credible technical leaders have either performed the tasks they oversee or at least understand the details involved in these tasks. They continually update their knowledge to stay abreast of new developments, especially as they relate to team/organization needs and directions. They clarify expectations to limit misunderstanding and confusion, thereby ensuring that goals and vision are evident; this facilitates realization of success for their subordinates and fosters loyalty, satisfaction, and commitment. Establishing appropriate goals for each group member requires that the leader knows and understands the talents of each member, along with the members' technical, professional, and personal priorities and goals. Credible leaders set priorities in conjunction with their subordinates and assist achievement of the associated goals by supplying attention, resources, and encouragement. Committed listening to understand concerns and suggestions followed by clarification questions, demonstrates caring, humility, and interest in their efforts. By taking seriously the concerns and suggestions offered when formulating directions and making decisions that affect the group or organization, credibility and trust are nurtured.

One of the most important acts a leader can perform is to admit a mistake, apologize for any problems it has caused, and indicate how the mistake will be rectified. In addition to demonstrating that the leader takes responsibility for his/her actions, this approach indicates that the leader is ethical and genuine, and behaves in an honorable and open fashion. This conduct also serves as an example to other engineers and scientists whose collective role is to improve the human condition. Such behavior further indicates that leadership is not merely about personal success, but that the leader values helping and serving others, performs in a way that shows commitment to honesty, truthfulness, and strives to benefit society and the profession.

An effective leader gives credit to others for successes. He/she generally accepts blame and the resulting consequences of an error that was made by individuals reporting to him/her; this action shows support for team members and creates an environment of trust and credibility. This situation may have been caused by poor judgment or simply a mistake by the employee. Acceptance of this indirect responsibility demonstrates accountability and thus credibility to both those above and below the leader in the organization/group. In such cases, the leader needs to evaluate whether proper training or education for employees was lacking, which is an obligation of the leader. If a lack of judgment or error by the employee was involved, then the leader should have a one-on-one conversation with the employee to determine why this situation occurred and how recurrence can be prevented both by the employee and others within the organization. Such practices show that the leader is supportive of his/her employees and is interested in improving the effective functioning of the team rather than placing blame. These acts engender trust and credibility and lead to loyalty and commitment within the team and to upper management. When trust has been established, mistakes are often viewed less harshly and the offender forgiven for a (but not several repeat) lapse(s) in judgment.

5.1 Leader Behaviors that Establish (or Lose) Trust and Credibility

As described previously, it is often helpful to personal and professional development to identify ineffective behaviors and the resulting responses from employees. This information can indicate the consequences of leader-inappropriate behavior in order to sensitize leaders to their destructive habits and allow plans to be made to alter their conduct. When trust is lacking, open discussion and constructive criticism are inhibited which greatly limits innovative directions, risk-taking, and

improvement in performance. All group members must feel that they are taken seriously and respected for their opinions and novel ideas, even when these are countercurrent to the existing direction or assumed "facts"; frequently these "off the wall" suggestions yield the highest potential gain. Only when respect for and an understanding of others' viewpoints and beliefs are displayed can open and productive debate and decision-making take place. Rather than directly pointing out that someone's statement is incorrect, questions could be raised in an attempt to clarify the assumptions implied by the statement. This is particularly true of comments being made by team members with varied backgrounds, cultures, and experiences, since these lead to different opinions and interpretations of the issues being discussed. Efforts to better recognize the assumptions and beliefs involved in opinions improve understanding for everyone and allow alternatives to be considered objectively while avoiding ego outbursts.

Do you give your employees the responsibility and the authority to make decisions based on their professional and ethical judgment? If not, this often violates the concept of mutual trust. If those reporting to you are required to obtain your approval for all decisions and actions, are judged regarding their decisions before you know all facts, must follow bureaucratic sequences for even minor decisions, or if you feel that everyone must be carefully controlled and monitored for them to perform adequately, you demonstrate that you do not trust them and that you afford them no credibility. This behavior leads to disengaged employees who are frustrated, and feel unappreciated and dissatisfied.

Do you show appreciation for the efforts and accomplishments of those reporting to you by thanking them and explaining how they have made a positive difference? All individuals should be recognized for their contributions to the goals and vision set and for facilitating others' accomplishments. Such gestures build trust and motivation and result in a feeling of appreciation and satisfaction. Do you offer feedback in the form of sharp criticism? This approach puts others on the defensive and often results in the subordinate trying to justify their actions. Posing questions concerning alternative views or suggestions for further consideration, or asking for clarification to better understand their view can introduce the same information in a less-threatening way, thereby promoting open discussion. Similar approaches are generally effective when disagreements with bosses occur. Such tactics show respect for and trust in the employee (and boss) and often avoid egotistical, heated, and unproductive exchanges. Cooperation and collaboration are also promoted, thereby enhancing the effectiveness of individual and team interactions. When exceptionally good performance occurs, strongly positive feedback and praise should be offered to express appropriate credit for a job well-done.

When you are disappointed or unhappy with an employee's response or behavior, do you react with anger, disgust, or sarcasm? This conduct encourages others to keep opinions to themselves and builds distrust. It also sets an extremely toxic example that can permeate the group and destroy respect, collegiality, and credibility. A much better approach is to meet individually with this person and ask questions regarding what they thought of their performance or behavior; this gives them a chance to explain their frame of mind and view of the situation, and opens the door for a productive and calm discussion. If you ignore or delay dealing with "people" or conflict issues, trust degrades. Ultimately, such responses and behavior can establish an "us versus them" mentality between the leader and the led, leading to degradation of productivity, cooperation, and team satisfaction.

Finally, each individual is subject to and affected by his/her "initial conditions" when dealing with others and engaging in team activities and duties. That is, individuals have different starting points. They have different social, political, and economic backgrounds and experiences [5] and come from a different family or a different organization where dysfunctional, adversarial, or extremely collaborative environments existed. Who we are has been determined by our innate personality, background, abilities, culture, and experiences. The mixture and interactions of these varied traits and scenarios establish the way we perceive new situations, what outcomes we expect, how we interpret incidents in a specific setting, and what skill and leadership competencies we originally possessed or have developed; Figure 5.1 illustrates that a complex mixture of experiences and traits exist for each individual. The number of possible combinations of these traits and experiences is extremely large, which leads to the potential for numerous different attributes and thus responses to a specific situation or set of circumstances. Considering this broad range of possible outcomes, it is likely that some responses from team members or other participants concerning decisions or project directions will initially strike the leader as illogical or odd. In fact, if the initial conditions, experiences, biases, and values for each individual were known, many of these purportedly odd responses might appear much more reasonable. As a result, leaders should know and understand his/her initial conditions and should strive to know at least partial histories of those individuals reporting to him/her. Furthermore, the leader must be aware of, allow, and even take advantage of team member differences to forge new paths and improve the quality and performance of the entire group/team/organization. Only by acknowledging and understanding these diverse abilities and experiences, and using them to everyone's advantage, will frustration levels diminish and the benefits associated with the novel approaches resulting from these distinctions be realized.

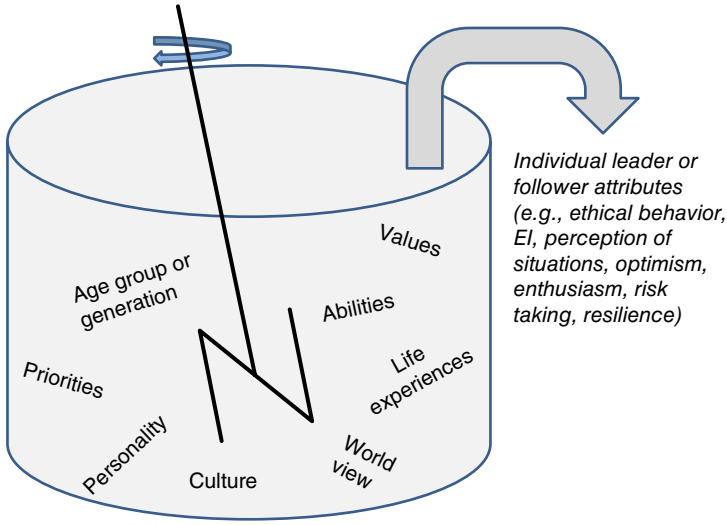

Figure 5.1 Mixture of inherent and learned characteristics of individuals that result in specific ways of interpreting observations and determining leadership and follower skills and approaches. *Source:* Adapted from Bennis and Thomas [5].

Discussion Questions

- Are different generations motivated by different issues/concerns and therefore do they respond differently to issues that must be addressed and to those who purport to be leaders? (see Bennis and Thomas [5]).
- If different generations respond differently, how does a leader bridge the different needs and outlooks of different age groups and/or of those individuals in the same age group who have different attitudes or beliefs within the group or organization?

5.2 Leader-Boss or Leader-Supervisor Trust and Credibility

If team leaders are to establish trust and credibility with their bosses or supervisors, leader actions must warrant these expectations. It is especially important that the behaviors and values displayed by leaders be consistent with those employed in interactions with subordinates. That is, fundamental behaviors cannot depend upon whether the leader is influencing up, down, or laterally in an organization. When differences

or inconsistencies are present in interactions with these levels, the leader will be viewed as duplicitous. Despite this fact, there are differences in the method(s) of interaction that should be employed due to the hierarchical structure that exists in organizations.

A major function of an employee (leader) is to make his/her boss or supervisor look good. That means that knowledge and understanding of the strategic directions, goals, and priorities of the boss are vital. When both leader and boss are pulling in the same direction, many potential conflicts either do not arise or dissipate quickly. When differences in basic opinions, priorities, assumptions, or perceptions exist, the leader must be open to considering alternative views of the situation; the disparate views should be discussed in a calm and honest manner to ensure that no misunderstandings are present. Offering reasoned, impassioned arguments counter to your boss's wishes demonstrates fortitude and courage to both the boss and those who report to you. However, the leader must sometimes yield to the boss' will, since the boss has the final "say" and therefore is always right, even when he/she is not.

As a leader, you need to know how the boss prefers to function. Specifically, does the boss want to know the details in a project or project direction, or are those left to you so that you simply provide the particular efforts, results, conclusions, and recommendations? Is your boss most strongly motivated by completion of tasks or by personal interactions and attitudes? Does he/she like to take risks? Is he/she a planner or a more free-wheeling type? Are deadlines to be met with spare time remaining or must the final few minutes be utilized to complete the task? When substantial or irreconcilable differences exist in these divergent attitudes and approaches, either you or your boss will need to change. Brief reflection indicates that the one who needs to change is most likely you. If the necessary change is not possible or it represents a sufficiently distasteful modification for you, then a reassignment request or alternative employment must be considered.

Provided that the boss is open-minded and willing to consider alternative views to his/her own, many issues can be resolved by defining how a win–win outcome could be achieved. That is, approaches analogous to those used to "lead down" also apply to "leading up." Indeed, to some extent, a successful leader leads or manages his/her boss. It is therefore critical that a good rapport be established with the boss or supervisor so that candid discussions can take place. Remember that a boss is seeking the same conduct from you as you expect from your subordinates: Honesty, sincerity, dedication, and

open communication so that he/she is informed of your activities, accomplishments, and concerns. Dealing with difficult situations or conflict (Chapter 11) will be greatly facilitated and stress alleviated, when trust and credibility with bosses/supervisors exist.

5.3 Summary

The primary bases for effective leadership are trust and credibility. A leader must display behavior that is consistent with his/her values and beliefs to be credible. When the leader is deemed credible technically and personally, and has established an environment of trust with members of the group or organization by being honest, forthright, and supportive of group members, group effectiveness is heightened. Such behavior creates a culture that encourages open discussion of problems and evaluation of alternatives because members feel "safe" to be themselves and offer constructive criticism of the issues being addressed. This condition promotes collegial interactions between members and controlled reactions to stressful situations. Successful leaders trust and respect their subordinates, thereby creating loyalty and commitment to both the leader and the organization. They recognize that each employee has a unique history and background and they find ways to use the individual traits, experiences, and abilities to add value to and enhance efficacy and performance of the group. Analogous approaches and behaviors are needed when leading up; that is, bosses expect to be treated in the same way that you wish to be treated by your subordinates.

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The leader could have been dishonest; spoke in a condescending way to or about team members; did not do what he/she said they would do; betrayed a confidence given to them by a team member; was not forthright when asked about current circumstances; did not effectively communicate priorities, performance, or expectations to the team.

One (or at most two) of the team members should hold a meeting with the leader to describe specific behaviors or circumstances that were disconcerting to the team and ask why the leader behaved the way that he/she did. The intent here is to open a dialogue with the leader and seek reasons why this behavior occurred. Seek advice from a third party/mentor who knows the leader and could either offer ways for the team to address the issues or speak with the leader. A last resort could be to describe the leader's behavior to his/her boss, but remember that this type of move may have unpleasant consequences. However, depending upon the severity of the leader behavior, this may be an appropriate response when other more diplomatic and less threatening approaches have failed.

The leader should apologize for his/her behavior and indicate how he/she will improve interactions with the team. The leader should thank the team for making him/her aware of the behavior and make clear that future open discussion and questions are welcome if the team has subsequent concerns. Depending upon the severity of the leader actions, regaining the team's trust may take a long time, so the leader must be patient and continue to act in a way that engenders trust: Displaying openness, dignity, and respect for others.

Homework Questions

1 From the list of values that you developed or considered in Chapter 2, Homework Question #7, select the three that you feel have the most impact on developing trust and credibility within and effective functioning of a team. How will team members behave if these values are lacking?

2 If someone asked members of your team for feedback on your credibility and trustworthiness,
- **a** What do you expect their responses would be? What justification can you offer for positive or negative responses?
- **b** Would your boss and peers offer you the same feedback?
- **c** How might you improve such responses regarding your behavior from those above (boss), below (subordinates), and laterally (peers) within your organization?

3 As the team leader, you prefer to address issues by email or texting and resist having face-to-face meetings.
- **a** What message does this send to team members?
- **b** Do you expect that they will they react well or poorly to this mode of operation?

4 When replying to a judgmental or negative email from a subordinate,
- **a** Should you copy others (including your boss and other members of your team) to inform them about the issue as well as your response?
- **b** If you copy others, how might this be interpreted?
- **c** How can such interactions be best handled?

5 What would be necessary for you to trust someone (leader) to the extent that you buy into their vision or directions and contribute to these by going above and beyond your assigned duties to ensure success? Are you displaying those characteristics/traits to those
- **a** reporting to you
- **b** to whom you report
- **c** whom you consider friends or colleagues?

6 Technical leaders must both develop/evaluate/supervise others and maintain and extend their technical capabilities/expertise if they are to continue to be effective, have credibility, and trust from those reporting to them. Since there are only 24 h in a day, how can a technical leader maintain and extend his/her technical abilities while functioning as a leader to others?

7 Your boss delays making difficult decisions concerning the specific directions that your team should undertake.
- **a** Why do you think she behaves that way?
- **b** How can you rally your team to overcome such issues?

8 You are having a disagreement with members of your research group regarding interpretation of your recent data.
- **a** How do you react to these challenges?
- **b** Are you open to consideration of interpretations different from your own?
- **c** How do you settle the disagreement without losing mutual respect?
- **d** Does your behavior encourage further questions or discussion?
- **e** If trust is present between the two of you, does this facilitate resolution? What could be the outcome if trust is lacking?

9 One of your subordinates, Tom, approves a change in the production process temperature used to alter the structure of a polymer semiconductor for transistor fabrication in an attempt to improve the device yield. Unfortunately, he did not run reliability tests before implementation. This change results in improved device properties and initial yield, but poor reliability. The poor performance that results causes a primary customer to cancel their future orders.
- **a** How should you discuss this incident with Tom and your boss?
- **b** How will you re-establish trust and credibility between you and Tom, between your organization and the customer, and perhaps between you and your boss?

10 As robots are designed to perform more and more human activities (e.g. self-driving cars), we have to trust that they will carry out these functions properly.
- **a** What does it mean to trust a robot?
- **b** How can we ensure that any trust we ascribe to the robot is justified?
- **c** How does this trust differ from the trust we place in our colleagues, leaders, family members, and friends?

6

Risk-Taking, Creativity, and Confidence

The biggest risk is not taking any risk… In a world that is changing really quickly, the only strategy that is guaranteed to fail is not taking risks.

Mark Zuckerberg

I've made lots of mistakes. Probably the worst one – I would say they tie. It's either when I didn't move fast enough on something, or I didn't take a big enough risk.

Virginia (Ginni) Rometty

Often the difference between a successful man and a failure is not one's better abilities or ideas, but the courage that one has to bet on his ideas, to take a calculated risk, and to act.

Maxwell Maltz

Creativity is allowing yourself to make mistakes. Art is knowing which ones to keep.

Scott Adams

If you want something new, you have to stop doing something old.

Peter Drucker

Creativity is the sudden cessation of stupidity.

Edwin Land

All you need in this life is ignorance and confidence, and then success is sure.

Mark Twain

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

Risk-taking, creativity, and confidence are capabilities that leaders must exhibit if they are to move their team/group/organization forward. These proficiencies are discussed as "a package" because it is extremely difficult to effectively display one of these without possessing the others, since all are necessary when new directions are being considered or tough choices/decisions must be made.

6.1 Risk-Taking

In Chapter 2, we listed a number of traits and behaviors associated with successful technical leaders. These traits included a readiness to consider alternative/creative views or approaches and an openness to change while taking (calculated) risks on difficult problems. As scientists and engineers, we strive for excellence and intend to contribute to society, our organizations, colleagues, and families. Our professional raison d'être is the development of new processes, products, and scientific/engineering understanding. Such expectations supply motivation and drive and represent the reason that most of us went into our respective fields. Achievement of these goals requires dedication, hard work, an eagerness to attack challenging problems that have a high failure rate, and thus represent significant risk. This statement is consistent with Norman Augustine's comment:

> Any attempt to zero-out risk merely assures mediocrity

If we want to rise above mediocrity, and be stellar and accomplished leaders, we must take risks. Anything less yields little if any progress and thus essentially maintains the status quo. Followers seek leaders with a vision to alter current science and technology and the passion and optimism to persevere despite setbacks. Effective risk-taking therefore requires creativity and confidence, qualities that are developed through technical education, multidisciplinary activities, training, successes, experience, and a willingness to challenge conventional views and learn from (rather than attempt to avoid) mistakes.

Exciting challenging problems that offer extensive upside potential but have no obvious solution possess great appeal for scientists and engineers. Of course, it is unclear when or if a solution can be found; therein lies the risk. If a team is not failing at some of the projects they undertake, they are probably not aiming high enough. That is, the team has chosen to undertake projects where the outcome is essentially known prior to initiating the effort.

Why do some individuals embark on the unknown path that is fraught with risk, while others sit on the sideline and later wish they had taken the

first step? Fear is often the cause of inaction and this emotion appears in several forms [1]. Most common is the fear associated with either change or failure. Change is always unsettling and so inhibits actions because the outcome is unknown and we sometimes envision that we will experience the worst case scenario; more will be said in Chapter 10 about managing change. Failure is a result none of us wish to face, but if we are to make significant contributions in any of our endeavors, then we must surmount the activation barrier that prevents us from trying something new because we might fail. Professional hockey players acknowledge this need:

> *You miss 100% of the shots you don't take*
>
> Wayne Gretzky

Effective leaders are not intimidated or deterred by failure, because they recognize that failure results in new information or insight that helps them identify an improved or at least an alternative solution or direction. These sentiments have been proffered previously:

> *The most exciting phrase to hear in science, the one that heralds new discoveries is not "Eureka" (I found it) but "That's funny …"*
>
> Isaac Asimov

> *Success is the ability to go from one failure to another with no loss of enthusiasm*
>
> Winston Churchill

> *One thing a leader does is to remove the stigma of mistakes*
>
> Gordon Moore

Although most of us recognize that we can and do learn from failure, we still frequently avoid taking substantial risks. One reason for the unwillingness relates to a perceived loss of control due to the unknown outcome; the leader is therefore risk-averse and "plays it safe." Another reason that we avoid risks is due to our ego. The possibility that our peers, subordinates, and supervisors will view our failed attempts as foolish or ill-conceived inhibits our willingness to try something new and thereby removes the opportunity for success. This attitude must be altered through recognition that substantial advances will be achieved only by taking risks, and failure may therefore be the result. Analysis of why we failed to ensure that we do not repeat that scenario, followed by forgiving ourselves will pave the way to accept and undertake new challenges. That is, if we do not allow ourselves to move on after a failure, we will begin to second-guess every risk we take and thereby severely limit potential accomplishments and successes.

An additional reason that we hesitate to try something outside our comfort zone is that we feel ignorant in the new field or subject matter. However, ignorance [2] and stupidity [3] drive science. An appropriate statement along these lines is:

> *If we knew what it was we were doing, it would not be called research*
> Albert Einstein

Scientists and engineers expend considerable energy to better understand the background and peripheral areas that relate to a technical problem that needs to be solved. Many remarkable innovations derive from the intersection of radically different fields; thus, creativity demands that we move still further outside the knowledge base in our area(s) of expertise. This requires us to move away from the known and step into the unknown, a process that often results in success but has the potential to lead to failure; indecision or avoidance is therefore the choice we sometimes make. Of course, this approach is not the way to allay our fears of failure, since we never take the chances that will lead to success. Rather, we should embrace the challenge, do the necessary homework, talk with others about the problem we are undertaking, and move forward. Failure to act due to fear will not ensure that we do not fail; instead, it removes an opportunity to win.

Fear of success is not typically viewed as an inhibitor of risk-taking, but it can have that effect because future expectations may be raised after a significant achievement. Related to this situation is another condition generally known as the imposter syndrome [1]. This malady is characterized by an individual feeling that they are a fraud and the only reason they have achieved what they have is because of luck or deception of others regarding their own ability, leading to the belief that they do not deserve their success [4, 5]. "Imposters" often suffer from being perfectionists, so that a flaw they identify in themselves or any unsuccessful attempt to reach a goal leads them to believe that they are undeserving of the accomplishments they have achieved. Luck, which is sometimes equated with serendipity, stems from the recognition of seemingly unrelated connections or correlations among different topics or results. The "imposter" must realize that luck/serendipity is often fostered when reading or exploring a wide range of areas which appear to have no relationship to each other. However, since the "imposter" doubts his/her own abilities, accomplishments, and intelligence, risk and challenges are avoided whenever possible; that is, if the "imposter" fails, he/she believes that others will recognize them for who they really are. Such attitudes can stem from lack of self-confidence which will be discussed further below. In addition, the "imposter" needs to set realistic goals for himself/herself

and determine success according to those measures; direct comparison to others' achievements should be avoided.

Leaders must guard against inaction due to potential failure. Although all of us prefer not to fail, we certainly will experience that result, especially when we are venturing into uncharted territory to seek major advances in science or technology. If creative and innovative paths are to be developed and followed, we must recognize that this goal leads to an increased probability of failure. Effective leaders accept failure but expect that learning has occurred; they use that outcome to establish how to best move forward. Equally important is that the leader not impose negative consequences for subordinate failure that arises because too lofty goals and unconventional approaches/ideas were undertaken. Such behavior leads to frustration, dissatisfaction, and the belief that only "sure things" are acceptable. This outcome is detrimental to the individual, leader, and team because of the message that it sends: Avoid risk. Some companies (e.g. 3M, Milliken) expect employees to use a fraction of their time to investigate problems unrelated to their job duties; no penalty for failure is enacted, but significant praise and remuneration are levied for success in these unrelated areas [6]. Others (The Tata Group) have established an annual competition that presents a prize for the best failed idea [7]. Ratan Tata claims that failure is a "gold mine" due to the learning that has taken place. Such cultures supply the environment for innovation and creativity and motivate employees to assume the responsibility and risk to develop new products, processes, and directions.

Leaders can serve as role models by describing their own failures to team members, where they indicate how they recovered from these, and then describe how positive outcomes were realized. Such actions serve as constructive examples of resilience, fortitude, and positive attitude that should be emulated by others. This is especially important when the leader is providing professional development for team members, particularly early career engineers and scientists. The significance of demonstrating that failure can be important and motivating has been described clearly in the context of formal education [8]:

> Most teachers resist showing students the dirty part of real learning and by the dirty part I don't mean the hard work …. I mean the part where we fail nine times in a row before we find a good approach. I mean the parts where we are confused about our project, defensive in the face of criticism, doubtful of our abilities …. Whatever the venue … teachers like modeling their knowledge, not their ignorance, and they avoid referring to the muddy paths, fear-filled moments, and just plain failure that are the unavoidable parts of getting the knowledge we possess.

Incorporation of such approaches by current leaders when they develop and guide the next generation of leaders supplies encouragement and has an extremely positive effect on building confidence and willingness to take risks.

6.2 Creativity

Wikipedia (26 June 2017) defines creativity as a "phenomenon whereby something new and somehow valuable is formed. The created item may be intangible or a physical object." That is, a novel, musical composition, painting, idea, or invention are examples of the result of creative endeavors. Similarly, Richard Zare during his ACS Priestley Medal address in 2010 noted that

> Creativity is the process of forming original ideas.

These novel or original ideas include a discovery, a new interpretation of existing information, or the identification of previously unrecognized relationships among apparently unrelated areas. These possible outcomes arise because leaders or employees think "outside the box," are curious, and driven. Some individuals have higher propensity for this type of activity than do others. However, all of us can improve our creativity by conducting ourselves in certain ways. For instance, we can read broadly in diverse technical and nontechnical areas to expand our knowledge base and redirect our thought process, restate the problem in a different way to alter an existing viewpoint, challenge assumptions and conventional wisdom, embark on new (for us) activities such as hobbies or sports, and speak and collaborate with a variety of individuals on important problems/issues to obtain different perspectives. These approaches enhance individual and team/organization creativity. An interesting discussion of the way collaboration among various individuals results in creativity can be found in a recent book by Walter Isaacson [9], while examples of identifying innovative approaches by working at the intersection of different and sometimes divergent fields have been described by Frans Johansson [10].

Although the team approach to creativity is widely accepted and practiced, the "lone" or shy and inhibited person (introvert) often makes important discoveries because they are not biased by others' ideas and concerns, which allows new directions and concepts to be pursued freely [11]. This approach was promoted by Nikola Tesla, who stated:

> Be alone, that is the secret of invention; be alone, that is when ideas are born.

One way of broadly seeking creativity is to employ a combination of team members working alone and in groups. For instance, the team can first collectively define the specific problem to ensure that agreement on the problem statement or goal(s) exists. Team members can then individually contemplate their approach or ideas and develop these so that they can be discussed, debated, and further refined, in a team meeting. Such methods of problem solving can be extremely beneficial since members are often unaware of how much influence other team members have on their view of a situation or problem ("group think"). Removing themselves from the team initially to consider only their ideas and approaches can lead to fruitful suggestions or directions that might not have been expressed in the team discussion because the members wanted to conform to the general consensus.

Leaders must be aware that certain organizational structures and attitudes inhibit creativity. For instance [12], bureaucratic approaches that require rule and procedure standardization or centralized decision making for the organization irrespective of the unique responsibilities of the different groups, restrict flexibility and thus options available to address problems. When individual departments are treated as separate entities that are responsible and interactive only unto themselves, synergy and information sharing is hindered, and decisions are made with less information than is available. When a leader prejudges ideas because he/she has decided that the individual making the suggestion never has good ideas, is not willing to take sufficient risk to try something that deviates from the status quo, does not want to admit that he/she might not have all the answers or could be wrong, or clearly conveys the attitude that only positive results are acceptable, subordinates are greatly inhibited from expressing or practicing creativity.

Discussion Questions

- What are the best ways that you as a leader, can encourage and ensure creative approaches to technical problems, people issues, project directions, and goals within your group?
- High creativity in research, development, or production implies that a positive outcome is anything but assured. That is, truly innovative approaches/directions often walk a fine line between producing something novel and descending into chaos, failure, and lost time/effort [13, pp. 277–279]. How does a leader promote and achieve extensive creativity while avoiding chaos and inefficiency?

In contrast, leaders can enable creativity by developing and expounding a clear vision that is challenging and link this challenge to goals set for the group or organization. That is, when the vision of the leader resonates with the beliefs/desires of the team members, motivation, and initiative result. The leader must be inspiring, show his/her enthusiasm/passion for changing the status quo, and indicate the significance of succeeding in this effort. Many approaches offered as creative are simply extrapolations of current state-of-the-art or state-of-the-science; in this situation, the probability of success is reasonably high and no leap of insight or perspective is involved. Leaders should encourage consideration of scenarios that address what could be or could happen if we relax assumptions and beliefs, change our perspective, or move outside our comfort zone. A contrarian might proffer that instead of investigating how to improve the process or product, attempts to make the process or product poorer should be pursued since these may offer insight into the controlling variables or generate unique results that supply new paths to consider. Questioning whether the limitations that we imagine are real or perceived is also beneficial. Such approaches can lead to novel ideas, processes, products, and directions that have extraordinary impact.

Successful creative leaders recognize unexpected or unanticipated opportunities and are open to deviation from the original direction. That is, while seeking a solution to a specific problem, a surprising piece of information or new direction may be uncovered, that could lead to completely new approaches, applications, or objectives. The decision to pursue such tangents requires flexibility, confidence, and willingness to take risks, because the original intent or goal may need to change. Major innovations often result from exactly this type of adaptation.

Operationally, the leader should engage and integrate diverse individuals, groups, and fields to take advantage of the synergy that occurs when technically, culturally, and socially disparate members interact closely and have a common well-articulated goal and vision [14]. To benefit fully from such an organizational structure, the leader must be flexible, suppress his/her ego, and allow members significant independence while ensuring that the larger goal remains the overall focus; that is, discipline and responsibility must be balanced with unconventional, creative approaches. The number of ideas proposed should be maximized, since the likelihood of a novel solution or approach is enhanced as the number of ideas increases. Criticism of ideas and directions should be encouraged, but trust and respect among group members must be present for this approach to be effective. Individuals are frequently driven by constructive criticism because this helps them refine their ideas and views, **provided** that they feel psychologically safe in the group or organization. When trust is ubiquitous, open exchange of ideas and concerns

along with the willingness and acceptance to sort ideas by priority or feasibility takes place. These attitudes allow all team members to be themselves and the interactions thereby raise team energy and optimism. If these attitudes are absent, team members' energy dissipates and futility and possible disengagement results.

Finally, leaders (and teams) should view even their best ideas extremely critically in an attempt to establish as soon as possible if they appear viable. This obviates much wasted time and effort and thus improves efficiency and the chance of success. However, all team members should be encouraged to continue cultivating their ideas even when these are not selected initially to signify that different approaches are welcome and will be considered as the problem is better defined or new information acquired.

Creativity is a major component of successful technical endeavors. Leaders therefore want to maximize this team characteristic. However, highly creative individuals can be difficult to lead/manage because as expected, they are typically nonconforming and follow the path less traveled – or no path at all. They find difficult problems immensely interesting and motivating. One of their strongest attributes is their ability and intent to look at problems from angles that others ignore; they turn the problem inside out, upside down, and backward in an attempt to uncover unique aspects that may be useful in identifying solutions. They imagine unusual connections or relationships that have eluded others or that others insist do not exist. Such diverse views can also be initiated by naysayers who question, critique, or criticize the prevailing discussion or conclusion, which causes others to rethink their decision, thereby leading to novel or creative approaches or interpretations. These behaviors can be disruptive to a group or team that depends upon collegiality and commonality if mutual trust is absent; more will be said about this when team building is discussed (Chapter 9).

A successful technical leader must ensure that all team members feel valued and appreciated for their contributions, and are given flexibility and freedom to pursue their passions. Juxtaposed to these duties is the need to maintain focus and progress on the established goal, which requires structure. Therefore, leaders must be able to orchestrate numerous individual directions, inputs, and intents while influencing the overall direction to solve the assigned problem. At times, the leader may need to draw on more dictatorial approaches to ensure that too many diversions do not inhibit progress toward the goal. At other times in the project, the leader needs to loosen the reigns and allow more free-wheeling approaches. The balance is critical and will depend upon the particular team membership, the type of problem being addressed, and the timeframe necessary for completion. This requires patience and creativity on the part of the leader to recognize relationships between a plethora of

project segments and individuals that must constitute a whole; such tasks comprise what can be described as optimization.

Discussion Question

- How can a leader make group members feel appreciated and valued when numerous different directions and approaches (some creative and some mundane) are being proposed, but one (or at most two) can be followed?

6.3 Confidence

To take risks and benefit from creativity, we must have the confidence to move forward with actions we believe will have a positive outcome. In this section, we will discuss self-confidence, which is a trait that is easier to recognize than it is to define. Self-confidence connotes a belief or trust in one's abilities to accomplish a task or goal, despite any difficulties that may be present or anticipated, or unknown problems that show up as the project continues. Confident individuals are decisive and not afraid to voice their opinion when the prevailing sentiment is against them (courageous), even if it means they are uncomfortable or might be embarrassed [15]. They stand up for their beliefs; trust that they have the ability and determination to succeed; maintain self-control when demands, opposition, and stress are high; and inspire others. Confidence should not be confused with arrogance or "cockiness," where the person is certain he/she is correct simply because they feel that they could not possibly be wrong.

Why do well-educated scientists and engineers who have graduated from strong programs and perhaps had successful internships, co-ops and may even have held industrial or academic positions, lack confidence? Frequently these individuals are perfectionists, are uncomfortable with change, new situations/environments, criticism, and failure, and have a negative attitude about their chances for success. As a result, they avoid undertaking difficult tasks. When avoidance rules, the opportunity to succeed evaporates, which feeds insecurity. If they do attempt a challenging task and fail, this confirms their self-doubt, and corroborates their feeling of being an "imposter." Such reactions often characterize those who are more concerned with achieving expectations than they are in expanding their capabilities, maturing, and thus attempting new activities.

Some individuals believe inappropriate and unfounded comments made by others. That is, they are intimidated by outright claims or insinuations by other people that their abilities and accomplishments are second-rate.

The individual accepts that these statements or innuendoes are true, loses confidence, and ultimately is inhibited from attempting new activities and taking risks. Eleanor Roosevelt had the correct view of this situation:

> No one can make you feel inferior without your consent

An honest self-assessment of the individual's situation is needed in this circumstance. This effort is helped greatly by input and feedback from a trusted mentor who can assist the evaluation process.

Individuals who want to reverse this downward spiral and improve their self-confidence should engage in a few pursuits outside their comfort zone. It is important to go into these efforts with a positive attitude, recognizing that the necessary abilities exist but must be exercised, ensuring that advantage is taken of the education and training received to date, and understanding that knowledge and insight will be gained. Negative thoughts that enter your mind must be restrained because these hold you back. As noted by Henry Ford:

> Whether you think you can or think you can't, you're right.

Positive thoughts can be promoted by observing others similar to you who have succeeded (I can do this if they can), remembering past successes, managing stress by remaining calm, and developing a plan that illustrates how to proceed in the new pursuits in order to achieve the goal that you have set. Again, many of these efforts are facilitated if a mentor is identified who can offer feedback, encouragement, constructive criticism, and serve as a sounding board; peers in a support network can also serve this purpose.

Despite our best efforts, failure does occur. Confident individuals are not deterred by failure, but deal effectively with this outcome by viewing it as a way to gain insight and direction, which allows them to strengthen their resolve. We can overcome some of our negative feelings after a failure by recalling that some of our attempts have succeeded; we should therefore have high expectations for success upon undertaking subsequent opportunities.

6.4 Summary

Leaders must be willing to take risks if they wish to perform projects that have significant impact and thus move science and technology forward. Identification of novel projects and goals depends upon the creativity of the leader and group members. Thus, efforts to enhance the creativity and risk-tolerance of the leader and group members must be undertaken.

Diversity of technical backgrounds, experience, and viewpoints comprise an ideal collection of team/group members to address multidisciplinary and multifaceted problems. Confidence within and among the team members is necessary to ensure dedication and resilience to the normal successes and failures encountered during these investigations. The leader must take advantage of the divergent approaches and personalities of the individuals to converge on feasible directions while allowing each member to feel appreciated and contributory. This requires patience, flexibility, and open discussion, but the outcome is worth the effort.

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Homework Questions

1 What is the most significant risk that you have taken in your (i) life and (ii) career to date?
   - **a** Why did you decide to take that risk and what has been the outcome?
   - **b** Would you make the same decision again if you had the opportunity to alter your decision?

2 Read the article by Sitkin, S.B., Miller, C.C., and See K.E. (2017). *Harvard Business Review* January/February, pp. 93–99.
   - **a** Identify three critical "take home messages" from this study that are applicable to setting and achieving stretch goals.
   - **b** What considerations should be taken into account when establishing a stretch goal? Explain why you selected these particular ones.
   - **c** What is the difference between risk aversion and not pursuing stretch goals?
   - **d** Could stretch goals be a major component in the failure of a large fraction of technical start-up companies? Explain.

3 What do you consider to be your most creative accomplishment?
   - **a** Why did you embark on the path that led you to this effort?
   - **b** Was this a straight-line extrapolation from where you started or was it more of a random walk?
   - **c** Did another person assist you in this accomplishment? If so, in what way?
   - **d** Does this suggest ways that you might encourage others to embark on innovative or creative endeavors?

4 Identify three individuals who are self-proclaimed introverts, and were highly creative as defined by taking an established technical field into new directions or establishing new scientific or technological fields.
   - **a** Do you feel that their contributions would have been achieved if they were constrained to work only in teams?
   - **b** Would their contributions have been even more astounding if they had worked in teams? Explain.
   - **c** How can leaders effectively utilize both extroverts and introverts to build an effective team?

5 Read the article entitled, "Science in the age of selfies" by Geman, D. and Geman, S., (2016). *Proceedings of the National Academy of Science* 113 (34): 9384.
   - **a** Do you agree that group research or brainstorming stifles creativity? Why or why not?
   - **b** Is the reward system currently in place to recognize creative efforts inappropriate? Why or why not?
   - **c** Are there better ways to promote creativity?

6 In your current role as a researcher, engineer, or co-op student working on a project, what beliefs inhibit your willingness to embark on a most unusual and perhaps risky direction in the technical problem?
   - **a** Are these beliefs real or perceived?
   - **b** What might be possible if you ignored the limitations you feel are present?
   - **c** What would be the consequences if you fail or succeed?

7 How would you describe your confidence level? Do you believe that your behavior and persona are consistent with your description? Why or why not?

8 Do you allow people to see and experience the "real you"?
   - **a** How do you ensure that others truly know you?
   - **b** Why would you not want them to know the "real you"?
   - **c** Are there individuals whom you feel you know in the deepest sense? If so, why and how were you able to reach that level of interaction with them?

9 What opportunities have you not pursued because you lacked the self-confidence to begin?
   - **a** What experiences led you to believe that you should not begin this effort?
   - **b** Has your belief/trust in yourself and your abilities become more or less inhibiting over the past 10 years? Why do you feel you have experienced this change?

10 What opportunities have you pursued despite misgivings or concerns for the outcome?
   - **a** Why did you make that choice?
   - **b** What was the result of your effort, and what did you learn from this experience?

11 Is your confidence level sufficient to cause you to leave a comfortable, secure, prestigious technical position to pursue a very different position in a different organization, a different technical area, or a nontechnical (perhaps administrative) position that you have always wanted to experience? Under what circumstances would you consider such a move?

12 Are you more afraid of failure or success?
- **a** What outcomes might be expected from each?
- **b** Are your actions consistent with the priority that you have espoused?

Part II

Putting Leadership Principles into Practice

In the first six chapters, we detailed the various traits and characteristics that define ineffective and effective leaders, what attitudes and behaviors are critical, and how our responses to situations can affect others and ultimately determine success or failure in leadership roles. A few examples of leader interactions and reactions have been noted and suggestions offered concerning how we might alter our behavior and thus improve leadership skills and approaches. The remainder of the book will use this background to consider how to address a number of diverse duties and responsibilities that leaders assume. As indicated previously, there is seldom a single correct answer to such complex, people-oriented, organization-dependent situations. Discussion Questions, Vignettes, and homework problems that probe these scenarios as well as our own personal beliefs/values/biases, will uncover various ways to think about and potential approaches to apply when placed in such circumstances. Of course, every situation is unique. In core science and engineering courses we were given fundamental background that we could apply to homework and exam problems. The formalism that we developed through those exercises was useful to address previously unknown or new problems. We will now follow a similar approach and use the leadership attributes and skills we have discussed in the first six chapters to address typical scenarios that can confound, frustrate, and discourage leaders.

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7

Leadership Through Questions

Judge a man by his questions rather than his answers

Voltaire

What people think of as the moment of discovery is really the discovery of the question

Jonas Salk

What we observe is not nature itself, but nature exposed to our method of questioning

Werner Heisenberg

He who asks a question is a fool for five minutes; he who does not ask a question remains a fool forever

Chinese proverb

You can tell if a man is clever by his answers. You can tell whether a man is wise by his questions

Naguib Mahfouz

As the newly appointed team leader, you want to demonstrate that you are interested in and are engaging all team members. You decide to accomplish this by dropping by each member's office on a periodic basis to inquire about their project. In your first attempt, you ask Sally how her new process for oil–water separation is progressing; her reply is that it is going fine. You then ask if you can supply assistance of any type; she says that none is required. Finally, you ask if she will be able to meet the deadline set for next month; she indicates that she can. You subsequently leave

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Sally's office feeling that everything is fine and that your questioning approach is effective.

- How would you assess the knowledge content of the responses that you received?
- What do you think Sally's impression was of your discussion?
- How could you have carried out the questioning session to extract more useful information for both you and Sally?

[Suggested approaches at end of chapter]

A questioning approach to problem solving (and leadership) has its roots in the Socratic Method and thus systematic critical thinking and inquiry-based learning. In this method, structured questions are employed to lead someone through a logical thought process that also involves subsequent questions regarding the answers offered. This effort further refines the answers and exposes the thinking pattern applied. Although the individual may not initially appear to be responding or behaving logically, when the known or unknown biases, beliefs, values, assumptions, and personal experiences are considered, the responses displayed and conclusions drawn often make more sense, and understanding is thereby improved. That is, the questioning sequence can uncover many of the issues that determine the outcome for both the questioner and responder, and often identifies a path forward.

Successful engineers and scientists have learned to ask critical questions of themselves and their team members as part of their role in research, development, and manufacturing. Thoughtful and well-formulated questions frequently lead to solutions to difficult and perhaps initially intractable technical problems. That is, engineers and scientists question or challenge technical results, theories, and explanations to refine and correct their initial thoughts and viewpoints; questions can also identify new directions to investigate.

To be effective as technical leaders, engineers and scientists must similarly ask important questions when taking risks, making decisions, setting goals, and dealing with conflict. A primary difference between these two types of situations is that scientific or technological questions can be solved, or at least approached, in an analytical or logical manner. They can be validated or further studied by experiments or calculations because fundamental scientific or engineering principles do not depend upon the circumstances nor the individuals involved. When people issues or dependencies are included, it is unlikely that there will be a single or perhaps even a good answer, because each individual's values, biases, priorities, and backgrounds are different, which leads to behavior that may not appear to follow a logical or consistent theme. That means

that leaders must engage many people, especially each team member, to take advantage of their collective wisdom and experience, and thereby gain the broadest and most comprehensive outlook possible. This is most effectively accomplished by asking questions that are not intimidating and delivering them in a nonthreatening tone. Colleagues, subordinates, and bosses generally respond positively to such approaches since they feel that they are part of the decisions made, are being engaged, and that their opinions/ideas are valued.

7.1 Basis Behind Using Questions in Leadership

A leader's use of questions to improve his/her own knowledge and perspective and to assist others in gaining knowledge and perspective can reap the same rewards as posing technical questions. With technical questions, the answer may depend upon the assumptions and particular experiments/calculations performed, because different aspects of the problem or scenario are probed. Similarly, because people have individual emotions, traits, and experiences, they display distinct reactions to situations. The questions raised can also expose various aspects of the problem that were not evident previously, resulting in motivation and in creative or innovative directions. As a result, the specific question and the manner in which questions are posed can significantly affect the response, the information available, and thus the outcome. Awareness of such concerns and the value of open-ended questions posed by leaders have been recognized and are addressed in detail in several recent books and articles [1–5]. Extensive examples of questions that facilitate or discourage discussions within teams and with team members are included in these references, as are implications of the presence or absence of a questioning culture to team or organization operation. A short synopsis of salient issues and methods to be considered in technical leadership is presented here.

As evidenced by the suggested approaches to dealing with the scenarios in Chapter 1 and the vignettes described in Chapters 2, 3, and 5, self-questioning by the leader and proffering questions to the people with whom they interact or lead are effective methods of learning and insight generation. Leaders should continually pose questions to themselves concerning their activities, conversations, and procedures. Reflection of recent interactions with those who report to them, to whom they report, and to colleagues, should lead to questions regarding how those interactions could have been improved and enhanced. Such evaluations are greatly facilitated and insight enriched by asking mentors or close colleagues for their frank assessment of your behavior or actions.

Leader questions to others direct the focus of a conversation to the other person so that they can be influenced, assisted, or challenged rather than directed or told what to do. This shows leader faith in their capabilities and ability to address issues, thereby building self-confidence and independence that helps them develop as engineers, scientists, and leaders. If handled properly, this approach can also avoid confrontation and initiate discussions where egos can be shelved and honest exchange of information can occur. Equally important is the new knowledge, understanding, openness, and mutual respect that generally results from the dialogues. Such achievements promote personal relationships and can thereby alter the culture and improve the operation and efficacy of the team by establishing or promoting interdependence among members. For instance, when a questioning culture exists, change is facilitated because team members are continually probing and evaluating the status quo and so are open to reconsideration and re-evaluation of decisions and conclusions. When a questioning culture is absent, individual defensive positions that impede effective decision-making and change are more likely to exist.

The venue under which questions are invoked is also important. Although electronic means of communication and interaction (e.g. email, texting) are clearly efficient when dealing with multiple people, they are not effective when sincere inquiry and understanding are desired. That is, multiple back-and-forth emails or texts become tedious quickly. More importantly, face-to-face discussions supply considerably more insight into responses than are possible with electronic communication. When the leader cannot observe facial expressions, body language, tone of voice, reactions, or emotions, information content is lost and responses can be misinterpreted more easily. Furthermore, when a leader takes time for an in-person meeting, the genuineness and sincerity of the leader, and the importance of this activity to the leader, are evident, thereby building trust and credibility.

Since appropriate questioning can have numerous beneficial effects, why is this technique not used more extensively? Technically trained leaders often feel that they should be visionary and able to correctly answer any question or address any issue that surfaces – after all, they **are** the leader; this view is frequently upheld by subordinates as well. Engineers and scientists are generally taught to offer answers and solve problems directly when questions are posed. If they do not offer an insightful reply to questions raised by others, doubts could surface regarding the competence and suitability of the leader; they therefore resist a questioning culture. Furthermore, leaders may feel that extensive use of questions that they themselves cannot answer will label them as "imposters" as discussed in Sections 6.1 and 6.3. Such considerations are

particularly difficult when deadlines are approaching and decisions are needed; under these conditions, it is challenging to initiate a series of questions rather than dictatorially make the decision. Considerable self-discipline and courage are required for the leader to admit he/she does not know the answer, and then delay the decision while questions are tendered and discussions enacted. However, this is exactly the time that a message can be sent to team members that questions are critical parts of the decision-making and direction-setting process and that you respect and trust their judgement. Since team members are performing the studies and therefore are closest to the problem being addressed, their insight and knowledge are vital. Furthermore, the members and leaders can learn from each other. This approach also demonstrates that the team is a safe environment to express opinions and ideas and establishes the leader as a role model for team behavior and interactions.

Team members may resist the development of a questioning culture when they are unsure of the intent of this effort. That is, they may feel that the leader is "testing" them to determine if they support or are loyal to him/her, or if they are competent to perform their assigned duties. Employees may believe that responses/answers not congruent with that of the leader will be met with negative consequences. Also, some team members may feel that loyalty to the leader or the organization supersedes a questioning culture (i.e. they do not want to appear in conflict with the leader or organization) and so do not buy into or may not participate in this approach. It is therefore important that the leader stress that a questioning culture is meant to benefit everyone, including the leader, by developing an open route for discussion and debate where all members learn and feel more involved and confident. Disagreement on issues is healthy and should be promoted, while maintaining civility and respect for each other. Beneficial results from such a culture are only possible if each team member feels safe, and is considered trustworthy, credible, and amenable to alternative viewpoints. Insightful, challenging questions stimulate new ideas and approaches, and help to better define a problem. This conclusion is true when dealing with technical or personnel issues, because questions can remove perceived roadblocks in either realm. Leader behavior is especially important during such questioning sessions, because if the perception is that the questions are posed to demonstrate how intelligent the leader is, then the employees will sense an agenda other than the one stated. During questions and responses, there can be no judgement or insinuation that one question is more suitable or that certain questions are naïve or inappropriate. The intent must be to present a broad variety of questions to ensure that nothing that should have been considered was neglected, and to allow valid and justifiable solutions or approaches to be identified.

An example of a situation where questions, communication, and input were suppressed with disastrous consequences is the Challenger incident [6]. The problem with O-ring sealing at low temperatures was well-known to members of the technical staff at Morton Thiokol. Although they expressed their concerns, they were not comfortable taking too strong a stand against the decisions being made by higher level administrators. The problem was exacerbated by numerous previous weather delays and therefore the short time frame desired for the launch; these events interfered with a more reasoned and questioning approach. The result was a catastrophe. Such events demonstrate that by discouraging questions or avoiding answering questions, we implicitly indicate that we have all the information necessary to make an informed decision. This conclusion is viewed by individuals with detailed knowledge about the situation as arrogant and closed-minded, and is an indicator that there is an unwillingness to listen to alternative opinions and established facts.

An effective leader asks questions even (or especially) when they are assured that no questions are necessary. That is, when raising questions to gain insight or understanding regarding a procedure or direction, a leader is sometimes told that there are no problems and everything is under control, or that progress is being made and the correct approach is being taken. This type of response should prompt more questions from the leader. For instance, there is virtually never a process or direction in place that is free of assumptions or prior biases/opinions. When such boundary conditions exist, justification for employing the current approach(es) should be questioned in an attempt to uncover unstated or unrecognized perceptions, new results, or directions in the field, biases, or assumptions. For example, the individuals responsible may have developed the current process and are protective of their accomplishments and beliefs or they may not be aware of recent developments outside their organization or field; alternatively, they may feel that interrogation of this well-established procedure calls into question the fundamental direction or culture of the team or organization. Strong opposition may therefore exist to the questions you raise. One of the biggest mistakes a leader can make is to accept at face value, even a trusted peer, boss, or subordinate assurance that a specific aspect of their responsibility needs no further investigation. Even if this turns out to be true, revisiting or reassessing the situation in light of current knowledge and understanding ensures that the best information has been brought to bear on the issue and thus that due diligence has been performed. However, when questions are raised regarding commonly and widely accepted precepts, it is particularly critical that the leader present his/her questions in a diplomatic and earnest manner where gain of understanding of the salient

issues is clearly the goal. This type of discussion sometimes uncovers new insight into, ways of viewing, and novel directions for a situation that can be characterized by "we've always done it that way."

7.2 Questions that Encourage Rather than Discourage

Despite the usefulness of questions to motivate and "stretch" employees' competencies and self-assurance, leaders must be mindful of the type of questions and the manner in which they ask questions to avoid discouraging others. That is, employees should be empowered and inspired by the questions posed. Examples of discouraging or demeaning questions include:

- Why haven't you made more progress with your project?
- Why have you failed to meet the deadline set for you?
- How could you have made that decision?

These questions seek to place blame and thus put the individual on the defensive; they are representative of ineffective leader approaches that were described in Chapter 2. More appropriate ways to ask the same types of questions that initiate a dialogue are:

- What limitations have you experienced on your project? How might these be overcome?
- Was the deadline for your project unreasonable? If so, what aspects were initially not taken into account?
- I would like to better understand why you took the approach that you did to address that problem. Can you explain the sequence of events to me?

Similar question types that place the employee in a lose–lose situation are queries such as:

- You agree that this is the direction the project should take, don't you?
- Does anyone disagree that we should abandon this project?

These are blatant attempts to force or at least manipulate the individual into agreeing with the leader; answers may therefore supply little to no useful, helpful, or truthful information. Effective leaders ask questions such as: what direction do you feel the project should take, or do you feel that this project should be abandoned or are there other directions to consider? This style of questioning shows trust, credibility, and respect for the individual and indicates that the leader is interested in

the knowledge that they bring to the team and that their views/opinions are valued.

Appropriate questions are formulated in a way that precludes simple yes or no answers or even direct answers. Rather, questions should be open-ended to incite discussions that reveal new information, directions, or insight, present the reasoning behind opinions and conclusions reached, and identify both subordinate and leader biases. In many cases, biases are unintentional and unrecognized, but crucial to the perception, interpretation, or issue under consideration.

For example, effective leaders solicit responses to queries such as:

- Why do we perform tasks or procedures in the way that we do?
- Are there better or alternative ways to accomplish the same goal? What are these and why would they be better or worse?
- What aspects of the project or process have not been addressed or considered?
- What is possible if we change our view/approach to the problem?
- What do you feel should be my (leader's) top priority and why?
- What do you like/dislike about your job?
- Are we as a team or organization going in the right direction; if so why and if not, why not?
- How could we improve our organization, team, accomplishments?
- How do you and others feel about recent changes to the team or organization?
- What is (are) the greatest limitation(s) you face in being able to accomplish your task(s)? How could these be best addressed?
- What could I do to facilitate your success professionally and personally?

None of these questions can be answered simply, but stimulate open discussion and consideration of different ideas and approaches. A particularly perceptive question, and one that demonstrates openness and transparency of the leader, is to ask a subordinate (or boss, peer) if they have any questions for you. Responses to this question can offer considerable insight into the primary issues on the subordinate's mind. If the person is unwilling to engage with you on this question, then you must consider why not. Does the individual feel uncomfortable speaking with you about general issues, is he/she concerned about repercussions, have you given the impression that only facts rather than opinions are of interest? Self-reflection and self-awareness are extremely helpful here as is input from a trusted mentor or advisor. Realization of shortcomings is critical to continued improvement of leader performance; such questions represent a way to access that information.

A most appropriate venue to introduce questions is when a leader supplies feedback to employees. For instance, rather than explain to the individual what improvements are needed in his/her behavior or accomplishments (i.e. criticize performance), first open the door for discussion. This can be done simply by considering each duty or responsibility that the employee has and asking how they would view their accomplishments, and if there are areas they feel could be improved? For each of these, a further question regarding how improvement can be achieved, and what you (the leader) can do to facilitate this process puts the entire evaluation on a professional and personal development path. We all recognize when we performed well and when we could have done better. Allowing the individual to bring up areas of concern to them permits a leader to mentor and help develop further, certain skill sets in a nonthreatening and nonconfrontational manner.

7.3 Caution When Asking Questions

Although the extensive use of questions in leadership is critical and can be extremely valuable, this is only part of the equation for a successful leader. The follow-up – **listening to understand, reconsider, and perhaps act** – is at least if not more important. Active listening (Chapter 2) invariably generates additional questions and insight and therefore supplies a deeper and more meaningful exchange and evaluation of information that may result in a different approach or direction. However, when leaders ask significant and revealing questions, but do not engage in active listening, subordinates as well as bosses and peers, view leader efforts as superficial and the effects derived will be negative. That is, if the leader has already made up his/her mind regardless of what issues are brought forth, then asking team members for their opinion and alternative suggestions is insulting. This type of behavior merely demonstrates that the leader is "going through the motions" to give the impression that others' opinions and ideas matter or that they desire alternative views when in fact, they do not. Leaders who take this approach frequently listen (halfheartedly) to the response to their question and then explain why the view, opinion, or alternative offered is incorrect or inappropriate. When leaders behave in this manner at meetings or discussions, the energy level of participants dissipates quickly; interest in the issue wanes; and employee hopelessness, frustration, and disengagement are the outcomes. Ultimately, this type of approach is guaranteed to result in the loss of respect and credibility for, and trust in, the leader.

7.4 Summary

Considerable information and knowledge exists with team members. If a leader feels that he/she should be able to address any issue or question that arises because they may otherwise appear incompetent, then he/she is not taking advantage of the expertise and experience of the team. Worse yet, he/she gives the impression that trust in team abilities and capabilities is lacking. The expertise can be unleashed if each team member feels part of the collective wisdom and insight that the team possesses and is encouraged to contribute. Furthermore, employees need to be empowered, engaged, credible, and valued if they are to contribute to the fullest extent possible. By asking open-ended questions, a leader indicates that he/she seeks input and suggestions and shows that he/she trusts and has confidence in team members. Provided that the environment is deemed safe to offer opinions and views, the team is thereby energized and their creative juices are released. This type of atmosphere fosters a "can do" attitude where challenges are accepted readily and interdependence is evident. Active listening is an important component of a questioning culture, since the leader must demonstrate his/her interest and confidence in team members. Such efforts build confidence, motivation, and initiative in employees. Questions can be encouraging or discouraging, so leaders must avoid asking questions in such a way that blame is being assigned. Open discussion where all suggestions, opinions, and comments are considered frees all team members to be innovative and creative. The leader must seriously consider and when appropriate act on responses to questions raised; otherwise, team members will feel that their opinions do not matter and that the leader is merely trying to appear interested in their input.

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The useful and helpful information content in the exchange with Sally is near zero. Both you and Sally should be disappointed in the outcome of this discussion. It is unlikely that you made a positive impression on her despite your attempts at engaging her and demonstrating your interest in her efforts. She most likely felt that you were "checking the box" to convince her that you were truly interested in **her** thoughts, accomplishments, and concerns.

A better way to have this conversation would be something like the following. I know that the oil–water separation process has been a focus of yours and I want to make certain that I understand more of the details of this potential advance. Can you describe each approach that you have investigated and indicate your thoughts and conclusions about them? Which do you believe are the most promising ones and why? What are the advantages and disadvantages that you have observed? What is unique about your approach relative to the existing methods? How can you be certain that you can meet the deadline next month that our VP has set for this project? Such questions show your interest in her progress and success and indicate encouragement and appreciation for her efforts. They also show your attempts to follow her work and to demonstrate that you find this work significant.

Homework Questions

1 You are serving as a mentor for a young scientist who has been at your organization for 1 year. He tells you that he is unable to focus on his assigned duties because he does not get along well with his boss. What sort of questions could you pose that would allow detailed and meaningful discussions of this situation?

2 A young engineer who reports to you informs you that she is going to turn in her resignation because the opportunities in her current position are very limited. What types of questions could you ask to assist her evaluation of current or future positions and opportunities?

3 Recall a time when you asked a question of someone with whom you were collaborating or who was reporting to you, that was meant to manipulate or ensure a specific answer. How could you have posed the question to elicit a more meaningful response?

4 An employee of yours expresses his frustration to you because he is not making progress with the project he has been assigned. What questions could you ask to help him assess this situation and plan a path forward?

5 How can you encourage and promote more insightful questioning on your team?

6 Out of frustration, leaders sometimes make negative comments to their subordinates. Examples of these are:
   a Why aren't you as good at running this process as Janice is?
   b Why did you even decide to take this job?

Formulate questions that address issues (a) and (b) but are stated in a less confrontational and demeaning way.

8

Creating a Vision

The greatest danger for most of us is not that our aim is too high and we miss it, but that it is too low and we reach it.

Michelangelo

… the first question for a leader always is: 'Who do we intend to be'? Not 'What are we going to do'?

Max DePree

Vision without action is a daydream. Action without vision is a nightmare

Japanese Proverb

The very essence of leadership is that you have a vision. It's got to be a vision you articulate clearly and forcefully on every occasion. You can't blow an uncertain trumpet.

Theodore Hesburgh

Logic will get you from A to B. Imagination will take you everywhere.

Albert Einstein

The founders of a start-up company set a very lofty, essentially unachievable goal, which led to a division among the employees: Some thought that this was a grand challenge worthy of effort, while others felt the goal was so ridiculous and unattainable that it was not worth their time or effort. The founders/leaders therefore devised an intermediate, but achievable goal. Groups of employees were charged with particular tasks that ultimately could be combined to achieve this intermediate goal.

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Published 2018 by John Wiley & Sons, Inc.

However, since resources were limited, the groups could not follow multiple approaches simultaneously, which minimized the opportunity to learn from unsuccessful directions, and thereby virtually eliminated the possibility of success. These circumstances led to an overall failure to meet milestones, loss of funding, and company dissolution. How should this situation have been handled by the founders/leaders? [Suggested approaches at end of chapter]

A leader must inspire and stimulate motivation in others if he/she expects to attract followers. The leader must craft and continually promote a vision that presents a great challenge but equally important, offers a purpose or reason for what will be done if others are to be engaged. The most successful leaders spend considerable time envisioning what the future holds and what it might look like for their team or organization. They consider the current state of their field or organization, pose questions regarding needs and directions, and thereby anticipate or wonder what the future might look like. Strong and successful leaders ask numerous questions for which they do not have answers (see Chapter 7) – such efforts promote new ways of thinking and acting and engage and energize others. Leaders must use the vision formulated to set directions and thus strive for the future.

8.1 Differences Between Vision and Mission

A vision ultimately allows coordination and alignment of activities within a team, across an organization, or even outside the organization. The purpose described attracts followers who are passionate, share the same beliefs or aspirations, and commit to and want to be part of the larger envisioned/imagined benefit that will result. That is, a vision is distinct from a mission that describes what will be or has been accomplished [1, 2]:

Mission: statement of purpose; indicates the basic intent and reason for existence of the group or organization.
Vision: offers a view of what the future could be; serves as an enabler to activate a group or organization to achieve that possibility; transformative to technology and/or society; exact path forward is typically undefined and the vision may initially appear unachievable.

Mission statements in particular are much maligned; in many instances, this response is warranted. They should not be vague nor longer than

20–30 words, and must indicate the primary focus and reason for the organization's existence. Attempts to indicate that the organization is "everything to everybody" or to garner attention by use of current political or social terms/issues, call into question the veracity and focus of the organization. Sadly, many mission statements violate these simple rules as is evident from inspection of mission statements offered on organization websites.

Since achievement of the vision formulated is not assured, the leader must have patience, optimism, and persistence, even in the face of minor or major failures. Without these attributes, enlisting and retaining followers will be difficult or impossible. The best way to describe a vision and the type of person who is considered a visionary is to first offer a few examples of individuals and their vision:

Henry Ford (~1908): produce simple, affordable transportation.
Bill Gates (~1977): place a personal computer in every home.
Steve Jobs (~late 1970s–early 1980s): create a computer that is a cross between art and technology.

Steve Jobs is a most interesting recent example of a visionary due to his attitude toward establishing a vision or direction for his efforts [3]. For instance, he did not believe in market research because he felt that the customer did not know what they wanted until they saw it. He remarked that:

> Our task is to read things that are not yet on the page.

Despite a personality that was demanding and sometimes abrasive, Jobs commanded considerable respect due to his technical ability and insight, charisma, and complete dedication to his vision.

Discussion Question

- Watch a few web videos about or by Steve Jobs and/or read biographical accounts of his life and leadership practices (e.g. Walter Isaacson's extensive biography [3]). Do you consider Steve Jobs to be a leader **based on** the various effective and ineffective traits and characteristics that we have discussed? Why or why not? At what traits did he excel? Which ones were lacking? Did he have significant failures? Was he enormously successful because or in spite of his limitations and failures?

A leader must recognize that despite his/her best attempts at predicting the future, many, if not most, of the prognostications will not come to

pass. For instance, a President of the Michigan Savings Bank told Horace Rackam, Henry Ford's attorney, in 1903:

> The horse is here to stay, but the automobile is only a novelty – a fad.

Similarly, Thomas J. Watson, President of IBM in 1943 stated that:

> I think there is a world market for maybe five computers,

and Ken Olsen, founder of Digital Equipment Corporation, claimed in 1977 that

> There is no reason for any individual to have a computer in his home.

Of course, many technological predictions are wrong simply because these predictions are extrapolations of the current state of technology. It is virtually impossible to envision what new discoveries may arise and what may be possible with these breakthroughs; such considerations make Steve Job's comment about reading things not yet on the page, particularly insightful. Clearly, the solid state diode and transistor bear no physical resemblance to the vacuum tube that initially served as a valve or switch in electronic circuits. For these reasons, successful technical leaders are always cognizant of and on the lookout for potential disruptive technologies that can replace existing products or processes and thereby generate novel applications. As a result, leaders must be adaptable, agile, willing to take a risk, and must move quickly when a promising new direction has been identified.

8.2 Vision Creation

What exactly is a vision and how can it be developed [1, 2, 4]? First, the vision can take two general forms: Personal or group/organizational. As discussed previously, it is critical for the leader to know himself or herself. This includes both the individual's values/beliefs, and what vision they have for themselves, their team, and their organization, because these affect how the leader will react or behave when placed in emotionally charged or other stressful situations. The discussion and methodologies described below will be broadly applicable to personal and team/organization vision development, since they require similar approaches although the intent is different. Specifically, a leader considers who

he/she ultimately wants to be and thus improves himself/herself personally, furthers his/her career, and enhances leadership skills to move toward the ultimate vision. This personal vision should be discussed with friends, family, and personal and technical mentors, all of whom can supply insight and encouragement. In developing a team or organization vision, the leader must first obtain general input from team members or others within or outside the organization regarding their concepts of the future. The leader then formulates a vision and vets it to the team along with a description of how this vision defines who and what the team is and most importantly, provides strategic guidance and planning for the team and each team member.

The following discussion focuses on the development of a vision for teams or organizations. However, it is imperative that leaders develop a personal vision to ensure that congruence between personal and professional vision exists. Unless equivalence is present, variations in professional versus personal values, beliefs, and priorities will reduce or inhibit commitment to the professional vision and lead to ineffectiveness and dissatisfaction with job responsibilities. Consistency also ensures that the leader recognizes who he/she is, and thereby can easily share aspirations and plans with subordinates, peers, and superiors, an act that will establish authenticity, trust, and sincerity with colleagues.

A vision is a brief (usually <25 words, although it may be longer depending upon the complexity of the message being offered) statement that is inspiring, captivating, suggests a novel way of thinking, and paints a picture or offers an image of the future, that causes others to associate with the grand challenge described, thereby engaging emotions and eliciting commitment. Most importantly, a vision describes core values/beliefs/purpose of the group or organization. It is critical that the culture within a team or organization is consistent with and thereby supports the vision in order to achieve buy-in and ultimately move the organization in the direction of the vision. An effective vision does not include generic statements such as "we want to be the best in …," or "we will achieve excellence in …"; **everyone** wants to be excellent or the best in their discipline. Rather, a vision clearly differentiates what the organization aspires toward, distinct from others in the same field. A vision must be ambitious and enduring; a set of goals with specified timelines should not be the intent, although there certainly must be small steps taken as progress toward the vision occurs. The vision should not focus on the details and individual steps or goals; leaders and followers must imagine what a product, organization, society, and so forth, will become as the vision is approached.

After formulation, the vision should be shared with those who will have responsibility for and will promote the vision to obtain feedback

and ensure involvement. Part of the input sought from the group/organization is an assessment as to whether the vision represents a new, significant, and worthwhile direction and aspiration. Such discussions allow improved understanding of the vision and its context as well as establish a shared vision with ownership borne by all members. The leader should also describe the previous achievements of the group/organization involved; such efforts establish the positive base to justify undertaking the grand challenge and thereby offer an indication of why all team members should support this undertaking. It is critical that the leader describe how each team member is expected to contribute to the stated vision and how their responsibilities are critical to overall success. The leader must continually refer to the vision to ensure that this remains the guiding principle for subsequent efforts and connect individual goals to the larger vision.

The leader must also be aware of potential difficulties and worst case scenarios related to the vision in an attempt to avoid being blindsided if new information is uncovered, or a change in short-term goals or current direction is needed. Describing potential problems to the team demonstrates leader credibility, dedication to the overall vision, and an interest in input that can facilitate problem solution. After proper vetting of the vision within the group of individuals who will be working in this area, considerable insight can be obtained from vision presentation to selected technical and nontechnical individuals outside the immediate focus area. Feedback from such communities often uncovers different perceptions and reactions to the vision than those from people with background in the particular subject.

A specific route to realize or move toward the vision is neither defined nor should it be – envisioning the destination is the important part. The leader must allow innovative directions and ideas to surface and be pursued, which will enable progress toward the vision. Motivation builds when the followers' passion and drive take over; the ultimate result may be men and women who do things that are out of the ordinary, sometimes referred to as outliers [5]. These individuals recognize accidental or extraordinary opportunities and take advantage of them when given a vision of what the future could be. The leader's role at this point is to be patient and ensure that the group embraces the vision in their activities to avoid too many nonproductive tangents. Since serendipity often plays a positive role in solving difficult problems, it is healthy to allow some latitude for unexpected discussions, discoveries, and associations. Although the leader must not direct detailed group activities, he/she should offer guidance and assistance as needed by setting shorter-term more specific goals as the vision is pursued.

8.3 Summary

A leader must develop and pronounce at every opportunity a vision of what he/she believes the future could be. This should not be a specific goal within a particular timeframe. Rather, the vision should describe a purpose for the organization that is inspiring and incites emotion, passion, and engagement in both the leader and the followers, because dedication and perseverance will be critical as various paths toward the vision are pursued. Responsibilities of each team member that allow progress toward the vision must be communicated clearly so that each understands his/her role; this supplies motivation and allegiance to the effort. No detailed directions should be offered. The creativity and commitment of the individuals should drive progress and ensure continued dedication. That is, the vision should be enduring and represent the core values, beliefs, and destination that are associated with the leader and the organization. The vision will serve as a means to coordinate activities and ensure that members are involved.

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The founders/leaders should have better planned their approach and then shown decisiveness to follow the plan but allowed deviation as further information/insight was generated. They must develop a reasonable focus and make decisions based on the specific focus established. When directions and focus are continually changed, uncertainty reigns and lack of confidence/trust in the leadership results. If an essentially unachievable goal is set, then the reasons for this must be clearly explained to the employees so that general agreement (or agreement with slight alteration

of direction) that the outcome will be worth the short-term frustration is established. That is, the leader(s) must describe what the team will "win" when they are successful to create enthusiasm and excitement; such discussions also allow concerns raised by team members to be addressed and perhaps variations on the original proposal invoked. The founders/leaders must be confident but willing to listen to valid feedback and input that anticipates major problems. There must be a clear path forward with well-defined stepping stones to evaluate whether success is looming. They must be willing to change direction when the results warrant.

Homework Questions

1 Select an individual whom you consider to be a visionary. Discuss the visionary's background (credentials, experience), the specific vision developed, how realization of the vison altered previous paradigms in this field or developed a completely new approach/direction, and the ultimate impact the vision has had or is likely to have.
- **a** Did this visionary have major impediments or failures in his/her life or career?
- **b** How did this person overcome such setbacks and how did these ultimately affect his/her success?

2 Devise vision statements for your life, your family, and your career.
- **a** What personal traits could hold you back as you consider the visions you developed for these segments of your existence?
- **b** How can you address these limitations?
- **c** Are there circumstances beyond your control that can affect your ability to pursue those visions? What are some of these and how do you handle such barriers?

3 If a leader proposes a technical goal associated with a vision that is either (i) easily met or (ii) virtually impossible to meet under any timeframe,
- **a** How will his/her (potential) followers view the leader in cases (i) and (ii)?
- **b** What will likely be followers' reaction to either immediate success or unachievable success?
- **c** How can a leader best propose a vision that will be motivational and accepted by his/her followers so that they remain committed and engaged?

4 Look up mission statements for five technology-based companies that serve different markets.
   a Which of these are inspiring and meaningful? What was it about these statements that caused you to feel this way?
   b For the ones that are not meaningful, why is that the case? Are any of them demotivating and simply useless? Why? How could you change these to be more effective?

5 Look up vision statements for five technology-based companies and answer the same questions posed in Homework Question #4 above.

9

Team Building and Teamwork

A team is a reflection of its leader.

Sunday Adelaja

The ability of a group of people to do remarkable things hinges on how well these people pull together as a team.

Simon Sinek

A group becomes a team when each member is sure enough of himself and his contribution to praise the skill of the others.

Norman S. Hidle

A major reason capable people fail to advance is that they don't work well with their colleagues.

Lee Iacocca

An R&D team is comprised of a team leader, project managers, operators, and technicians. The team leader demonstrates little regard for and spends no time with the operators and technicians as he feels that they are beneath his stature and that their job is to perform the work requested. The technicians and operators are assigned a higher workload than is reasonable for a 40-h work week; they do not appear to be interested in the work assigned, leading to the implementation of "short cuts" to meet the demands of the managers and leader. Since this approach leads to problems in generating reliable and reproducible data, new directions and experiments were constantly requested, resulting in still higher workloads for the operators and technicians. What should the leader do to address the issues that have been created? [Suggested approaches at end of chapter]

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

Much of the work performed by engineers and scientists is done as part of a team or group. Numerous definitions of a team exist, but one that is particularly insightful is [1]:

> A group of people with a full set of complementary skills required to complete a task, job, or project. Team members: (i) operate with a high degree of interdependence; (ii) share authority and responsibility for self-management; (iii) are accountable for the collective performance; (iv) work toward a common goal and shared rewards. A team becomes more than just a collection of people when a strong sense of mutual commitment creates synergy, thus generating performance greater than the sum of the performance of its individual members.

This is the type of team that leaders hope they can assemble and guide. To have a team that abides by the above definition, the team members must first trust the leader (and vice versa), trust each other, behave with integrity, and feel responsible/accountable for team success and failure. These attitudes begin with commitment to and passion/energy for a common vision and goals. Members must treat each other fairly, communicate clearly, and have the best interests of the team and organization at heart. Team members must be open to new ideas and directions, listen carefully to each other's concerns and suggestions, and practice shared leadership. A team that functions in this way is effective, maximizes each member's strengths, and perhaps most importantly, minimizes the members' limitations and weaknesses. When these characteristics are not present within the team, interactions among members are often hostile, defensive, and competitive, resulting in anxiety, disengagement, and inefficiency. Such dysfunctional behavior inhibits progress and effective decision-making and creates an unpleasant working environment.

How can a technical leader facilitate team operation in the manner described by the previous definition? A leader is ultimately responsible for group accomplishments and thus has somewhat different duties/responsibilities than do other team members. However, the leader must ensure that he/she functions, and most importantly is viewed, as a team member rather than a task master. The leader must serve as a role model and thereby set an example and standards for group behavior and expectations. He/she should be cognizant of his/her position in the hierarchy, and how that may affect the manner in which subordinates interact. That is, subordinates typically mimic the behavior and attitudes of the "boss," whether this is good or bad. An approach of "Do as I say, not as I do" is unreasonable and unproductive for a technical (or any other) leader. Feedback on progress (or lack thereof) should be offered to subordinates

on a regular basis (a yearly or even bi-annual review is typically inadequate) to clarify expectations and offer guidance and assistance as and when needed (perhaps weekly or monthly). Extensive discussion and "operating manuals" have been offered for effective (and ineffective) team building and teamwork; see for example, Refs. [2–4].

In some situations, teams are formed and disbanded on a regular basis. That is, teams can have short lifetimes because they are sometimes created to address a particular problem; when that problem has been solved or is no longer relevant to the organization, the team is dissolved. Such demands indicate that a leader may form teams continuously and therefore must effectively organize and manage numerous personality types, skill sets, and problems, all of which change frequently.

When formulating and leading teams, multiteaming is typically invoked [5]. In this concept, team members are assigned to and function on multiple (often 5–10) projects and thus teams. Such approaches offer a number of advantages, including (i) efficient and effective use of critical technical skill sets on a variety of projects, (ii) obviate the need to hire additional personnel and thereby reduce costs, and (iii) application of experiences and knowledge generated to multiple projects. However, this type of assignment creates considerable difficulties for leaders. These include (i) establishment of priorities and thus time management/coordination for an individual assigned to different teams is challenging for the individual and the leader; (ii) development of effective personal interactions, trust, and team engagement during continuous movement among teams is difficult; (iii) heightened stress and burn-out due to multiple commitments occurs; and (iv) reduced incentive/motivation on any task is experienced due to continual switching among projects. To address these acute problems, leaders must effectively communicate and coordinate personnel, both with the other team leaders as well as with team members. In addition, leaders must show appreciation and acknowledge effort routinely for outstanding performance to keep everyone engaged and focused on the numerous objectives that are part of multiteaming.

A team leader must be a role model; communicate clearly a reasoned vision/mission/goal for the team; and display passion, drive, and a positive attitude, even (or perhaps especially) when the difficulty level is high. Clear duties and responsibilities for each member must be articulated along with how these assignments contribute to the entire effort. Success is difficult or even impossible to achieve if expectations are unclear. Recent changes in priorities and directions of the organization should be communicated to the team members to allow concerns to be raised and ensure a common knowledge base for decision making within the team.

An effective leader insists that all ideas and suggestions regarding how to achieve the vision or goal(s) be considered seriously rather than

dismissed summarily. That is, a leader's demonstration of respect and consideration for others is critical if the team is to behave in this same manner. One way for the leader to describe the type of conduct desired is to indicate that the proper way for team members to interact is to **listen first, understand second, speak third**. This sequence demonstrates respect and open-mindedness regarding different opinions, and makes clear the behavior expected within the team/group. These dialogues or differences of opinion must focus on the issues being discussed rather than personalizing comments or criticism to minimize the possibility that egos become engaged. As an example, the leader should avoid asking questions such as how the individual could possibly believe that their statement is true; instead an effective leader asks for additional information to help them understand the logic behind the statement offered. Furthermore, it is essential that the leader develop a "thick skin" to criticism or rude remarks/statements so that he/she is not easily offended. Criticism should be evaluated with respect to the veracity of the remarks and then reasoned responses offered. That is, the content of rude comments should be considered to determine if there is validity to the intent, even if the mode of delivery is inappropriate. Emotional reactions by the leader based on anger or frustration can only escalate the situation; self-control is crucial in such instances.

A leader can often elevate comradery and a sense of belonging by describing team or organization history and successes. Discussion of previous failures and how the team recovered from or dealt with these also builds cohesiveness and resolve and demonstrates that the leader is not intimidated or hindered by failure, but uses such outcomes to devise alternative directions. Such conversations are also useful to ensure awareness of mistakes that led to failure; this identification and recognition verifies that a repeat of the same mistake must be avoided.

A leader ensures that the team is composed of individuals who have relevant knowledge for and varied approaches to undertaking the task or goal. This means that individuals with direct knowledge are engaged along with individuals who are not experts in (or perhaps have little familiarity with) the specific area or have different views of the problem; diversity of views/ideas is crucial, because this offers the opportunity to identify creative directions, concepts, and solutions. An effective leader seeks team members who are technically competent, perhaps more capable than the leader; this requires that the leader put team demands ahead of his/her ego to assemble a group that is capable of performing the tasks desired. The leader must engage and employ the different talents that the team possesses. This leader ability and its importance have been described by Jim Collins [6] who used an analogy to the driver (leader) of a bus (organization) where the driver/leader must decide who should be on the

bus, who should be off the bus, and must ensure that everyone is in the right seat. That is, selection of the appropriate vision and goals cannot overcome second-rate team members. A high-functioning and collegial team requires competent and motivated individuals, the correct/essential skill sets, division of duties according to which team members are best suited for different tasks, and clear team member responsibilities and goals. When these criteria are met, the best performance from individual members as well as the collective team will be achieved. Such delineation allows each team member to contribute to team success and thereby feel satisfaction from and comfort in their role. Many bureaucratic procedures are established to ensure that everyone has taken responsibility for and is acting in the best interest of an organization. When the appropriate team/organization members have been assembled, little bureaucracy is needed [7]. Rather, discipline is displayed by each person in that they take responsibility for achieving the vision and goals, while the leader allows reasonable risks to be taken provided that the potential to attain the goals exists [7].

Discussion Question

When building your team to attack a difficult technical problem, you need the expertise of an employee who has an extensive and impressive skill set, and numerous accomplishments relating to the problem at hand. However, this person is extraordinarily difficult to deal with, is a nay-sayer, is confrontational, and alienates those around him.

- Should you enlist him for the team?
- What are the consequences if you do or do not enlist this person?
- How does an effective leader deal with such individuals?
- What measures can you take to encourage everyone in the team/group to help or support each other?

9.1 Hiring or Appointing the Right Team Members

How does a leader assemble the "right people" so that an effective and successful team is formed? Since team membership may change depending upon the specific problem being addressed and the emphasis within the organization at a given time, hiring people who are capable and can contribute broadly irrespective of the type of problem currently of interest is essential. If you feel that you are the most capable person on your team, either you are extremely arrogant, or you did not hire well. The intent

should be to hire individuals who are more talented than you are, at least in certain areas, and thereby raise expectations, identify new opportunities, and enhance potential accomplishments.

On occasion, someone may be needed with a very specific skill set. When this is the case, this individual should be someone with a strong fundamental technical background, interests that are broader than the narrow skill set desired at that time, high motivation level, and good people skills. These are critical attributes, because hiring an individual who does not possess these traits can be disruptive. That is, they may not contribute substantially to the technical efforts and may disturb the smooth and effective operation of the team. This wastes time and resources, is frustrating to other team members – especially the leader – and establishes an unpleasant working environment.

A resume or curriculum vitae indicates the pedigree of an individual along with their experiences. Although both pedigree and experiences are critical and may be impressive, other factors may be more important in assessing a good fit for a team. For instance,

- Is the individual someone who would contribute to team comradery and interactions; does he/she refer to previous accomplishments as "we succeeded" in this effort, as opposed to "I succeeded"?
- Have they developed the talents and skills that they possess at present or have they depended solely on the abilities they inherited at birth?
- Are they curious and interested in learning?
- Have they taken advantage of a variety of opportunities to broaden and deepen their abilities and knowledge base?
- Do they have confidence in their abilities?
- Have they undertaken significant new (to them) challenges?
- Have they learned how to deal with high stress levels?
- Have they learned how to deal with failure?

A person who has taken a big risk and failed is sometimes an excellent team member relative to someone who has never failed, provided they learned from the failure. Dealing with failure and recovering from it are marks of maturity. In fact, interviewers often ask questions related to challenges and failures experienced by the interviewee to assess the motivation and resilience of an individual and their ability to learn from new opportunities and failures.

Diversity in approaches to problem description and solution is beneficial on a team to ensure that a variety of viewpoints and methodologies are considered; such differences frequently yield creative outcomes. Some individuals solve problems by adapting their approach using logic to meet the conditions of the challenge, while others innovate and use unconventional techniques to achieve solutions. These somewhat

disparate approaches have been labeled by Kirton [8, 9] as adaption and innovation – they could be considered as engineering and scientific styles of problem solving, respectively, although this is too simple a demarcation since engineers can be innovators and scientists can be adapters. The distinction is made for general labeling purposes since most technically trained individuals apply one or both of these approaches according to the problem that must be addressed. In general, adaptors emphasize problem solution using standard, well-proven methods, while innovators seek original and sometimes unusual resolutions. Often, innovators generate additional questions and insight which can facilitate unexpected benefits and directions. Of course, innovators may not conform to the usual team member interactions and approaches involved in collegial behavior, thereby offering leadership "opportunities" through the resulting challenges to team cohesion and operation.

Different personality types are beneficial (as described in Chapter 2) on teams since the varied outlooks and attitudes often inspire new directions and identify or anticipate difficulties. Teams benefit from nay-sayers or pessimists because they motivate others to rethink their ideas and biases and thus can stimulate re-evaluation and change. Perhaps most importantly, these individuals force highly critical evaluation of current ideas and proposed directions that when not assessed fully and appropriately, can lead to considerable wasted time, effort, and possibly failure. Of course, the benefit provided assumes that the nay-sayer is not particularly rude or arrogant in his/her approach such that other team member comments or ideas are repressed. If this is the case, then the leader needs to moderate the nay-sayer by making clear the important issue raised, while downplaying the delivery. A one-on-one discussion with the nay-sayer may be required to ensure that this individual recognizes the effect his/her behavior is having on the team. Despite the advantages of nay-sayers, too many of them is not an improvement to team effectiveness, since an entire team of nay-sayers will result in chaos and likely little to no progress toward goals.

The leader should not depend only on strong (outspoken or extroverted) personalities, highly charismatic members, or high-profile individuals to ensure that the team will be successful. Although these team members may be very important to team success because of the skill sets that they possess, they may also generate discord that is detrimental to team effectiveness and requires considerable time from the leader to address the issues created. Collegial team players, shared leadership, and "can do" attitudes are requirements for effective operation. These attributes are especially important when failures occur or technical results are negative. Such scenarios will be a true test of a highly functioning and supportive team, and demand that the leader remain positive and in the

extreme, be willing to alter the current path or even goals despite any personal (strong) feelings he/she has.

9.2 Leader Approaches to Effective Team Operation

A leader exercises transparency in all operations and decisions; this engenders trust and credibility. A constructive leader demonstrates that he/she is a strong supporter of team members and rewards them, tangibly and verbally, at every opportunity. A simple coffee and donuts social gathering to celebrate specific successes, builds morale and job satisfaction. Even the celebration of incremental accomplishments on the way to achieving a much larger goal has a positive effect on team member attitude and confidence. Such actions indicate that the leader has confidence and pride in the team, shows recognition for members' contributions, and promotes the cohesive nature of the team. In addition, an effective leader takes responsibility for mistakes made by his/her team members. This action builds trust within the team and demonstrates that the leader is indeed a team member, thus succeeding and failing with the team. Of course, discussions with the individual are needed to understand why the mistake occurred and to determine how to avoid this situation in the future both for the individual and other team members.

As mentioned previously, an effective leader need not be an extrovert who is highly visible and dominates discussions. When an extrovert wants to be in control, he/she may not listen carefully to or even consider alternative views [10]. As a result, he/she can overlook more suitable approaches to or does not benefit from discussions that may uncover different (and better) ways to address a situation. Extroverts are most effective at leading teams whose members are somewhat passive and thus hesitant to take charge [10]. When a team is able and willing to take the initiative needed to meet a problem "head-on," an introvert may be the most appropriate leader type, since they encourage and trust their team members to assume authority and accountability.

Technical teams share many commonalities with other types of teams. Numerous analogies have been offered with sports teams. For instance, Jerry Lynch [3] specifies 10 building blocks of a strong (sports) team culture; these traits have already been discussed in some detail with respect to technical leaders:

- Commitment
- Responsibility
- Accountability

- Integrity
- Respect
- Trust
- Leadership
- Courage
- Service
- Humility

Discussion Question

- One of your team members is highly creative but lacks the ability and interest in implementing her ideas. Another team member lacks creativity, but she can devise a way to test, assess, and implement any idea proposed. The personalities of these two individuals clash inhibiting their ability to work together. How do you take advantage of these two talented individuals to enhance team performance?

Such characteristics are also prevalent in successful (and absent in unsuccessful) political teams. One of the most phenomenal examples of team building and leadership was displayed by Abraham Lincoln after being elected President in 1860 [11, 12]. He served as President from 1861 to 1865 and is widely considered one of the most effective US Presidents in history. Against the strong opposition of his advisors, he appointed his adversaries (those who ran against him for the Republican Presidential nomination) to top cabinet posts because he wanted diversity of opinion. Lincoln relied on his integrity; collegiality; confidence; ability to persuade rather than coerce; and adeptness at recognizing the desires, motives, and feelings of others to build trust and therefore deal effectively with difficult and contentious situations. He did not allow strong opposition toward his efforts to destroy his resolve, confidence, and belief in doing the right things. He maintained a calm demeanor rather than acting in anger, frustration, vengeance or spite, and thereby convinced his detractors of his point of view by reasoned arguments, or achieved problem resolution via compromise. The conversion of those who were initially his "enemies" was made possible by his kindness, moral compass, honesty, compassion, and his willingness to share credit but accept blame. This level of character and inner strength are rare, but are attributes that all of us should seek and develop.

Lincoln abided by clear principles and actions that are beneficial for all, including technical, leaders. He strongly promoted close interaction with subordinates, which he referred to as "circulating among the troops"; this

has been described in technical circles as "management by walking around" [13]. In today's world, face-to-face meetings are often downplayed in favor of emails due to the time required and the inefficiency of speaking with only one or two people at a time. Time efficiency may improve with email; international teams make face-to-face meetings much more challenging. However, when possible, meeting with subordinates one-on-one, in their work environment, frequently uncovers their personal insight and concerns that they may avoid expressing in any other venue. This is an opportunity to ask questions about how to improve the team and/or organization, what perceptions exist outside your office, and how each employee is doing in their life and career. Furthermore, such actions demonstrate to those reporting to you that you are interested in them and their opinions/views, thereby building credibility, trust, the feeling that you are all part of the same team; ultimately, this results in improved employee engagement. Since "virtual" or dispersed teams do not have the advantage of close personal interactions, discussions, and social time, building trust and credibility among virtual team members is challenging [14]. Especially in this situation, personal knowledge of team members, even if not achieved by face-to-face interactions, is critical to high-functioning teams, because facial expressions and body language are difficult to discern, despite the use of video conferences.

Lincoln believed in preaching a vision, setting goals, practicing innovation, acting decisively, and having sufficient courage to deal with unjust criticism. He felt that it is critical to become proficient at public speaking whereby you can influence others by dialogue and telling stories.

Another example of a diverse team is the "Intel Trinity" [15]. Intel founders Bob Noyce and Gordon Moore, along with Andy Grove made Intel into an extraordinarily successful company. Each of these individuals had quite distinct personalities. For instance, Noyce was a physicist and was the person who appealed most to the creative, high-tech, science community. Moore was a physical chemist who was a strategist and extremely collegial. Grove was a chemical engineer who was highly organized and a hard task master. As might be expected, Noyce and Grove seldom saw situations in the same manner. Such conflict is not unusual due to the different perspective that highly creative individuals bring to problems, in contrast to individuals with manufacturing duties and mindsets. Although disagreement was frequent, Moore ensured that the team functioned effectively, and all three made difficult decisions with a view toward what was best for Intel. The ultimate success achieved by this team speaks for itself; Intel is one of the world's largest semiconductor chip manufacturers and the inventor of the microprocessor family used in most personal computers.

Discussion Question

Diversity is beneficial and thus desired when forming a team. The current connotation of this term implies gender and ethnic diversity. However, there are other types of diversity.

- Identify other types of diversity that could be considered when building a team.
- How do these additional types as well as gender and ethnic diversity contribute to the effectiveness and potential accomplishments of the team?
- Can the various types of diversity introduce challenges insofar as running a team/group is concerned? Explain.

Due to the importance of teams in problem solving, considerable effort has been expended to establish why some teams are more successful than are others. Google performed an extensive study that addressed how a "perfect" team could be built (see Homework Question #4 at the end of this chapter). Other efforts focused on identification of the causes for intelligent and effective teams. Specifically, investigation of how different teams addressed a variety of problems led to several interesting conclusions [16–18]. Contrary to expectations, teams with higher average IQs or higher motivation level did not stand out as the most intelligent or successful teams. Rather, the higher performing teams showed enhanced "collective intelligence" which was correlated with several characteristics: equal contributions to team discussions among members, ability to assess emotional state(s) of others, and the fraction of women on the team [16–18]. The authors note that the presence of more women on the higher "collective intelligence" teams is in part due to the heightened awareness and sensitivity of many women to social interactions. Such conclusions are consistent with the fact that the most effective teams have diverse personality types, regardless of gender.

As discussed previously, time is an important parameter for everyone, but especially for leaders. With multiple team members, a leader must decide how to allocate his/her time and effort while ensuring awareness of and input into the accomplishments of all team members. Leaders often chose to offer more assistance to those team members who are struggling to meet their goals and obligations. A contrarian view of this situation has been stated succinctly as:

> … one moves a group's mean performance to a new plateau by motivating the high performers, not by rescuing the low performers [19].

This leadership style may seem cold and divisive, and carried to an extreme, it can be exactly that. However, this tactic can be viewed and employed in a positive way. Each team member has been selected because they bring specific expertise to the problem(s) being addressed. By placing more emphasis on improving team members' strengths rather than their weaknesses, individual and thus team performance, often improves significantly [19–21]. Considerably more effort must be expended to improve someone's performance in a particular area from poor to good, than to change a good performer into an excellent one. Further development of strengths also enhances confidence, motivation, effort spent, and accomplishment level; that is, people typically work harder and enjoy more, tasks and opportunities where their probability of success is higher. A team with complementary skills where each person has advanced from very good to outstanding in his/her primary talent, is a high-functioning entity with great confidence in their own and each other's ability to achieve. An effective leader will recognize and develop individual members' strengths, even when these strengths are not apparent to the team members.

9.3 Cross-Cultural Teams

Due to globalization, current and future teams are and will continue to be cross-cultural. The varied approaches, backgrounds, and experiences of the members are extremely valuable because they offer alternative ways of thinking and promote synergy that expands the opportunity for novel and innovative ideas and directions; this results in unique solutions to technical problems. However, this diversity can present impediments to effective and efficient team operation if the leader does not understand and value differences among team members. These issues are particularly important for meetings in which attendees are not in the same room and so lack the face-to-face interactions that allow enhanced insight into and awareness of each team members' viewpoint; more will be said about this when running effective meetings is discussed. Different cultures represent variations in values, beliefs, worldviews, active behaviors, and the nature of interactions, leading to misunderstanding, disagreement, and therefore conflict [22, 23]. Such diverse viewpoints must be recognized and appreciated by the leader who must focus on communicating a clear vision and technical goals that transcend cultures. Even when this is accomplished, different cultures have different views of leaders, their responsibilities, authority, and attitudes with respect to team and organization members. Depending upon their culture, employees may defer to the leader for ideas, new directions, and a well-thought-out plan or strategy rather than offer their own suggestions and critiques; this posture varies depending upon the country and thus the

culture represented. Different cultures also have different expectations with regard to how decisions are made and the level of risk that is acceptable; specifically, dictatorial approaches are common in many cultures (more will be said about this in Chapter 10 when decision-making is discussed). Such tactics may be especially important for technologies where rapid changes are occurring. In other cultures or different technical areas, consensus building is the prevalent methodology. Irrespective of the array of cultures (or technologies) represented, the focus should be on the vision and mission and thus on what responsibilities each team member has that contributes to goal achievement. When the team subsequently succeeds, confidence develops in each other's abilities, and dedication to the team is heightened because of joint accomplishments. Trust and credibility among members are thereby enhanced, which allows more effective functioning of the team.

9.4 Collegiality

Collegiality is defined as cooperative interaction among colleagues, a condition that leaders need to develop within their teams or organizations. When present, collegiality yields numerous positive outcomes. Specifically, it promotes effective communication of ideas/expertise, teamwork/collaboration, creativity, responsibility, willingness to change and take risks, and support for other team members; in addition, it lessens divisiveness. That is, collegiality is a necessary part of a well-functioning and engaged team that leads to team member satisfaction and loyalty to the team and to each other.

Discussion Questions

- You are the team leader responsible for developing an environmentally benign method of waste disposal. Most team members are quite collegial and interact effectively. However, Dan and Jose bring out the worst in each other. They argue over trivial as well as substantive issues, significantly disrupt decision-making at every point in the process development, and are now affecting team morale. How do you overcome this problem and ensure that team progress on the task is not affected?
- You have been assigned as leader to an existing team that is dysfunctional and nonproductive. Unfortunately, no opportunity exists to add personnel to the team membership. You are asked to alter the course and attitude of the team to enhance their achievements and add value to the organization. How might you accomplish this goal?

How does a leader establish and maintain collegiality within the team? First, a leader must demonstrate that he/she is collegial by actions and attitudes; this sets the tone for interactions within the team. Trust, respect, and support among team members are critical and begin with the leader. Discussions, decisions, disagreements, and mistakes must be handled honestly and with transparency; such team dynamics should be modeled and demonstrated by the leader who is responsible for promoting and managing appropriate behavior. Likewise, disagreement with other team members' views and beliefs must be described respectfully and with the intent to understand the basis behind the differences. Common vision or goals should be established and communicated clearly to ensure buy-in and engagement. Criticism must be constructive in that concerns should be directed at the ideas or concepts offered rather than at individuals. In addition to recognizing accomplishments by individuals, the team or group should be acknowledged. If the leader is able to select or hire individuals for their team, collegial personalities should carry weight in the final decision; that is, is this person someone whom we want to be a team member and will they add to the comradery, professionalism, and sense of cohesiveness?

Team members should serve as mentors for each other either informally or through assignment by the leader. Frequently, we think of mentors as senior people who guide and offer insight to less experienced members. Although this is certainly one type of mentor, at every stage of our careers and lives, we need mentors to supply perspective, serve as sounding boards, and thereby assist our continuing professional and personal development; elder statesmen or stateswomen are not the only category of individuals who can supply these essentials. Mentoring activities build cohesiveness, trust, and loyalty and therefore job, career, and personal satisfaction for the mentee and the mentor.

Discussion Questions

- When a team/group is making a decision (e.g. hiring personnel, eliminating particular technical efforts) or considering a change in procedure/process (e.g. implementing new training procedures, merging with another group) acceptance of the decision/change by all team members is desired.
  TRUE or FALSE: If a group of people are collegial, they will agree on a proper/appropriate solution or decision for a specific problem or issue. Explain.
- How can the collegiality of a group of individuals be assessed? What can you do to enhance this characteristic of the team?

9.5 Motivation

An effective team displays high motivation, engagement, and drive. Although leaders cannot directly motivate individuals (only the individual can decide to be motivated), they can establish an environment that allows motivation to flourish, which facilitates this trait in their subordinates [24]. As mentioned previously, everyone is motivated – the claim that some people are not is specious. However, the individual may not be motivated by the current circumstances, vision, goals, values, assignments, or reward system, and thus is not contributing to team progress. This means that the leader must identify goals and assignments that resonate with that individual's personal and professional interests and needs and determine how to meld these with team and organization demands. Accomplishment of such intent is dependent upon the leader's ability to know and understand those who report to him/her. Equally important is the leader's willingness to allow employees to know him/her. This type of personal interaction also promotes trust in and loyalty toward the leader because the employee views the leader as a "person" rather than only a boss. In addition, such behavior promotes the feeling that the leader has the individual's personal and professional interests at heart.

Motivation is and should be considered a positive trait. However, when motivation and ambition are too high, with little to no regard for others, negative consequences result. Highly competitive individuals can destroy or at least challenge collegiality and smooth operation of teams or organizations. The reasons for this are numerous, including their own and others' expectations for the level of achievement desired; this can lead the individual to strive for success at any cost. In addition to establishing an unpleasant work environment and frustration for the individual and team members, this behavior results in a loss of trust within the team and presents a challenge for leaders. Under these circumstances, the leader must discuss this situation with the individual to better understand the reasons for his/her behavior. A plan can then be formulated to satisfy ambitions while meeting team needs.

An effective and successful leader knows, recognizes, and values each employee's experiences and roots. Such knowledge is essential to understand what motivates, and perhaps most importantly demotivates, individuals. An interesting discussion of the stark differences in motivating factors in distinct age groups has been offered by Bennis and Thomas [25]. Life experiences are sometimes due to actions taken by the individual. In other cases, the experiences are thrust upon them. For instance, occurrences such as a world war, economic depression, extreme poverty, or family crises, imbue individuals with attitudes and outlooks that seem to others who have not experienced these events, odd or illogical.

However, such catastrophic episodes color the way these individuals view and interpret situations and make decisions; often, these events determine their responses to circumstances. In addition to differences in individual personalities and experiences, different generations have varied expectations for their life and career, view authority differently, and have wide-ranging priorities. Appreciation of these distinctions can minimize or perhaps eliminate conflict and misunderstanding within teams; at the very least, recognition of the differences can establish paths to deal with disagreements in an open and calm manner. Engineers and scientists should relate well to these effects, since they are frequently considered odd or pedantic when they express certain opinions and offer their views to nontechnically trained acquaintances or co-workers.

Excellent examples of the wide variation in expectations, aspirations, and thus motivation of two disparate groups of individuals have been discussed by Bennis and Thomas [25]. They contrasted the concerns, attitudes, and motivation of geeks (born in the 1970s) and geezers (born in the 1920s) when each group was in the 25–30 age category. This study demonstrated clearly the challenges involved, and why leaders must recognize and understand how particular circumstances and incidents motivate specific team members if harmony in decision-making and goal-setting is to be achieved. For instance, geezers wanted to earn a good salary and have stability and security in their employment, whereas geeks desire personal wealth and expect that change and impermanence will be the rule. Rather than viewing employment as a way to make a living (geezers), geeks want to change the status-quo, have impact, and receive recognition. Geezers strove to start a family and expected to enjoy life in retirement. In comparison, geeks want to establish their career and achieve work/life balance throughout their careers. Finally, geezers felt considerable loyalty to their employer, expected to be rewarded for this commitment, and gratefully took advice from the previous generation(s) to assist their decision-making and planning. In contrast, geeks often do not feel loyalty toward their employer because they are not convinced this is reciprocated, want to be their own boss, and wonder if the previous generation(s) had the correct perspective and direction.

Since the publication of Bennis and Thomas' work [25], considerably more has been written concerning the complications experienced when multiple generations of workers are present on teams and in organizations. Currently, there are three (or four depending upon how the groups are defined) noticeably different age/generational groups employed in nearly all organizations; detailed discussions of the characteristics and motivation of these groups along with the problems that arise and potential approaches to ensure effective collaboration and interactions among

the groups are available (see, for example, Refs. [26–32]). The specific idiosyncrasies associated with each member of this eclectic combination makes effective leadership difficult to navigate. This point can be most easily understood by looking briefly at the disparity of traits that have been identified with the various age groups [26–32]. It is important to recognize that a strict categorization likely misrepresents the situation because not every individual associated with a particular generation has the same values, beliefs, and priorities. That is, in practice, a statistical distribution of traits exists for any age group which makes application of specific leadership styles to those individuals within an age group a questionable approach. Dealing with employees by understanding their individual needs and aspirations is a much preferable tactic.

Although the exact demarcations that define the different age/generational groups are not well-defined in some cases, broad guidelines have been proposed. Individuals categorized as traditionalists or those born in the era of World War II have generally been defined as being born between the late 1920s and 1945, and are no longer in the workforce. These people were accustomed to hierarchies and directives issued by bosses or leaders one or more levels above them; the bosses or supervisors were assumed to be experts who deserved respect. They preferred face-to-face meetings or when necessary, a (rotary) phone conversation and expected annual feedback on their performance. Baby boomers, born between 1946 and 1964, expected/accepted decision-making by consensus, generated self-worth by hard work, used phones to interact, and craved impressive titles that described their responsibilities. Generation Xers (gen X), born between the mid-1960s and late 1970s, seek equality in leaders and followers, use cell phones extensively, seek more personal time away from work, and respond best to constructive feedback that offers direction or criticism. The birthdate ranges associated with subsequent generations is even less clear: gen Y or millennials (purportedly late 1970s to mid-1990s), gen Z or iGen (purportedly mid-1990s to ~2012). Exact birth dates for these categories will not be debated here. Although gen Y and gen Z display distinct differences, both can be described as enthusiastic, have a strong achiever culture with high expectations, desire to change their place of employment and the world, believe that their opinions and views should be considered seriously from the start of their employment, want to intermingle free or personal time and family commitments throughout their career, communicate via the internet or smart phone, are highly technology savvy, and expect frequent feedback and meaningful work assignments. Like baby boomers, many millennials are politically and socially engaged and active. An extensive comparison of the (general) characteristics, priorities, values, and behavior of traditionalists, baby boomers, gen X, gen Y, and gen Z is offered in Ref. [26]; unique attitudes of gen Z (iGen) are discussed extensively in Ref. [33].

When difficult decisions must be made by teams/groups whose members are disparate in their experiences and world views, strong disagreement will likely exist as to the proper plan/approach. How does a leader move past the biases and varied perspectives of different team members and get buy-in from such a heterogeneous group? Each generation has its own set of national and global experiences and individuals have distinct personal experiences through which they interpret events and situations (Figure 5.1). When decisions are made, an effective leader recognizes these dichotomies and displays caring, authenticity, and fairness when evaluating these views. He/she then establishes an environment that motivates team members by formulating and expounding a clear vision. In addition, short-term goals that focus on the here and now are also needed to establish and realize common objectives, meaningful judgments, and appropriate outcomes. This requires that the leader communicate clearly and often and display extreme flexibility and outstanding questioning and listening skills to define, coordinate, and integrate disparate views and directions. Otherwise, miscommunication, misunderstanding, and lack of focus will embody the team or organization; in the extreme, dysfunction is likely.

A leader can establish an environment conducive to employee motivation in several ways. For instance, the leader can supply significant and challenging problems or assignments that offer the opportunity for subordinates to expand their knowledge level, make major contributions to their field and society, receive acknowledgement for their efforts, and progress in their life and career. Without appropriate challenges and goals, employee engagement and professional satisfaction and fulfillment are lacking. The entire team must be involved in goal-setting, idea-generation, and decision-making, so that the directions and objectives are shared. Such behavior indicates that the leader values the employees and their opinions and suggestions, which establishes trust. Leaders must demonstrate openness, empathy, respect, and transparency to team members if they expect their employees to have confidence in them and the organization. An effective leader gives feedback, advice, and input on performance on a regular basis to assist employee development; this is important both to commend the employee as well as point out responsibilities or behaviors that require improvement. In addition, a successful leader seeks input from employees on his/her performance and team operation, and makes clear that he/she is open to advice and suggestions for improvement. Rewards and especially recognition are essential to demonstrate a supportive, appreciative, and caring culture. A simple but most effective way to accomplish this is to send short emails/memos of encouragement or congratulations to employees who attain specific goals, receive awards, or have gone significantly beyond

their responsibilities to enhance team or organization accomplishments. This raises the morale, fosters the motivation of the individual, and promotes team spirit.

Motivation level is generally associated with three specific types of employees [34]. When employees are highly **motivated, responsible, and engaged**, they believe that they can succeed if they expend sufficient effort. This type of team member is in demand because they need little supervision and their drive and effort contribute extensively to the goals and directions of the team and organization. They function above the expected performance level. Many teams have members who are **apathetic** and therefore uninterested. These individuals perform their duties, but that is where their effort ends. They do not go beyond the minimal tasks assigned and so marginally meet the requirements. These employees are barely motivated because they assume that their personal and professional satisfaction cannot be met in their current position. **Disengaged** employees are not involved with others on their team or with the goals and vision set. Like apathetic individuals, they do not believe that their needs can be met by the team and organization. Their performance is lackluster at best and often unacceptable.

Some team members are disgruntled, unhappy, and toxic to the team or organization. They create discord by their negativity and cynicism of the organization and other team members' actions and beliefs. They may even spread hurtful rumors or inappropriate stories within and outside the organization. Such behavior is unprofessional and destructive, and lowers morale. How can a leader deal with this type of team member [35]? A one-on-one meeting to discuss the conduct displayed will be useful. In this situation, the leader must listen carefully and attempt to understand why this behavior has appeared. Perhaps there is something going on in the employee's personal life that has consumed their energy or colored their outlook on the work environment. A serious situation may have arisen on the job where he/she felt they were unjustly treated or accused. Asking what can be done to address their concerns offers the opportunity to discuss issues rationally and calmly, and demonstrates the leader's concern for the employee. When the issue or issues have been identified, an action plan to deal with them can be formulated. This involves the expectation of employee responsibility and accountability, which must be communicated to the employee. A leader must make clear that he/she believes appropriate goals can be met with sufficient planning and effort and that he/she is available for further discussion as needed. Progress on the plan should be monitored, albeit not in a threatening manner, but by showing concern for problem resolution and offering assistance.

Discussion Question

- How can you as both a leader and a colleague, deal effectively with difficult personality types in team settings?

Despite a leader's best efforts to understand, coach, and encourage his/her employees, there will be individuals who do not take advice, are not willing to work toward problem resolution, are not team players, do not perform at a level consistent with fair expectations, are not motivated, and are not engaged in the team and organization. This is a difficult situation, because it demands a decision on the part of the leader: Is the team and/or organization better with or without these individuals? This is one of the most stressful situations in which a leader finds himself/herself. If you enjoy dismissing employees, then leadership is not the position for you, because such considerations are distasteful for effective and dedicated leaders. Nonetheless, there are times when this decision is warranted because it is in the best interests of the team and organization to dismiss someone who is disruptive, negative, inhibits proper functioning of the group, and refuses to work toward a resolution to these issues. In this case, the leader is not doing their job if they allow this situation to continue. It is worth noting that in some instances, people who have been dismissed find that being fired was the best thing that could have happened to them! This outcome is frequently a result of a lack of enthusiasm, interest, and effort in the position they held, likely because they no longer enjoyed or were challenged by their job. However, due to uneasiness about leaving a job with which they were familiar, being comfortable, and receiving a paycheck, they remained in the position and continued to be unhappy and unfulfilled.

9.6 Summary

A technical leader must ensure that he/she has motivated, dedicated, and talented team members with diverse skills and backgrounds. A team cannot be successful without the appropriate members who contribute to the goals and vision established. Assignments should be tailored to the individual team member's strengths and abilities to improve the chances for success. However, unless the team members and the leader are collegial and willing to work well together, productivity and accomplishments may wane. Specifically, the team must be comfortable with disagreements that allow improved definition of problems and solutions without the engagement of egos, and be willing to consider a variety of approaches and creative ideas. The leader must demonstrate and thus set the tone for such behavior. In addition, the leader must have high integrity, and display a positive attitude

and resiliency to failures to avoid team negativity and discouragement. Social times, even simple gatherings where coffee or snacks are available, should be planned, since these promote personal interactions and enhance team cohesiveness, loyalty, and trust. Team member roles and responsibilities within the larger goals and vision must be clearly articulated. Accomplishments should be celebrated and rewarded both as individual and team successes to promote comradery and display respect and appreciation. Feedback to the team and the individuals is critical to stimulate professional and personal growth, facilitate progress toward the goals set, and demonstrate that the leader cares about his/her team members. The leader should be a servant leader, accept much of the blame when problems occur but assign most of the credit to team members when success is achieved; this shows support for the team and engenders trust and loyalty which permeates and aligns team attitudes. When disgruntled or toxic employees degrade the collegiality and smooth-running team operation, the leader must act to assist those employees to become productive and supportive. If they are unwilling or unable to make such changes, then termination may be warranted.

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The leader must realize that his treatment of the technicians and operators is creating at least some of the problems. If he does not recognize how he is behaving and how he is perceived by the operators and technicians, he should ask trusted mentors (or his boss) to indicate clearly the actions and attitudes that are being conveyed to the other team members. If he is indeed indifferent or disrespectful to the technicians/operators, then he should issue an apology. In addition, he must be willing to change the way he interacts by communicating directly with the technicians and operators and thereby show respect and acknowledge their contributions to the team. No one does his/her best work when they feel unappreciated or not respected. The leader must become more involved in the details of the work being performed by the technicians/operators both in the planning stage (data and studies needed to address specific questions) and in the interpretation stage. This will show interest in the technicians/operators and indicate the importance that the leader ascribes to their efforts. The technicians'/operators' disinterest in their duties could be due to a number of issues; e.g. they may feel that they are not appreciated, consulted, or asked their opinion of the project and direction; lack of training/background to address the duties assigned; constant changing of directions; or lack of clear understanding of their role in the team efforts. The technicians/operators should be asked about these (or other) possibilities.

Homework Questions

1 Have you served as the leader of a technical project or other group of individuals? If so, what were your responsibilities?
- **a** Did you need to organize the team members? If so, what was most enjoyable about this position? What was most frustrating?
- **b** If you have never organized a team, what do you expect you will enjoy most? Least?

2 Consider the last technical team of which you were a member. This may have been in a laboratory course, a co-op, an internship, or a recent permanent job. Answer the following questions.
- **a** How would you characterize the morale of the team? If it was not good, what could have been done to improve morale? Why do you suppose it was low? If the morale was high, why was that the case?
- **b** Were the team members collegial? What led you to your conclusion regarding collegiality?
- **c** How would you characterize the leader's style? Was it effective? If so, why? If not, why not? What could the leader have done to improve his/her effectiveness?

d Did every team member understand the overall team goal? Was each member aware of their role?
e Was the work load evenly distributed? If not, why not? Who decided and how was the work load assigned?
f Who was the most difficult and uncooperative member of the team? What did they do that was disruptive? Why do you think they behaved that way?

3 Did you ever have to assume another team member's responsibilities?
a Why did this occur?
b How could this situation have been prevented?
c Was there a leader of the team, or were decisions and assignments made by consensus?

4 Read the article entitled, "What Google learned from its quest to build the perfect team" (*New York Times*, 2 February 2016) and answer the following questions.
a Identify what you believe to be the three critical "take home messages" from this study that are applicable to building an effective and productive technical team. Explain why you selected these.
b Do you feel that these messages are characteristic/symptomatic of all (not only technical) teams, or are Google and other technological organizations unique due to their vision and mission? Explain your answer.
c Are there other characteristics, traits, interactions, etc., that are important but have not been identified by this Google study? Could these have equally important effects on the functioning of a team? Explain your answer.

5 The Solar Cell Division (SCD) of Silicon Materials Processing, Inc. (SMPI), has not been profitable for 3 years. The SMPI Executive Committee feels that the current Vice President of Manufacturing is ill-suited for this position. The CEO makes an executive decision to fire the current Manufacturing VP and hires Leslie Snow, a most accomplished and successful former VP of Manufacturing for a frozen food company to fill this position at SMPI. The CEO's viewpoint is that someone who knows how to run a manufacturing operation can run any manufacturing unit. This appointment is met with intense dissatisfaction from the engineers in SCD, who report to you as Director of Technical Support, and you agree with their concerns. Your initial assignment is to call a meeting of your team to introduce your new boss, Ms. Snow, who has a BA and MBA in business.

a How should this introduction be handled?
b As Technical Support Director, how can you express your concerns to the CEO?
c When you have your next Technical Support meeting, what should you tell the engineers that report to you regarding this appointment?

6 You have been a member of a stable, successful, and high-functioning product development team for 5 years. The leader suddenly retires, and the Vice President of Product Development appoints you to the team leader position. The other team members, your former colleagues, now report to you.
a What challenges do you envision with this appointment?
b What different types of reactions might you experience from your team members?
c How will you address these reactions?

7 Consider the situation where you are a process engineer in a power plant.
a What might be your motivation to continue in this position?
b What motivating factors would cause you to leave this position and become the plant safety officer when this new position would involve higher pay, more responsibility, and higher stress?
c Will your decision be motivated more by the rewards associated with the new position, or by anticipated problems and responsibilities?

8 Would you expect the specific employee motivational factors to be different for:
a R&D versus manufacturing personnel. Explain.
b Start-up versus international conglomerate. Explain.
c Early career versus late career. Explain.

9 As the leader of a new product development team, you are suddenly unsure if sufficient funding will be obtained to continue the project. Do you tell your team about this situation or wait to find out if funds appear? Explain.

10 Should a leader know all the technical details of the projects being supervised by him/her? Explain. Who is ultimately responsible for success or failure of the team? Explain.

11 Dr. Simpson, leader of the process development team, decided to reward her team by giving equal percentage raises to everyone. This decision was not received well by many members of her team.
- **a** Why were some team members displeased with this situation?
- **b** Why would Dr. Simpson have taken this approach?
- **c** How might she respond to the concerns raised?
- **d** How do you suppose her team will react to this decision?

12 A senior team member reluctantly attends planning and review meetings, but generally falls asleep or reads during the meeting. When other team members complained to the team leader about this behavior, they were told that the senior member is highly productive in research and he (team leader) does not wish to jeopardize the senior member's technical contributions to the team.
- **a** How would you describe the senior member's EQ and professionalism?
- **b** How would you describe the team leader's EQ and professionalism?
- **c** What possible ramifications are there to a continuation of this behavior?
- **d** How should the team leader's supervisor handle this situation?

13 As team leader, you have been given an extra position to fill in order to undertake a new product development project where you need a specific skill set to complement the existing team members. You have interviewed a number of people, and although several of them have the appropriate technical background and experience, you do not feel that any of them will be collegial and productive team members.
- **a** Should you compromise on the traits that you consider important or do you move forward with an offer to get the project underway?
- **b** Explain the pros and cons of continuing your search for the appropriate team member versus moving forward with an offer to one of those already interviewed.
- **c** If you decide to wait, how can you proceed with minimum time lost?

10

Running Effective Meetings, Making Decisions, and Managing Change

A committee is a group of people who individually can do nothing, but collectively can meet and decide that nothing can be done.
Alfred E. Smith

The optimal committee size is three, when one is sick and the other absent.
Unknown

People who enjoy meetings should not be in charge of anything.
Thomas Sowell

People are very open-minded about new things, as long as they're exactly like the old ones.
Charles F. Kettering

Faced with the choice between changing one's mind and proving that there is no need to do so, almost everyone gets busy on the proof.
John Kenneth Galbraith

An engineer at a small company has for several decades been solely responsible for the software used in the primary (extremely profitable) product sold by the company. He originally wrote the code and continually maintained and further developed and updated this code. Since he is now nearing retirement, company management attempted to manage this upcoming change by adding a person in this technical area to learn the software and eventually take overall responsibility. However, the current software engineer is resistant to working with anyone and alienated

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

the first and second individuals assigned to work with him; both individuals quit within a year. How should the team leader address this situation to ensure continuity of this most important product? [Suggested approaches at end of chapter]

Although the above platitudes are (sadly) often true, they belie the critical and positive role that meetings, decision-making, and change play in effective, efficient, and successful operation of a team or organization. Meetings are often bad, ineffective, and a waste of time because of ineffective leadership. To ensure that meetings are effective and efficient, considerable planning must take place **prior** to the meeting, certain ground rules must be established and enforced **during** the meeting, and clear decisions communicated **after** the meeting. If any of these aspects are overlooked or given insufficient attention, meeting outcomes will be at best disappointing, and at worst nonexistent. Time will be squandered with no resolution to the concerns or problems that were the motivation for the meeting. Overall, the issues and approaches required are related to those discussed in team building and teamwork in that attention to interactions among attendees is critical in meetings, decision-making, and change.

Running effective meetings, making decisions, and managing change may at first appear to be unrelated topics that have been arbitrarily combined into one chapter. Detailed consideration of these topics leads to a different conclusion. Decision-making is seldom performed independently; team (or larger) meetings are held to discuss germane issues, debate interpretations and insight, and consider pros and cons of a specific decision. Even if the leader ultimately makes the final decision, that individual is best able to make a decision and have the decision widely accepted, when all pertinent contributors have supplied input, generally via a meeting. One of the primary reasons why decisions that alter the status quo incur strong resistance is that change must occur. Therefore, in an attempt to describe how to efficiently and effectively make decisions that impart change, the sequence of meetings, decision-making, and change are grouped. Hopefully, this collection of thoughts and approaches will be helpful to leaders as they embark on these sometimes difficult efforts.

10.1 Running an Effective Meeting

Meetings are much-discussed and participated-in activities. Unfortunately, the comment following most meetings is not, "that was a really useful and helpful meeting"; rather, the comments made are often of a different

kind, in that they are inappropriate when young children are within earshot. Suggestions and guidelines for calling and running a meeting have been documented extensively [1–5]; the principles are reasonably well-defined and understood. The limitation is usually an ability to deal effectively with the different personalities and egos present while still accomplishing the meeting intent.

The first consideration in calling and running a meeting is to decide whether you actually need to have a meeting. A meeting forces many people to disrupt their task schedule and technical effort, which requires that their work-related responsibilities now have less available time. Since the work assigned must be completed, personal time is used to ensure that work deadlines are met; such demands result in employee dissatisfaction and an upset in work/life balance. Therefore, the necessity for a meeting should be established prior to enlisting everyone for this activity. For instance, minor issues that involve only one or two other people and can be addressed easily by short emails or phone calls do not require a meeting. A clear purpose/objective/goal is needed before announcing a meeting. Meetings that intend to "see what others think" because you are having trouble making a decision are often an attempt to avoid that decision. Meetings that are brainstorming sessions on a quite general topic with no specific outcome defined usually result in lots of discussion with no focus or useful result. Although this may be advantageous to gather general information and input, you should not expect to leave such a meeting with a decision in hand. Meetings that are meant to defend your or someone else's opinion or to convince others that they have input into the decision that you are making (when they do not) will be a waste of everyone's time. That is, seeking approval or support for an idea that has not been vetted but will be adopted irrespective of the outcome of the meeting leads to frustration and even hopelessness in team members, and a loss of leader credibility.

Team members need to be an integral part of the entire process if they are to be effective, empowered, and engaged. Meetings that present information that has already been distributed or discussed to "ensure that everyone is on the same page" typically are frustrating to attendees. However, if you have a proposal to present and need to assess input, support, or opposition to refine that proposal; or you wish to obtain novel ideas and directions to achieve goals that have been set; or there is important information, knowledge, or policy issues that affect a specific group of people, then a meeting is likely warranted. Invite key individuals who have a stake in the topics being discussed or in the outcome of the meeting, or have specific or related knowledge of the topical areas and thus can offer insightful suggestions and input.

All invitees should receive an email that **includes an agenda** several days before the meeting; this document must include the window allocated and the location. Some leaders go so far as to allot time windows to the various topics to be discussed. This can be effective provided that times assigned are enforced. However, since accurate time allocations can be difficult to estimate if open discussion is allowed, the times specified are frequently breached. This leads to loss of credibility and a subsequent disregard for the time schedule. Irrespective of specific time schedules, agendas offer the attendees an opportunity to consider the topics or issues to be discussed and the types of decisions that must be made so that they are better prepared to contribute positively to the dialogue.

The individuals you invite are there because they have much to offer; that means that they are in demand and busy. The leader must therefore ensure that the meeting begins and ends on time. When the meeting starts late and/or runs past the designated time, leader credibility suffers and (further) negativity regarding meetings surfaces. Late arrivers are frequently a problem because this behavior can send a message that the meeting is not viewed as being important, at least by the person arriving late. Of course there are instances where late arrival was anticipated due to conflicting responsibilities; in this case the individual arriving late should have notified the leader prior to the meeting. To discourage late arrivers, some meeting organizers **lock the door to the room** after the meeting time is reached; this sends a strong (perhaps stronger than necessary) message which may not be desirable. Nevertheless, arriving late to scheduled meetings is unprofessional and disruptive. Regardless of how the leader choses to handle this situation, under no circumstances should the discussion backtrack to bring the late arriver "up to speed." Such actions condone irresponsible behavior.

Meeting efficiency can be improved if a brief synopsis of the background and discussion material along with a proposed path forward is circulated to meeting attendees a few days prior to the meeting. Unfortunately, a common complaint from nearly everyone who has employed this approach is that many attendees have not read the material. Amazon CEO Jeff Bezos has utilized a variation of this approach to enhance meeting efficacy: The meeting begins in silence while attendees quietly read a several page summary of the meeting agenda/content prior to beginning discussion [6]; this document is distributed as the meeting is called to order. Such procedures force attendees to focus on the issues to be considered so that meeting dialogue is better directed and relevant.

Begin the meeting by thanking everyone for attending and indicate that you look forward to their suggestions and concerns as the discussion proceeds. You should then present a brief statement as to the purpose of the meeting, i.e. what do we need to accomplish? This sets the goal(s) and

focuses the discussion. Indicate how you will use the information/recommendations generated so that the attendees recognize that their effort will have utility and impact. If progress is to be made in a limited time, the leader must encourage detailed discussion and comments but stay on task. This may require that the leader continually remind attendees of the meeting purpose and keep the focus from wandering, perhaps by asking if the current discussion is leading to problem resolution. If the discussion becomes too focused on technical details, the leader must decide if further debate is better handled outside this particular meeting. Perhaps a smaller group must be formed to consider only technical details and report back to the committee; a similar situation applies to issues that do not need extensive debate or consideration, e.g. operational details such as committee composition. The leader must calmly and professionally guide the dialogue to retain focus. However, some tangentially related issues should be permitted to encourage creative leaps, but care must be exercised to take such tangents only if these appear to incite novel ways to view the problem.

Free-flow of ideas is critical so that all viewpoints are considered rather than dismissed out-of-hand; i.e. all suggestions should be considered seriously and evaluated for their viability. This shows respect for team members, demonstrates that the leader is open-minded and willing to consider alternative/different viewpoints, and that other meeting attendees are expected to behave similarly; such conduct promotes collegiality. The leader must ensure that individual comments and issues are stated clearly so that time is not wasted; requests for clarification ultimately save time. When necessary, an effective way to accomplish this may be for the leader to restate the individual's comment to ensure that everyone understands the point being made. This also gives the individual the opportunity to further clarify their remarks. Invite objections/concerns to the considerations and directions being discussed to better refine and improve the final conclusions and approaches. The leader cannot allow dissenting comments to be personalized. Ideas and concepts should be debated and criticized, not the individual who made the proposal. When personalized aggressive behavior is tolerated, dysfunction sets in. The leader may need to redirect or restate the issue raised and make clear that the focus of the debate must be on the idea/concept.

A common occurrence in meetings, especially when there are numerous aspects involved in the situation being discussed, is that the dialogue takes on a life of its own. That is, the conversation rambles through numerous tangents, some of which are then selected by certain attendees who subsequently drive the topic still further from the initial goal. In order to minimize wasted time, the leader must refocus the discussion. The most effective way to accomplish this is to pose a few well-directed

questions. For instance, asking whether the current conversation is contributing to likely resolution of the issue can redirect the discussion. Alternatively, the leader can postulate a potential cause or "straw man" that may force the discussion into a smaller phase space where the number of possible contributing factors is reduced.

Encourage all attendees to participate; perhaps ask for specific input from individuals who are not offering opinions/comments but have much to gain/lose from the outcome. Suggest that people speak with you individually after the meeting if there appears to be reluctance to offer opinions at the larger gathering. Use the last few minutes to sum up the conclusions reached, propose next steps, and ask for corrections or other interpretations. After the meeting, provide a brief written summary and follow-up actions (including time frame), along with individuals responsible for these actions. Follow-up is a critical part of the meeting plan because it ensures that the decisions made and duties assigned are carried forward; memories are often short and days are busy, so the leader must oversee this final component of the meeting.

The higher order goals for every meeting are for all attendees to leave the meeting having learned something new, gained insight they did not have before, raise questions, and discuss issues. An effective meeting causes attendees to reconsider and refine their viewpoints, develop alternative (novel) ideas and approaches, make any decisions associated with the meeting purpose, and carry out or implement the outcomes. When these goals are met, the meeting was a success and the resistance to subsequent meetings is reduced.

10.2 Making Decisions

Decision-making is a part of planning and is generally performed during or following meetings that discuss relevant/important issues. Decision-making is familiar to engineers/scientists with respect to their research, development, and production activities and proceeds in the following way: (i) Problem definition, (ii) identification of limitations or boundary conditions, (iii) identification of potential solutions/approaches, (iv) analysis of possibilities and selection of the most suitable, (v) implementation of the solutions selected, and (vi) evaluation and perhaps modification of the decision. The appropriate/best decision is made by analysis and evaluation of opposing viewpoints, and by seeking opinions of those closest and most familiar with the science/technology involved.

Technical leadership and management decisions are made in the same manner as are technical decisions. However, the "wild card" or unpredictability that exists in decision-making by leaders is the "people" aspect

(you and your team) due to the emotions, biases (known and unknown), and egos that are often involved. A leader must recognize and hold back his/her own biases and emotional reactions to situations, and may need to step in to supply a calming voice when other team members display this behavior.

The proper response to emotional reactions should be careful analysis of the situation, analogous to the way technically trained people address technical problems. That is, everyone, but especially the leader, must avoid making decisions based solely on "System 1 Thinking" [7], which is automatic, instinctive, emotional ("shooting from the hip"). Although strictly instinctive decisions are not desirable, avoiding them is not easy, especially when numerous conflicting pieces of information are being evaluated with little time to think carefully. Nevertheless cooler heads must prevail wherein the leader ensures that the team engages "System 2 Thinking" [7], which is slow, logical, and deliberate. Trade-offs between these methods of making decisions are evident; rational thought and deliberation are the proper approach, but instinct is not to be ignored, since this is generally based on previous experiences. To be effective, the leader has to have patience and acknowledge the emotional responses from team members but draw the discussion into the logical and deliberate phase. One way to accomplish this refocus is by questioning the assumptions and statements made to enable a more complete analysis and evaluation of the situation as described in Chapter 7. It is important that leaders recognize emotional responses (or potential responses) in themselves; although engineers/scientists generally do not believe that they allow emotions to control their responses, exactly that path is frequently followed. Through logic, discussion, questioning, evaluation of the responses, and relevant experiences, a reasoned decision can be sought. While the final decision may not be different than was the emotionally generated one, due process will have been performed, which allows team members to contribute to the debate and therefore feel engaged in the process and hopefully buy into the final decision.

Discussion Question

The Research Director of Novelty Products, Inc., has had serious accusations directed against him because no new marketable products have been developed for 2 years. The VP of R&D asks you, the team leader for product development, to chair the committee charged with evaluating the Research Director's performance and recommend whether he should be terminated. In preparation for the first meeting of this committee, you

try to anticipate what concerns and charges will be brought forth and how a justifiable conclusion and recommendation can be reached.

- What System 1 reactions might be expected from the committee?
- What System 2 reactions might be projected?
- Since there will likely be members in favor of and opposing dismissal, how could you build consensus and move the process forward?
- If consensus is not reached, how do you make the final recommendation to the VP?

The decision-making process must be characterized by open discussion. Although this seems obvious, leaders (as well as followers) sometimes have already decided what the outcome should be prior to beginning the discussion. This attitude has been described by and attributed to many individuals with a variety of wordings; the assertion can be stated in the following way: "I've already made up my mind; don't confuse the issue with facts." A leader should only argue his/her point for clarification purposes. That is, different viewpoints must be expressed openly by all team members and understood clearly by everyone. Otherwise, interpretations will rule, debate will be useless, and the process will be characterized primarily by egotistical and emotional reactions and responses.

Since the education and ability level of most technical team members in the current environment is high, they typically wish to be involved closely with decisions, direction-setting, and strategy. When team members feel that they should be more heavily involved in decision-making, they do not respond well to being told what they should do and how they should do it. Such approaches are often demotivating and so counterproductive. Rather, the leader should supply an environment where openness, inclusiveness, support, and mentoring for team members exists. Of course, with these all-encompassing opportunities comes the expectation of responsibility to other team members and to the overall goals and directions set. Close involvement by all team members allows broad, insightful, and critical evaluation of a variety of possible approaches to problem solution. Often, good decisions are the result of considering numerous options. Unfortunately, when the leader or a team member professes that the only viable option is A, the debate can wane quickly. Several possible options should be formulated by the leader or a subset of the team, and discussed. When only one option has been expressed, one way to facilitate new ways of thinking is to indicate that the team needs to consider the worst case scenario: Suppose decision A proves to be wrong. What is plan B?

The approach of insisting that all team members be engaged in decision-making may encounter problems when the team member culture or even

his/her previous experience is in opposition to this mode of operation (see the discussion in Chapter 9 concerning cross-cultural teams). Due to this caveat, communication with the team is especially critical to describe clearly how the decision-making process will take place. That is, will consensus rule or will the ultimate decision be made by the leader after input is received? This gives everyone the opportunity to ask questions, raise concerns, and understand the process. Using a continuum, Meyer mapped the attitudes to decision-making according to whether decisions are made top-down, consensual, or somewhere in between, and whether the authority for these decisions is hierarchical, egalitarian, or somewhere in between; 19 countries have been positioned within the quadrants (top-down/hierarchical, top-down/egalitarian, consensual/egalitarian, consensual/hierarchical) according to data obtained via interviews with leaders and managers of corporations within these countries [8]. As expected, variations in leadership culture for decision-making are extensive which requires a flexible and attentive leader if effective global team decision-making is desired.

Ultimately, individual, team, and organization decisions are made according to the priorities that have been established. That is, specific actions demonstrate priorities, whether these are stated or unstated. When leaders make decisions that are inconsistent with the priorities they proclaim, trust and credibility are diminished and may be lost.

Leaders encounter several problems when contemplating a decision. Unlike the situation when the leader was only a team member, a wrong decision affects the entire team, not merely one individual or one part of the project. More problematic is that with the decision comes **change**, which means that the team/organization is likely venturing into the unknown. Fear of making a wrong decision often delays or extends the time invested, because leaders and followers seek additional information, even when little to no useful additional information is available. Simply put, decisions are required in a timely manner. As stated concisely by Sir George Adrian Cadbury,

> Shelving hard decisions is the least ethical choice.

In some cases, the decision will be to maintain the status quo and not impart change. This decision also leads to ramifications due to a nonresponse to whatever initiated the consideration of change. Causes could be external (e.g. market share, funding) or internal (reorganization, resources, sales), all of which can be stressful and thereby cause modification of people's behaviors and attitudes. When agreement among the team members is lacking, everyone is tired of debate, or the time frame for decision has elapsed, the final decision rests with the leader who has

to be cognizant of the fact that the decision must be in the best interests of the team and organization. Operationally, this behavior has been referred to as that of a benevolent dictator. Clear explanations to the team are then needed so that everyone understands why and how this difficult decision was made; this demonstrates responsibility, selfless conduct, and consideration for others' views. When such transparency and respect for the team is displayed, the leader can (or should be able to) depend upon the collegiality and cohesiveness of the team to move forward.

Discussion Question

- After two meetings and numerous individual discussions, your team has unanimously decided that an employment offer should be extended to a new graduate who has interviewed with your team. Although the applicant appears technically well-qualified, you are quite uneasy because you do not feel that the applicant will be a team player and you sense a lack of initiative. You finally decide that you will not make an offer. How do you effectively present and justify this decision to your team?

10.3 Managing Change

Change in a technical (or any other) position is always difficult, because it affects us in initially unknown ways, both professionally and personally [9–11]. However, in today's world, change is inevitable even when we resist, due to many factors that are beyond our individual control, e.g. national and international economic and social instabilities, institutional and political organizational changes, increasing complexity, resource availability. This means that effective leaders must be agile. They must accept and sometimes initiate change and manage it to their and their team's or organization's benefit. However, most people do not like change; they resist it as long as possible. Even among those who say they welcome change, (many) embrace it primarily when the change does not affect them substantially; i.e. change is good for others.

Before discussing why people avoid change, it is important to recognize that change for the sake of changing is counterproductive. That is, leaders, especially newly appointed leaders, sometimes feel that if they do not make changes, they are not being effective, will be viewed as lacking initiative and drive, and do not have new ideas to offer. Such beliefs are ill-founded. Often, the worst thing a new leader can do is begin to

change various aspects of the team, organization, and procedures before they understand the situations or circumstances currently in place; current practices are in place for specific reasons and these must first be understood and acknowledged (see discussion of enabling culture change in Section 3.3). A much better approach is to first understand how the team/organization functions and how it evolved into its current state. Discussions with people new to the team and those who have had a long history with the organization are extremely helpful to gain perspective of the culture, strengths, and weaknesses present. This will allow careful consideration of not only what changes might be beneficial at this point, but how the leader can effectively implement changes that are deemed necessary. Furthermore, if the leader can identify individuals who have suggested changes that are consistent with the directions the leader wishes to undertake, these individuals should be encouraged to move the effort forward. Change is facilitated when those who implement the change feel that they are responsible for initiating the proposal and thus are motivated to ensure success. Such an approach also establishes confidence, trust, and credibility in the leader by subordinates, peers, and superiors, because due process and honest evaluation have been performed.

Why do people often resist change? First, they are sometimes comfortable with the status quo – the devil they know rather than the devil they don't know. Going outside their comfort zone may create confusion regarding new expectations and goals. When dissatisfaction with the status quo exists, then the desire for change is heightened, which supplies a primary driving force. Second, since the outcome is uncertain, people often assume that change will affect them adversely, even if this is not true. We often avoid change because we imagine numerous possible negative outcomes or anticipate that the problem will not be solved despite the change. In fact, it is extremely easy to justify not making a change. Effective leaders help subordinates (and themselves) envision what positive outcomes could result from change and thereby establish the environment to change with a positive attitude. Finally, one of the most insidious reasons for resisting change is mistrust of leaders, which represents a deeper and perhaps unstated reason to avoid change. When leader trust has been established, at least this reason for not wanting change is minimized.

A major reason that change is intimidating involves answering the question: "What if I make a wrong change/decision?" We can convince ourselves that we do not have enough information to make a correct decision, which is not unusual for a technically trained individual; more data are always better. The proper question is whether additional data

would lead to substantially less uncertainty in the decision/change. Since a leader can never be certain about the ultimate outcome of a change, and delays in the decision can cause other problems (e.g. miss a deadline, lose market share, be scooped on a patent or publication) action is needed. Furthermore, an effective leader recognizes that change is necessary for the organization (and each employee) to avoid stagnation, to take advantage of new opportunities, and perhaps to meet changing conditions or situations within the organization and the world.

When change must take place, action must be taken. That is, discussion of the pros and cons of change is important, but by itself, yields few useful results; a clear plan and follow-through are needed. First, a leader must understand the "why, when, and how" aspects of the change so that he/she can adequately address pertinent issues when raised by team members. Vision is particularly important when change is to take place, because this allows the leader to describe the benefits of the change and how it will impact team members. Such efforts can allay fears by removing or at least reducing confusion and ensuring that each team member's role in the effort is clear. A major change is frequently resisted strongly because envisioning a successful outcome can be difficult. Breaking the overall goal into smaller parts/tasks often makes acceptance more likely. This also offers the opportunity to continually monitor changes as well as the feasibility of the larger change and is analogous to the use of controls schemes where critical parameters are measured. Furthermore, this approach gives a feeling of accomplishment and progress as the change is being implemented which builds confidence that the larger change/goal can be achieved.

Talk with others (perhaps one-on-one) to get an initial sense of the possible responses/attitudes/resistance to your views or proposal. Naysayers are particularly useful when evaluating a change because they will generally offer a number of reasons why the change should not be made and point out leader (unintentional) bias. In this context, it is imperative that **careful listening** to the responses is practiced. The leader can evaluate the comments offered and address valid concerns. Specifics of the proposed decision or change can be altered depending upon these initial responses and leader assessment of the level and details of reluctance. When this has been done, the individuals whose advice was taken to modify initial directions should serve as advocates who can speak up in favor of the change/decision during subsequent meetings. The modified proposal should then be presented at a meeting where all interested or affected parties have been invited.

Begin the discussion with the advantages associated with the change and the vision that has been formulated. This step is especially critical if the change is being legislated to you and your team, and shows your

loyalty to the organization. However, after offering reasons for the change, the leader can voice concerns if he/she does not agree with the change so that the issues can be debated effectively. Clear communication regarding the various team members' roles in the change is critical. Resistance to change is often encountered because expectations and responsibilities are uncertain, resulting in anxiety and opposition. Challenges anticipated in implementing the change or decision should then be presented. It is important to be forthcoming to those affected as to what these issues may be and how they might be addressed. "Devil's advocate" or nay-sayer comments that offer alternative approaches should be welcomed; this offers the opportunity to reconsider (if possible), re-evaluate, and refine details of the proposed change. Strong leaders encourage objections to proposed directions or processes; this is sometimes called "controlled chaos," and often leads to previously unrecognized problems or new approaches. Concerns raised should be addressed calmly and thoughtfully. A successful leader does not hesitate to state that he/she needs to rethink the proposal when a valid concern is voiced that they have not considered. The approach described requires a confident, trusting, and secure leader, because the final direction or approach may not be the one he/she anticipated or favored. Such behavior demonstrates leader transparency, trust, and integrity.

An effective leader recognizes that a "silver bullet" or simple change/decision that is ideal insofar as it fixes/solves the problem(s) but does not create other problems is highly unlikely. As noted previously, the complexity of a change or decision is high due to the (typical) numerous interacting issues and causes for the problem that exists. Anticipation of the specifics of such "collateral damage" is important and should be evaluated carefully. Furthermore, the leader should envision the worst case scenario given the change or decision being made, which allows further evaluation of the level of risk being taken. Where possible, embarking on several different paths simultaneously may offer a higher probability of quickly identifying the most feasible approach. Of course, this requires additional resources to allow such an undertaking. To obtain buy-in from team members, the reward structure may need to be altered to entice team members to embrace the newly expected behavior.

A major concern with engineers and scientists is that they must make decisions or changes with imperfect or incomplete information and data; as discussed previously, this is often difficult because risk is involved and the outcome is uncertain. However, if postponement is practiced until all information is available, there will never be a decision. This means that successful leaders must deal effectively with uncertainty, be decisive, and display confidence going forward. Begin this process by establishing what you do and do not know with certainty; you always know some

aspects of the problem. In addition, there are frequently results you can predict (e.g. how certain types of materials respond to stimuli or how particular reactions take place). The difficulty is dealing with responses that cannot be predicted (e.g. how a new material different from the ones with which you are familiar responds, how an individual will react to a certain dispute). If you are unable to control certain aspects, avoid worrying about them. At this point it may be necessary to revisit "Strategies to Manage Stress" that were described in Chapter 2.

Discussion Question

- As a result of a new directive in your organization, your development team is given the task of enhancing the long-term research activities in your technical arena. You need to refocus the team to achieve this goal, but certain team members strongly resist this effort. Why do you think this might be the case? What can you do to promote the new direction and comply with the charge given to you?

An interesting example of combining leadership, vision, decision–making, and managing change with far less than complete information has been described by Andy Grove [12]. In 1985, major problems were plaguing Intel and the US semiconductor industry in general. At this time, Japanese companies had assumed major market share in the memory business, and the demand for integrated circuits was down worldwide. Andy and Gordon Moore (then Intel CEO) discussed what the prognosis for Intel was and it was not good. Andy posited to Gordon that the Board of Directors might decide to replace the current management, and wondered what the new CEO would do. The response was that the new person would move Intel out of the memory market. They realized that there was no reason to wait for them to be replaced by a new administration – they could undertake a new direction. This was the start of Intel's extraordinarily successful microprocessor business.

After the change or decision has been finalized, implementation must take place. This requires a positive attitude by the leader even if he/she has reservations. In addition, an effective leader recognizes that the "final" decision may need to be altered in the future when the implications are fully appreciated or situations at the organization have changed. At this stage it is critical to realize that not everyone is likely to embrace the change/decision. If you have decided to go forward, put these concerns aside, but explain clearly why the change or decision was made. This act will confirm leader credibility, integrity, and transparency.

The leader and subordinates must also recognize that the decision or change implemented could ultimately be wrong; in this instance it is important to avoid blame of any kind. When proper evaluation was done, all input considered, and reasons for the decision/change were clearly understood, then the decision was correct at the time given the limited information available. Technical (and people) decisions are always complex with numerous interacting and nonlinear parts, so logic may not save the day. Everyone needs to learn from this experience, assess the situation, correct or alter the change, and move forward with enthusiasm. Unless the leader clearly displays this attitude, discouragement and negativity may result and the team will hesitate to take subsequent risks, irrespective of the potential gain.

10.4 Relationship Between Team Building and Change

Although team building was discussed in Chapter 9, it is appropriate to revisit this topic and tie the effort to decision-making and change, since these activities are closely related and are essential to leadership and team success. A team or organization that is stable and has been successful over a number of years or many decades has learned how to make difficult decisions and manage change. As noted previously, change is the only constant and dealing with change is imperative. This means that a successful team or organization is not resistant to change, embraces novel directions and concepts, adapts readily, and shows resilience; numerous examples and detailed discussion of the salient issues are available [13]. Such attitudes require collegiality and trust among the members, openness in decision-making, and respect for alternative opinions/options. The leader is responsible for building that environment, and everyone reaps the benefits when that pinnacle is reached.

The components or factors needed to effectively impart change and realize significant accomplishments are well-known [8, 14]. Managing change is always difficult due to the complexity and interactive nature of factors involved in making changes to a well-functioning or a dysfunctional unit. These components have been described as vision, skills, incentives, resources, and action plan [8]. If any of these components is missing or is inadequate, specific consequences ensue. For instance [8], if a clear, motivating vision is lacking, confusion reigns; if the proper skill set(s) is (are) missing, anxiety in accomplishing the task exists because certain expertise is needed; if incentives are absent, resistance to perform

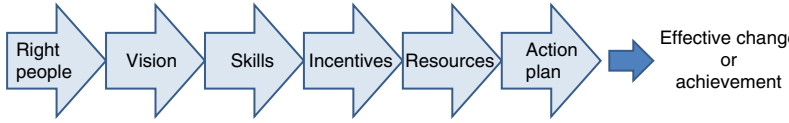

Figure 10.1 Sequence and components needed to effectively manage change and ensure accomplishments by a team or organization. *Source:* Adapted from Knoster et al. [8].

the tasks is evident because win–win does not appear possible; if resources (e.g. number of people, equipment, facilities, support) are inadequate, employees are frustrated because they cannot efficiently or effectively complete the task; if the appropriate action plan is not in place, then many false starts and wasted time occur because of lack of coordination and unclear responsibilities. Leaders must consider these issues carefully as they embark on change or even during normal operation of their team. However, Collins [13] points out that without the right people in the proper positions, the likelihood of operating an organization successfully, especially over a long period of time, diminishes greatly; this is also valid in team operation. Such conclusions can be combined with Knoster's list of factors to give a sequence for achieving effective change or ensuring achievements/accomplishments; this progression is shown schematically in Figure 10.1.

10.5 Summary

Effective and efficient operation of a successful team or organization that flourishes for extended periods of time requires change because external and internal situations and circumstances are altered on a regular basis. Since change is disruptive, it must be managed, which demands cohesive and collaborative efforts among all members of teams or organizations. Without change, teams and organizations stagnate, creativity is often lost, and opportunities for major successes are diminished. Typically, success is achieved when leaders establish a common vision and associated goals via shared leadership; buy-in and passion by members is critical. This requires planning and often difficult decisions, where the outcome is uncertain and may be negative. The leader must demonstrate by his/her actions, and thereby impart the team with a positive attitude, enthusiasm, and resilience. Meetings are held where decisions and change are discussed, debated, and finally the directions to be undertaken established. Meetings must be well-organized and run in order to take full advantage of the diverse skill sets that the team members

possess. After decisions are made, the leader must ensure that each team member understands his/her responsibilities and that they agree to succeed or fail as a group.

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This is a very difficult situation if the engineer refuses to work with anyone. His supervisor or team leader should have a serious conversation with him asking why he does not want to work with anyone. This could be a matter of wanting to feel needed (if so, there may be other ways to satisfy that need), or needing income and so does not wish to retire, or wanting an income source in retirement, or feeling no one else could do as good a job as him. Perhaps appropriate incentives could be put in place to facilitate cooperation in training a new person. Perhaps he has not been presented with an individual with whom he felt a connection due to personality differences, or feeling that the person(s) selected indicated clearly that he/she wanted to change a number of aspects of the software approach. If he has not been invited to participate in the search to find an appropriate person, then the leader might involve him more closely. The leader should stress to him the need for mentors to ensure the engineer's and the company's legacy in this technical area (i.e. appeal to his ego). If his attitude will not change, and none of the attempts to appease his concerns have been successful, then the leader will either need to assign him to a different position, or fire him; of course, these rather drastic measures will have their own consequences (no one is ready to adequately perform his duties and so extensive resources and time may be necessary to understand what the engineer already knows – if that is possible; make the engineer angry at and feel slighted by the company). This type of problem brings up a larger issue: No one should ever be the only person who knows the details of a specific part of an organization's critical components (e.g. processes, hardware, software).

Homework Questions

1 Recall a particularly productive and informative meeting that you attended recently.
- **a** Why was this meeting productive and informative? How many attendees were present? Would the discussions have been facilitated if there were more or fewer attendees?
- **b** Were there procedures that if they had been implemented, would have improved further the utility and benefits of this meeting?

2 Recall a particularly nonproductive and uninformative meeting that you attended recently.
- **a** Why was this meeting neither productive nor informative? How many attendees were present? Would the discussions have been facilitated if there were more or fewer attendees?
- **b** What changes should have been made to improve the usefulness of this meeting?

3 Consistent with our current technological society, many meetings take place electronically (e.g. phone, WebEx) and involve participants from around the world. Consider a meeting where all participants are physically in one location (room) and compare that to a situation where participants are at three or more locations, some of them outside the United States.
- **a** How do these situations differ with respect to the manner in which the leader runs the meeting?
- **b** How might challenges differ between these two meetings when conflict and disagreements arise and decisions must be made?

4 How do you interpret Sir George Adrian Cadbury's comment that "Shelving hard decisions is the least ethical choice"? Do you agree with this statement? Why or why not?

5 Are there changes that you would like to implement in your personal life? Are there changes that you would like to implement in your professional life and career? Are these in conflict?
- **a** What is preventing you from making those changes?
- **b** What processes or procedures can you put in place to initiate these changes?

6 Describe a situation you encountered in a technical problem that arose in your job, internship, co-op, research, process development, manufacturing, where you were certain of an answer, approach, or model but later changed your mind.
- **a** Why did you change your mind?
- **b** Describe a situation where a personal bias of yours was changed. What caused this change to occur?
- **c** Could you have saved yourself time and frustration if you had changed your mind early in either of these situations? Why did you not institute that change?

7 You have asked your team for a decision regarding the appropriate process to use to fabricate a particular product. They claim that they cannot agree on the proper approach at this time and want to generate more data.
- **a** How do you decide when you should make the decision yourself, thereby legislating to the team what process to pursue?
- **b** If you take the decision out of their hands, how do you handle the backlash from team members who thought that you were open to and would back their suggestions, concerns, and decisions?

8 When a change in your team's outlook or performance is necessary, would you first expect change from your subordinates or would you assume that you must set a better example? How might you assess the best way to proceed?

9 Goals for your organization have been formulated by the VP of R&D without input from the engineers and scientists who will be responsible for manufacturing the product involved in these goals. After your process development team critically evaluates the assumptions used to establish the goals, it is evident that the specifications needed for the raw material supply cannot be met by any existing vendor.

- **a** How do you as the team leader convince the VP that the goals are unrealistic?
- **b** Suppose that the VP is exasperated by your attempts to change the goals set, and tells you to simply make it happen. How do you deal with this situation both with regard to your superior(s) and your team?

11

Conflict Management and Resolution

Leaders approach conflict with an eye for resolution. When handled effectively, confrontations raise team performance. To manage conflict effectively, you must begin by recognizing there are three sides to every story: Yours/Theirs/The Truth.

Angie Morgan

*Conflict can and should be handled constructively; when it is, relationships benefit. Conflict avoidance is *not* the hallmark of a good relationship. On the contrary, it is a symptom of serious problems and of poor communication.*

Harriet Braiker

The most intense conflicts, if overcome, leave behind a sense of security and calm that is not easily disturbed. It is just these intense conflicts and their conflagration which are needed to produce valuable and lasting results.

Carl Jung

A key to resolving any conflict is to identify a common goal.

Anna Karpman

As the Division Head, you call a meeting of your three supervisors (design, manufacturing, and facilities) and the engineers who report to them (12 people in total) to discuss progress on the development and manufacture of a new sensor. Specifically, problems have been encountered finalizing the physical design and sensor manufacturing process and facilities; the time frame for completion of the project is approaching quickly.

Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

The manufacturing supervisor and the design supervisor disagree strongly about the reasons for the delay in project completion, with each blaming the other. This situation quickly degrades into raised voices, inappropriate language, and personal insults. The situation was made still more awkward by the presence of the individuals who report to these supervisors. How do you gain control of this meeting and resolve the dispute? [Suggested approaches at end of chapter]

When more than one person is in a meeting, disagreement on the interpretation of results, conclusions, implementation, and subsequent directions is the outcome. Such situations lead to conflict, which is defined as (Free Dictionary):

> A state of disagreement or disharmony between persons or ideas.

Since conflict is inevitable, effective leaders must manage and where possible resolve conflict to benefit their team and organization and ensure that the conflict does not inhibit effective operation and progress. If not managed properly, conflict leads to a reduction in productivity, creativity, communication, and relationships among team members. Considerable prose has been written regarding how to manage and resolve conflicts; extensive discussion of some of these approaches that are useful for technically and nontechnically trained individuals can be found in Refs. [1–5].

11.1 Causes of Conflict

The ubiquitous presence of conflict suggests that it has many causes. Indeed, conflict will occur in every project and interaction from sources as diverse as [4, 5]:

- Actual versus perceived facts
- Poor communication
- Technical methods, views, and opinions
- Values and beliefs
- Goals and objectives
- Priorities
- Resources (manpower, finances, facilities, equipment)
- Personalities

Some of these can be addressed readily by meetings and knowledge sharing (e.g. relevant facts, communication, technical methods,

goals/objectives, resources), while others may present serious difficulties for the leader (e.g. values/beliefs, priorities, personalities) and therefore require considerable effort, perhaps with less than satisfying results.

11.2 Approaches to Control/Manage Conflict

Conflict naturally engages emotions and egos. Leaders must be aware of such reactions and attempt to remove this contributing factor from those engaged in the conflict. At times, the leader is one of the conflicting parties. In this case, it is important to realize that methods to mitigate conflict apply to him/her as well as to subordinates. Recognition of each other's frustration, followed by open, calm, common sense approaches and effective communication frequently resolve many conflicts that arise. Numerous conflicts surface because there is **perceived** disagreement; brief discussions, provided that each individual desires a resolution, can often clarify and thus identify the cause, which leads to relatively simple solutions. That is, each party must be willing to describe succinctly what they want and need to resolve the conflict and what options they have considered. Such discussions frequently indicate the proper path for resolution. When fundamental differences in values and priorities, or rigid personalities exist, the path to a positive outcome is much more tortuous. An effective leader must first determine what the issue is (this may be different than what is claimed by those in conflict), refocus the discussion to concentrate on overall goals, establish what is necessary to address the conflict, and then plan how the conflicting parties can be brought into harmony. As usual with leadership issues, most conflicts are unique because they depend upon personalities, egos, and (perhaps unstated or misunderstood) desires of the two sides. If the individuals involved are not open to fair and reasonable resolution, then the conflict will continue and may escalate. In this case, the leader may need to take a more direct and dictatorial approach where the consequences to the individuals of maintaining the unproductive and uncompromising attitudes are defined clearly.

An effective leader is not dismayed or upset when conflict arises because others disagree with him/her. Leaders sometimes view such disagreements as a challenge to their competence or leadership prowess, especially if the challenge is presented in a rude or abrupt manner. The leader must have a thick skin in such cases and evaluate the comments (instead of the delivery) to assess their relevance to the issues being considered. He/she must also assume that others are being genuine in their concerns and viewpoints. Different perspective(s) should be embraced and an attempt made to understand the fundamental issues and motives that led to the

differing opinion(s); the difficulty can be treated as an optimization problem. Such an approach typically leads to expansion of the leader's viewpoint and thus clarifies why the conflict arose. This is the first and most important step in addressing the situation and demonstrates that the leader is open-minded and interested in resolving the conflict.

When handled properly, conflict is constructive, since it can lead to [4, 5] improved communication, enhanced creativity, improved procedures, increased understanding of technical and interpersonal issues, expedited change, rapid personal growth, better productivity, and synergy among those involved. An effective leader must therefore view conflict positively to achieve a win–win outcome. If conflict is not handled properly, inability to meet goals/vision, discord, lack of trust, and frustration/anger will define the team and perhaps the organization.

Conflict escalation should be inhibited by addressing the conflicts before they cause major disruptions in team operation; such approaches are similar to delivering bad news in a timely manner to reduce the likelihood that rumors or incorrect conclusions are drawn. That is, to ensure that constructive use of conflict is achieved, a leader must function/behave in ways that promote win–win situations and minimize divisiveness. When a leader is proactive in such situations, leader credibility and trust are promoted.

A number of approaches to defuse conflict have been described in detail in Chapters 2 and 5 where positive leader traits and behaviors were discussed; additional information can be found in Refs. [1–5]. The leader should first question and evaluate his/her motives and views to ensure that he/she is neither a major cause of nor is promoting the conflict, or has a vested interest in the outcome. If necessary, an advisor or mentor may be helpful in this assessment. The leader must display a calm demeanor that sets an example; he/she should not react to initial conflict situations. Admittedly, this is extremely difficult, because the leader will have (perhaps strong) opinions, but if he/she reacts emotionally or offers a resolution prior to hearing all sides, the conflict will likely escalate. Approaches to controlling stress and reactions to situations that may be helpful in this regard, are described in Chapter 2. Emotions must be under control to allow thoughtful and logical responses. The intonation of voice, facial expressions, and body language often indicate more about your reaction to the conflict than do words, so leaders must be aware of how they are perceived. This is particularly important because technically trained individuals are sometimes not mindful of such elements of communication. Again, mentor feedback can be extremely useful in these cases.

The leader must listen carefully to all sides to understand clearly the basis for the conflict; this will help keep interactions and meetings under control and ensure that appropriate ways to respond to disagreements

are offered. A thoughtful analytical process is needed to arrive at a viable conclusion; jumping to conclusions before all facts have been presented and discussed is counterproductive. Everyone involved must show respect for others' opinions as well as understand and value their views. Agreement on the views is not necessary, but recognition that others view the situation differently and an understanding of how and why these views exist are required. This behavior is greatly facilitated if trust and credibility are team attributes. The leader must ensure that the discussion is limited to the facts and issues under consideration; personalizing the conflict only prolongs and likely escalates the confrontation. Asking clarification questions to bring into focus questionable logic, assumptions, and the views expressed promotes discussion and leads to improved understanding. When the conflict is extreme, a third individual might be invited to participate as an observer in order to supply a different perspective. This person should not have been involved in the conflict and must not be close friends with either person; again, a mentor (but not for either party) could be appropriate in this role.

When conflict is already well-entrenched and is affecting the productive functioning of the team or organization, action is required. Possible approaches to resolve or at least minimize the effects of conflict so that the team can move forward have been described in previous publications or blogs; see for instance, Refs. [4–7]. Asking probing questions to ensure that the conflicting issues are well-understood by everyone and that all possible scenarios that could lead to resolution or at least acceptance of different views have been considered, is beneficial. Sometimes a simple delay in a leader's decision or even taking no action can be effective if a "cooling off" time for the emotions and egos allows more reasonable interactions to take place. Other reasons for taking this approach may be that the issue is not particularly important at present, or that one of the viewpoints will receive no support from other team members; in both instances, the issue may simply fade away. In this case, the leader needs to observe the progression closely to ensure that the conflict does not fester, which may lead to an explosion at a later point. An additional reason for delaying or not making a decision may be that this is not an effort that you wish to undertake or cannot resolve at this time due to priority or time constraints.

When conflict arises because the team consensus is distinct from that of the leader, the leader may decide that he/she is not the best person to make the decision. Mentors or trusted colleagues outside the team may be able to assist in this case. Ultimately, the leader may decide to yield to the will of the team. An alternative approach is to iterate to a resolution that includes the best parts of the various viewpoints. When the conflict participants are not willing to bend, the time frame is such that a decision is needed quickly, or the leader is confident in his/her viewpoint, then a more aggressive

stance is needed and the leader may decide that the team must be overruled (benevolent dictator). In this case, it is critical that the leader be transparent, explain the reasons for the decision, and address questions or concerns voiced by the team members. As always, this builds trust and credibility even if team members are opposed to the final decision.

In instances where the conflict has reached the conflagration stage, team/group meetings may not be effective in gaining control of the situation, which is necessary for a positive outcome, due to the volatility in emotions that has been generated. That means that a face-to-face or confrontational meeting with one of the members may be required for resolution [1]. This approach allows isolation of the individual to avoid numerous emotional reactions and outbursts possibly caused by "group thinking or group response." In addition, if more than one person has shown disruptive behavior, individual meetings will likely be needed. After discussion with each primary conflict contributor, it may be beneficial to call a meeting of this (hopefully) small group to discuss final approaches to resolution.

Discussion Questions

- How do you handle the situation where the credit for your novel idea, suggestion, or work, is taken by
  - a colleague/team member?
  - your boss?
  - an outside individual (publication/patent appears)?
- How do you handle the situation where you are not listed as a co-author on a publication or report from your team (or an outside team) in which you had considerable input?
- How do you handle the situation where your boss/supervisor expects his/her name to be included in the list of authors when that person had no intellectual contribution to (or even understands) the work being published or issued?
- Considering the three situations described above and suggest possible actions on the part of the individuals involved that might have (i) caused or (ii) avoided or at least mitigated each of these.

The meeting(s) should take place in the other person's office (if indeed each person has an individual office) or another isolated area [1]; privacy is critical in such discussions. These locations are favorable because the individual may be more at ease and less defensive on their own or on neutral turf than if they are called to the leader's office because of the formality or official impression this can give. Perhaps more importantly

for the leader, meeting somewhere other than his or her office allows the leader to leave if the conversation degrades into anger or becomes irrational; this will give the individual an opportunity to compose themselves before the meeting reconvenes.

This type of meeting is no different than any other meeting (see Chapter 10). Preparation of specific, detailed items for discussion is essential. Anticipation of responses from the individual (e.g. defensive posturing on specific issues) permits formulation of reasoned replies prior to the meeting. Expect that emotional responses may be the norm because these are likely what perpetrated the situation currently in place. These responses should be handled in the manner discussed previously: most importantly, remain calm, focus on issues rather than people or negativity, and identify common ground between you and the other person that allows trust to rule and logic to be applied.

As you begin the meeting, remember that the overall approach must be nonthreatening and nonaccusatory. It is best to begin with an expression of appreciation for meeting with you and an indication of how the individual's accomplishments and contributions have benefited the team. You can then communicate your desire to resolve the issues promptly because continuation of this situation will negatively affect the individuals, team, and organization progress toward achieving responsibilities and goals. The person should first be encouraged to discuss their concerns/issues. Ensure that you do not dictate a solution or decision at this time. Rather, listen carefully and ask questions for clarification and in an attempt to lead the person into logical discussions. Indicate that you understand and acknowledge the person's views, opinions, and values. The meeting should end with a statement of the final conclusions or decisions, a plan for the next steps if needed, and by thanking the person for their time.

Discussion Question

Ginger and Teressa both moved from small R&D facilities to your medium-sized company because of the opportunities for advancement. They were at similar stages in their careers and both had families, so they quickly became friends. As the Division Head, you need to formulate a team to undertake the design and fabrication of a new product; both Ginger and Teressa report to you. Your choice for team leader is Teressa, because of her ability to develop collegiality and establish common goals for a team, although her managerial expertise has come at the expense of focusing on her technical skill set. Ginger has continued to grow technically and has developed several novel products that have been extremely profitable. Unfortunately, she has not shown the people skills you had hoped to

see. After the decision was announced, you observe significant friction between Ginger and Teressa. This has progressed to heated disagreements and unprofessional outbursts in planning meetings where both are present and has now begun to negatively impact interactions among members of their groups which are critical to the success of the new product development. How do you deal with the conflict between Ginger and Teressa and ensure that both groups succeed with minimal disruption?

11.3 Summary

Conflict is inevitable when decisions that affect all team members and perhaps the organization are needed. Since a multitude of conflict sources exist, it is imperative that the leader determine the cause (stated, unstated, or perceived) for the conflict. Without this information, effective solutions will be elusive at best. Resolution of the conflict requires that all parties desire and are willing to work toward a solution with the primary intent to enhance the effective functioning and betterment of the team. The leader may need to meet individually with some of the team members if emotions are dominating team discussions. Such approaches minimize the engagement of egos provided that the leader remains calm and is open to discussion of the concerns of that individual. When personality, value, and belief differences have been aired and addressed, agreement may still not be achieved. This means that the final decision is incumbent on the leader. In this case, it is especially unlikely that a solution agreeable to everyone involved will be identified. After the leader makes the decision, he/she must explain clearly why that particular decision was made. When trust and collegiality are core team characteristics, team members, whether they agree or disagree, will view the result as one they must get behind in order to move the team forward because that behavior is in the best interests of the team.

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As the Division Head, you should have intervened when the first personal insults began in order to avoid escalation of this situation. If all this happened so quickly that the time was already past, then you need to call a halt to the discussion immediately. You could ask the engineers (nonsupervisors) to leave, although this would probably start unfounded rumors, so perhaps they should observe how you handle this situation. Ask each supervisor in turn to describe what he/she feels the primary and secondary problems are and what might be done to solve these problems **without** allowing comments/remarks from the other supervisors; subsequent discussion can then narrow the possibilities. You should also ask that the engineers offer their suggestions, comments, and ideas for problem resolution. You need to establish the likely causes of the problems that are being experienced so that a plan can be put in place to investigate these possible causes and implement a solution(s) rapidly. After these decisions are made, and the meeting ends, you need to have individual meetings with the design and manufacturing supervisors and let them know that their behavior is unacceptable, unprofessional, and will not be tolerated. Remind them that their responsibility is the development of the sensor, that that effort must take priority over egos and personal feelings, that self-control is required, and that you expect them to cooperate with each other to achieve their goal. Insist that they work out their differences on the project between the two of them, not in front of their teams. You will need to monitor the interactions to ensure that your demands are met. You should also call a meeting of the engineering staff who witnessed the ego display and remind them that sensor development is the collective priority, that you have already discussed the outburst with their supervisors, and that you expect collaboration and cooperation to define everyone's efforts.

Homework Questions

1 Identify an individual with whom you currently have or have had a conflict in (i) a work or school situation and (ii) a social situation.
   a What is/was the fundamental disagreement or disharmony in these situations?

b How is/was the situation resolved and if it was not, why not?
c What would have been required for a more satisfying outcome?

2 Take the quiz entitled, "Are you a conflict rock star or conflict coward?" which can be found at: http://www.kevineikenberry.com/files/pdf/CC_Assessment.pdf
a Which perceptions or actions/inactions on your part will inhibit your effectiveness as a conflict manager?
b What can you do to improve your ability to handle conflict between you and others, and between those reporting to you?

3 During an Annual Review of your corporate R&D program, your team members must each present their technical goals and results to the Vice Presidents of Finance, Sales, Marketing, and Research. This effort serves as justification for the projects and thus resources allocated to the program; funding decisions are dependent on these presentations/discussions. In the current review, the VPs of finance and marketing take particular exception to one of the projects and criticize extensively the team member regarding the lack of importance/significance of this effort. Ultimately, the team member becomes defensive and explains that the problem is that the VPs do not understand the technical significance and potential of the work and thus the criticism is completely unfounded. The VPs are clearly offended by this attitude and response, and the team member is angry. How do you, as the team leader, handle this situation?

4 Are there situations where it might be appropriate to include your boss's name on a report, publication, or patent, even though he/she had no intellectual contribution to the effort? Explain.

5 How might you deal with the situation where your boss consistently blames you for mistakes that he/she makes, but assumes credit for all the positive outcomes that you generate? What consequences might result from different ways of approaching this issue?

6 The morale and collegiality on your team has diminished significantly over the past year. After you bring up this issue at a team meeting, one of your team members indicates that your erratic behavior has caused stressful conditions within the team. How do you respond to this statement at the meeting and how do you proceed after the meeting?

12

Communication

If you cannot – in the long run – tell everyone what you have been doing, your doing is worthless.

Erwin Schrödinger

The single biggest problem in communication is the illusion that it has taken place.

George Bernard Shaw

The biggest communication problem is we do not listen to understand. We listen to reply.

Stephen R. Covey

A key to healthy problem solving is good communication.

Asa Don Brown

Engineers, scientists, and even the general public spend significantly more time communicating with others than they do carrying out any other activity. In fact, communication is one of the most important functions a leader performs. Due to the extensive and continuing effort needed, an effective leader must have excellent communication skills so that he/she can present information clearly and logically, appear encouraging and inspiring, ensure that the information is accurate, and hold the attention of those receiving the message. Furthermore, the message being conveyed must appeal to the perspective and specific circumstances associated with the audience; that is, effective communicators tailor the content and approach for the particular audience receiving/hearing that message. Such tailoring can be challenging when listeners or readers are from different generations, cultures, or backgrounds; these situations place even more emphasis on clear communication in order to ensure

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Published 2018 by John Wiley & Sons, Inc.

that the message is understood when different perspectives, beliefs, and priorities exist. The objectives desired can frequently be accomplished by organizing the information to tell a story that leads the listener or reader through a logical sequence of events that allows conclusions to be drawn.

Whether composing a written document or preparing an oral presentation, technically trained individuals have particular goals they wish to achieve: Describe a problem and associated potential approaches or solutions, offer results and conclusions, and supply insight and make clear the impact of the work to the reader or listener. Readers or listeners always attempt to place your work in the context of what they know; that is, they filter the work through their experiences and background. As a result, insight or impact is better realized by adapting the approach used to the audience needs and background. Clear or effective communication is therefore particularly important when listeners or readers are from different generations or cultures. To address the other two goals, remember that the only way others will recognize, understand, and appreciate what you are doing is if you successfully communicate these issues to them. Since the reader/listener does not know what your goal is nor do they generally understand the details of how and why you have spent time on the subject matter that you are presenting, you must explain clearly and succinctly your starting and ending points, the path that you have taken, and why you chose to do this work, i.e. the bigger picture of benefits to society. In other words, your communication must be formulated for the recipient, not for you.

It is vital that you quickly gain the attention of the reader/listener and leave them with the salient points of your message when concluding. To accomplish this, communication beginnings and endings are critical. Presenting the key "take home" messages as you begin the communication and again when you end drives home the important findings and conclusions; the middle part of the communication supplies justification.

Communication can take many forms. In verbal communication, the voice tone, facial expressions, and body movements/posture all affect the message conveyed and received. Electronic communication offers a variety of methods that will be designated as email, although developments such as Slack offer team members the opportunity to converse or message among the team with all messages archived and thus available to team members. Written communication approaches include email and Slack but also reports and memoranda (memos). However, email and hard-copy reports lack the insight and message interpretation that face-to-face or video conferencing (e.g. Skype, WebEx) communications can offer. In general, information that will or might be considered unpleasant or damaging to an individual, team, or organization should generally be delivered verbally so that questions from those receiving the news can be dealt with

in a sincere and authentic manner; additional information regarding better versus poorer ways to deliver bad news is contained in Chapter 13.

Face-to-face meetings are also the preferred communication approach when the information to be conveyed is complex and therefore will require extensive clarification and discussion; alternatively, phone conversations serve a similar purpose.

Two generic types of communication occur within and outside of a team or organization: (i) Coordination of information, directions, and goals, and (ii) clear description/discussion of results and implications. Within the team or group, effective communication requires that goals, assignments, individual roles, level of urgency, and expectations are clearly described; employees must be kept up-to-date on team/organization strategic plans and problems to ensure trust in the leader. If this does not occur, then communication is lacking which results in numerous problems [1] such as tasks are duplicated among team members, assignments are not accomplished/completed, final project/product is not what was desired, priorities are not shared, stress levels increase, rumors may start, confusion and misunderstanding exists. Many of these problems arise from misunderstanding or miscommunication of the information described. Therefore, it is critical that the leader presents the necessary background when the information is offered, and clearly indicates the current situation and the next steps required. Even if these demands have been met, team members may not be listening to understand (they are listening to reply) or they do not buy into the goals set, resulting in a communication vacuum. In either case, clarification, feedback, and discussion to understand and deal with the situation are required so that uncertainty and confusion are eliminated.

Personal and regional attributes and behaviors can also contribute to communication difficulties. For instance, language barriers may exist due to the diversity in a team or organization. Such situations may occur due to ethnic or geographical distinctions, especially when international teams have been assembled, or to differences in experience level and age. The leader should ensure that clarity is paramount in these discussions, either by restating the points made in a different way to assist comprehension or encourage further explanation, or by stopping the discussion to obtain feedback and questions on the issues raised. A more insidious source of communication problems is due to team or organization members who are unresponsive to requests for input and opinions on issues where decisions must be made and priorities set. Such behavior is unprofessional and impairs collegiality and effective functioning of a cohesive team. If input from one or more individuals is critical to the issue being addressed, the leader may need to obtain information through one-on-one discussions. However, as part of these consultations, the leader

should indicate the negative impact that such behavior has on team cohesiveness, operation, decision-making, and (other) members. Approaches to deal with such concerns are discussed in more detail in Chapters 10 and 11.

Whether the communication venue is verbal or written, technical leaders must ensure that they avoid the use of acronyms, abbreviations, or (especially technical) jargon to anyone outside of their immediate team. Even within the same organization, different divisions or groups use different terminology whose meaning is obvious to them, but may be completely incomprehensible to those outside the "inner circle." When communicating with nontechnically trained individuals, recognition and avoidance of jargon is particularly important. The old adage of, could your grandmother with no technical background understand what you just said, is critical in these cases.

12.1 Verbal Communication (Presentations)

A presentation should inspire, energize, and motivate listeners and offer insight into the topic being discussed and the conclusions reached. With this in mind, three different aspects of the presentation must be considered when preparing a talk: Organization, visuals, and technique. With respect to organization, effective communicators begin by establishing the goal or purpose that they have in offering the presentation (e.g. report on progress, influence listeners, request information or feedback). They assess their audience and tailor the presentation to that group. If the group background is diverse (experts, nonexperts, administrators) then the presentation should resonate at some point with each of the attendees; an effective presentation to a diverse group bores everyone at some point during the talk. That is, those who are familiar with the topic are bored at the beginning when background is being covered and the stage being set for your contributions, while those who know little or nothing about the subject matter reach boredom when you begin talking about detailed results and inferences. If you did the work, you must remember that the audience is not as familiar with the subject and results as you are, and the presentation is generally relatively short (10–30 min). This means a little "hand holding" to lead listeners through the important points is required. A good way to think about this is to adhere to the often-used sequence: **Tell** the audience what you are going to tell them, **Tell** them, then **Tell** them what you told them. This will force you to identify the key issues and results and focus on them throughout the talk to ensure that the audience has received your message(s).

Proper preparation of visual aids is obviously important. When using PowerPoint (ppt) slides, be certain to formulate uncluttered slides and use large font for easy reading. To improve comprehension, employ only one primary idea or concept per slide. Some presenters go so far as to display and accentuate (e.g. bold type, box around the concept) the primary message on each slide to draw attention to it.

Finally, appropriate presentation technique is critical. First, practice, practice, and then practice more. You need to determine how you will present certain concepts without rambling or stumbling for words, and ensure that you adhere to a particular time frame; neither of these is possible without practice. Since there will be different parts to the talk – introduction/background/significance, results/discussion, conclusions/implications – the listener should be led through this sequence seamlessly. That is, transition statements or separate slides to offer suitable connecting information, greatly assists the audience in following your logic and improves their comprehension. When possible it is helpful to assemble a group of colleagues (with and without specific knowledge in the field) to listen to the talk; they can offer feedback, useful suggestions, and point out where clarity is lacking.

Body language, voice intonation, and gestures are also effective communication vehicles. Technically trained individuals often assume that the data offered and words used are the only important parts of their presentation. This is a gross misconception. Monotone presentations and avoidance of body movement leads to audience inattentiveness and precludes the opportunity to stress the most salient points of your presentation. Increasing or decreasing voice volume or speed and gesturing at or away from the screen or board calls attention to key aspects of your work and keeps the audience focused on you and your presentation. Such displays also demonstrate your excitement for the results and conclusions you are presenting. If you give the impression that you are not excited about the work you have done or are doing, why should anyone else be interested?

During the presentation, excellent communicators are aware of the context and unstated responses within the team or group to whom they are communicating [2]. That is, they "read" the audience (an individual or group) and are able to modify/adjust their presentation or remarks to capture the attention of and engage those listening when they sense that the message is not being received or is being misinterpreted. The leader must also avoid being too subtle in presenting information that is contentious or unpleasant. Although the communicator must not appear rude, dictatorial, or aggressive, a confident or assertive approach should be employed. As discussed previously, the leader must be sincere and transparent. Presentation of difficult or divisive information in such a way that empathy and appreciation for others are evident, shows strength and

courage. As always, asking questions such as what concerns do audience members have with this approach, or does this seem reasonable, shows awareness for and interest in the views, values, and priorities that others may have, and facilitates tangible communication. A painful but extremely useful approach is to record (a smart phone will suffice) your presentation and then listen to or watch it. This is normally a humbling experience, but shows clearly where improvement is needed.

Prudent oral communication is critical to effective and efficient functioning of individuals and teams and generally determines success in a profession. The listener(s) forms an opinion of you based on your presentation, which is only partly a result of the presentation content. Therefore, it is important for a leader to convey succinctly the message intended, recognize what primary communication style he/she uses, how this style is perceived by others, and be aware of the different styles used by the people with whom he/she communicates (see, for instance, Refs. [3–6]); such knowledge is also significant for effective listening. Self-assessment of communication style is possible by taking simple questionnaires to facilitate the identification of specific style(s) [7].

Communication styles are characterized by different categories that indicate particular behavior and personalities [3–6]; of course, these incite different responses from subordinates or listeners. The categories are known by various names/titles, but irrespective of the names chosen, the categories denote explicit conduct and attitudes. For instance, **assertive** communicators are confident, good listeners, flexible, decisive, and trust others, which results in enthusiastic, trusting, and motivated listeners. **Aggressive** communicators can also exude confidence, but they may be viewed as arrogant, confrontational, condescending, poor listeners, and closed minded. Although these later traits may lead to listener resentment, frustration, and inhibit personal relationships, the aggressive communicator typically displays excitement and motivation when presenting information. Nonconfident, apologetic, and hesitant, **passive** communicators frequently avoid problems/conflicts and thereby may lack recognition and respect by listeners and sometimes generate frustration in those around them because critical decisions may be delayed. However, if the audience is also somewhat passive, they may feel more at ease with this style. The **passive–aggressive** communicator appears passive, but is sarcastic, devious, and thus subtly aggressive, which causes listeners to question his/her veracity and authenticity which often leads to a lack of trust. According to the definitions, effective communication is primarily associated with assertive communicators. However, since different types of listeners relate better to one or more of the styles used, effective leaders may use aspects of the different communication styles during a presentation to engage as many listeners as possible. Also, as

with leader characteristics, a communicator seldom matches only one style, but combines attributes of at least two styles.

In addition to descriptions related to the operation, organization, and goals of the team, succinct, clear presentations are also required to describe technical results and to motivate listeners within or outside the team/organization. Of particular interest to a leader is a presentation that is sometimes referred to as an "elevator speech," "parking lot speech," or "golly-gee whiz speech." This type of presentation is short, typically 1–3 min, and is intended to serve as an enticement/appetizer to listeners to establish relevance or significance and thus to initiate a conversation. It can also serve as a brief advertisement or "marketing pitch" to superiors who ask you what your focus has been in recent months. This is a presentation that should allow others to quickly gain insight into your work and encourage them to **want** more details or in the case of superiors, be impressed with your accomplishments. This means that well-organized, brief, clear statements of the salient points and especially the implications of your work are needed. A successful leader is always prepared to offer this type of presentation at a moment's notice. That is, you may be asked to give such a presentation without warning as a result of a chance encounter with someone in an elevator or parking lot. Despite the unexpected need to give this type of presentation, much preparation should have taken place to plan for exactly this type of situation. As Joel Hildebrand remarked when asked how he managed to give such exciting and interesting lectures:

> Extensive preparation and knowledge of the subject are key. But the most important aspect is to be spontaneous. And remember, spontaneity is best when carefully planned.

To give an effective message in a few minutes, you must focus on the noteworthy problem you are trying to solve, and briefly offer your findings. Most importantly, the presentation should avoid details but focus on the significance and consequences of your work so that the importance is evident to those who are either experts or novices in the field. That is, you must stress **why** you did the work that you did and thus the implications. If you know or can quickly assess the type of person to whom you are speaking (e.g. expert in the field, novice, administrator) you can tailor your remarks to that particular person's background and interests. However, the primary emphasis should be on the impact of your work. Stressing the specific goals and relevance of the investigations is helpful to link your results and accomplishments with the interests or responsibilities of the person(s) with whom you are speaking. You need to make eye contact to engage the listener and display energy, confidence, excitement, and motivation to build enthusiasm with the individual or audience.

12.2 Written Communication (Emails, Memos, Reports)

Succinct, clear writing is critical to ensure an accurate archival record, to present a description of your procedures, results, requests, or observations, or to offer detailed vision/goals, instructions. Written documentation is the connection between your work/efforts and others within or outside the team/organization who require the information. Importantly, a communication should inspire and motivate your team/group. This undertaking can take the form of email, memos, abstracts, reports, and publications/patents. Again, it is imperative to identify the audience in order to deliver a message in a way that speaks to their perspectives and interests. Extensive guides are available for writing rather lengthy technical documents and publications [8–13]; these will not be summarized here, although the principles described are applicable to long and short documents. This discussion will focus on the preparation of short documents intended to deliver a crisp, clear message that offers information, announces an incident or event, or requests input. A good reference with many examples and practical insight into writing such impactful messages is Ref. [14]. Individuals who struggle with the formulation of coherent writing may prefer to write short documents as opposed to extensive tomes. However, it is often extremely difficult to condense considerable information into a digestible portion that concisely presents the pertinent information. As noted by Blaise Pascal (or T.S. Eliot, depending upon the search performed),

> I have only made this letter longer because I have not had the time to make it shorter.

Irrespective of the length of the document, a first draft is never the version that should be issued. Numerous revisions are typically needed to ensure that the content, presentation, grammar, and tone of the text are correct and accurately present the message to be conveyed. This requires patience and perseverance, but the outcome is worth the effort because miscommunication is minimized when significant attention is given to details. Quotes from either Thomas Hood or Nathaniel Hawthorne,

> Easy reading is hard writing,

and from Samuel Johnson,

> What is written without effort is in general read without pleasure,

pronounce clearly that skillful and effective writing requires considerable effort.

Technically trained individuals are often criticized because their written communication sometimes leaves much to be desired. This observation is frequently dismissed as being due to their focus on engineering/scientific matters and a lack of emphasis on writing during their education. The beginning engineer or scientist may even feel that in their profession, they will be performing technical tasks and not spending their time writing – this attitude will be subject to a rude correction after permanent employment is secured! Lack of exposure to writing is only partly accurate because engineers/scientists have been given opportunities to write and some have even been instructed in the importance of writing, although their grammar and syntax may need further development. A more relevant reason for poor writing skills relates to a lack of critical thinking, which results in inadequate clarity. Engineers and scientists obviously possess logic and critical thinking skills. However, these skills have often not been applied to the written word.

A technical leader must logically present precise information and draw/justify conclusions in the same way that they address technical problems and results: Begin with background and goals, followed by methods, results, analysis, conclusions, and recommendations. That is, the intent of the document formulated must be clearly presented to the reader to establish the context, offer insight into the problem, and propose solutions or request input. This initial portion of the document is extremely important, since it orients the reader regarding what is to be presented and presents clearly and concisely **why** you did the work. Results, analysis, and conclusions/recommendations follow. When this sequence is missing, the critical thinking aspect of the document often appears to be missing. Frequently, a technically trained person writes a document as if they or others with closely related background and experience in the specific technical area are the readers. Even other technically trained readers may not have the detailed knowledge of and experience in the specific situation possessed by the writer. That is, rather than writing for the reader, the author is writing for himself/herself. Writing that is difficult to interpret or understand, or in the extreme is incomprehensible due to lack of reader background or inability to understand what is being requested, gives the reader the impression that the writer is unorganized and lacks clarity of thought. Such conclusions reflect poorly on the individual, even if he/she is competent technically. An effective way to ensure that the reader has received the salient point(s) of the document or memo is to put the primary reason for the document or memo (i.e. conclusion or request) first ("beginnings"); this makes the reader aware of the critical content to be offered and the reasons that it is important. When this information is reiterated at the close of the document ("endings"), little to no misunderstanding regarding the intent should be expected.

A frequent problem that is encountered by technically trained individuals when they begin to write technical documents is that they describe the studies in a chronological fashion. In other words, they present the studies performed and the information obtained in the sequence in which it was carried out. Because we seldom know the outcome prior to beginning the studies, we make many wrong turns and assumptions during our investigations. When the results are presented in this way, logic is lacking due to the incomplete knowledge base when the project was initiated. Clearly, this approach to presenting results is confusing to the reader. A more effective way to present the information is to begin by explaining briefly the results in light of what we now know after the results have been acquired and assembled into a coherent picture, story, or model. That is, we justify why we performed the studies that we did, even though the conclusion(s) were not apparent when we began. Although this was not our original thought process, it allows the reader to more easily grasp the significance of what we did, and places our work and results in context; this makes the content considerably more digestible to those who are not as familiar with the area or field as we are.

Skill in writing is developed in the same way that any other skill is developed: Practice. A trusted mentor or colleague who has had more experience and whose writing is deemed excellent can offer suggestions to drafts of documents; this effort will supply guidance and assistance and promote improvement in written communication. Another effective way to improve writing skills is to read broadly, especially in technical books, journals, and compendia. In addition, reading carefully memos or short reports that you feel are well-written, concise, and informative, along with those that are lacking in these categories, supplies awareness of writing quality. That is, analysis of why certain documents are effective identifies the reasons for the quality; this technique also identifies shortcomings of poorly written documents. Most importantly, such scrutiny offers great insight into how to improve your ability to craft effective memos and reports.

Emails or memos are directed to a specific individual(s) from an (identified) other person(s) and are formulated to fulfill a particular purpose. The document requires a meaningful title or subject so that the content and intent are easy to identify and are informative so that the importance and significance will catch the attention of the recipient. The memo describes briefly (usually <150 words) the situation to be addressed and why this document and the content are vital to the recipient and to an individual, team, or organization. That is, the email or memo must describe what is needed, why it is needed, and the needed time frame. Clarity is essential so that the reader does not need to reread the email or memo several times to understand the content; as mentioned previously, beginning and ending the memo with the primary intent is beneficial and

ensures that the salient message is stressed. The memo gives instruction(s) for or proposes next steps, or it requests particular information. When information is requested, this may be best addressed by asking pointed, directed questions so that the reader knows exactly what is needed. In addition, it is critical that the email/memo includes the time frame under which action or response is needed. Finally, it ends with thanks or appreciation for the recipients' attention to the situation or request.

The memo should be direct with short sentences (<25 words). Long and complex sentences and difficult or obscure words often inhibit easy comprehension and may distract the reader. Spelling and grammatical mistakes are extremely annoying and give the impression that the writer is sloppy and does not pay attention to detail. Credibility and professionalism suffer when mistakes of this sort are present in written documents. When memos are sent to individuals who are high in the organizational structure, brevity is a particular virtue. Although none of us have time to waste, impatience with lengthy, verbose, and rambling messages generally increases with senior administrative level, which results in a poor impression of the writer.

One caveat should be mentioned with respect to the use of electronic (e.g. email, texting) communication. Although this is a most efficient and time-saving approach to presenting or swapping information, especially when personal schedules and time zones preclude direct interactions, it can incite difficulties if emotions are engaged. That is, when rude, inappropriate, or insensitive remarks are contained in the communication, our emotions or egos can be engaged quickly. It is quite easy to respond in anger, frustration, or defensiveness and send a response that we will regret. Self-control and self-awareness are critical in such instances. Time should be taken to assess and evaluate the response that is being contemplated rather than dash off a retort that we will need to retract or apologize for later. If, after adequate consideration, we decide that our initial response is indeed warranted, then careful wording of a reply can be crafted.

12.3 Communicating with Nontechnical People

Technical leaders spend considerable time interacting with individuals who have little to no technical background, e.g. those trained in finance, business, marketing, sales, or management. Even the leader's boss may fall in one of these categories. This process can be frustrating and uncomfortable on both sides of the aisle. However, there are approaches that a technical leader can take to at least minimize anxiety and impatience during this process.

First, to the extent possible, avoid the use of technical terms and jargon when speaking with nontechnically trained individuals. If you must use certain terms, explain the meaning and most importantly, the context and importance of the term when you use it, and ask if your description clarifies the concept. The general approach of asking questions can be helpful because it draws the listener into the discussion and may pinpoint the aspects of your presentation that are confusing. However, care must be exercised in these instances to ensure that your tone of voice and facial expressions do not exude arrogance and condescension. If the listener feels that the message is being "dumbed down" for their benefit, the likelihood of successful communication and interactions drops precipitously. The attitude exhibited on your part can either promote fruitful interactions and effective communication or make these nearly impossible. Clear evidence of patience and humility is critical to maintain open communication channels with and genuine interest by the other person(s). Maintaining eye contact demonstrates that you are focusing on the interaction with the listener. Remember that if roles were reversed and you needed to better understand the financial or business details of their job, your interest level would likely wane.

Technically trained people like details and enjoy argumentative discussions regarding information; its interpretation; and descriptions of how the data, results, or conclusions have been formulated. These aspects have been a major part of the education and training we have received. At least until degrees have been completed, the primary (if not the sole) communications have been with other techies. When interacting with individuals who do not have a technical background, or who have intentionally avoided gaining such proficiencies, stressing the gory details quickly yields information overload. Furthermore, these technology-laden conversations are certain to generate blank stares, eye-rolling, boredom, and attention loss from nontechnical people.

An effective approach to present the technology or science you perform to nontechnical individuals is often "telling a story" that discusses the broader picture of your work and its implications and benefits for commercialization and thus society. As described previously, **why** you performed the work must be a critical component in your presentation. One of the best approaches when offering technical information to nontechies is to explain clearly what the technology or technical product makes possible or facilitates **for that person**. That is, how can the technical work or results help the nontechnical person do his/her job better or expand their influence (this may be especially applicable to bosses)? This is typically why the nontechnical person is interested in or needs to know about that particular topic. Specific examples of improvements that might be realized with the new approach are especially relevant since

they engage the nontechnical person and help them envision how your work can be used. For example, explaining to someone with a business, marketing, or accounting background how your work could lead to improvements in manufacturing costs, product or process reliability, or result in new products that would open additional market segments will help them see the relevance of your studies to their responsibilities. Such conversations are analogous to the "elevator" or "parking lot" speech described earlier in this chapter. Specifically, focusing on the impact or significance of your work to their job obligations will likely motivate them to better understand and appreciate your work. If further details are requested, the information content can be expanded to the extent necessary, but this should occur only at the request of the listener.

The focus in this section has been on communication with nontechnically trained individuals whom the leader or other techies encounter at their place of employment. Analogous approaches and issues should also be used by technical people when they interact with the general populace. Perhaps most importantly, attention to the way technical information is presented can improve the way engineers and scientists are perceived outside the technical arena.

12.4 Summary

Success as a leader and a person depends strongly on the ability to communicate effectively and efficiently. Irrespective of the importance and significance of the message to be delivered, ambiguous, vague, and poorly presented information is often misinterpreted, misunderstood, and reflects badly on the presenter and likely on the team or organization. Whether the communication is verbal or electronic/written, the communicator must take into account the specific audience if he/she wishes to deliver the message or information in a way that resonates with those receiving the message; when this goal is accomplished, understanding and clarity are maximized. Achievement of these goals demands that the presentation is focused, organized, and logical, with implications for the reader/listener clearly described and any response or information needed, indicated. Mistakes in spelling and grammar in a written document or in ppt slides give a negative impression of the communicator. Such oversight suggests that he/she is not willing to devote the time and effort necessary to perform the communication task properly. Technical leaders must learn to communicate effectively with nontechnical people if they are to be effective. In this instance, a focus on the broad issue of **why** the work was done assists understanding by those unfamiliar with the engineering and science behind the work. There are more aspects

to and implications for the technical product or process than simply technical details. If the leader is to be successful, then engagement of individuals in marketing, sales, business, finance, and society in general, is essential.

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Homework Questions

1 Your team has been given an extraordinarily difficult project with a most aggressive time frame for completion.
- **a** How can you best discuss this with your team?
- **b** Is a written or oral communication best?
- **c** How can you raise confidence and motivation to tackle this assignment?

2 A common way for Geeks to communicate with individuals above or below them in the food chain is by a short email. A Geezer's way of doing this was via a memorandum, otherwise known as a memo. You are asked to practice your leadership skills by writing three different short emails/memos. Each should be less than 100 words.
- **a** Call a meeting of your team members to discuss an incident where lack of planning caused a spill of a hazardous chemical.
- **b** Request input regarding the recent interview of Sherry Dole and her suitability for employment in your team and organization.
- **c** Send a second request for input on Sherry Dole's interview and suitability for employment, because not everyone responded to the first request.

3 Write an email or memo (150 words or less) that requests assistance from a peer colleague in preparation of a proposal you are writing. The colleague is knowledgeable about materials and their structure/properties. Your proposal will be used to request funds for equipment that allows analysis of a material being considered for use as a corrosion-resistant container. Would the written request differ in any way if the person you contact (a) reported to you or (b) you reported to her? Explain.

4 The VP of Production assembles your team of quality control personnel to discuss a change in the supplier of raw materials for a specific product line. The plan is carefully described, but when questions arise regarding the details, especially the new supplier and material specifications, it becomes obvious that the VP has already decided on the "proposed" change and thus this meeting and presentation are perfunctory.
- **a** How do you, as leader of the quality control group, deal with this situation?
- **b** If indeed, the decision has already been made, how could the VP have better presented and discussed this information?

5 Record a video of a short (3–5 min) presentation that you made on a technical topic of interest to you. Analyze your performance in two ways:
- **a** visual only, with no sound
- **b** sound only, with no visual.

Does the visual only convey excitement and motivation in your work? That is, do you use facial expressions, body language, and gesturing to draw in the listeners? Without watching the visual presentation, but concentrating on the verbal part of the presentation, do you change voice level and pitch, or is monotone the prevailing result? Considering these two methods of communication with listeners, how could you alter your presentation to better motivate or stimulate interest in your work?

6 Practice communicating with others by formulating a 1–3 min oral presentation to offer a response to the individuals' requests in the following situations:
- **a** An individual who reports to you has requested 2 weeks of vacation time when a major deadline/report is approaching. The request has been made to take advantage of an extraordinarily inexpensive airfare and attend a family gathering.
- **b** One of the individuals who reports to you has requested a transfer to a different Division because she refuses to continue to work on the same team as one of her colleagues.

7 You are the process safety officer for CFX Chemicals, Inc. (CFXCI) who must explain the release of a toxic gas cloud from a manufacturing plant; this cloud reached a nearby town and has caused severe eye and throat irritation of town residents.
- **a** Write a short (~250 word) memo to explain this incident to the Vice President of Manufacturing who received a BS in chemistry 25 years ago.
- **b** Write a brief (~150 word) news release describing this incident that can be published in the local newspaper or presented on a public news broadcast.
- **c** Prepare a 5-min oral presentation that can be given at a townhall meeting of local residents explaining the release that took place at CFXCI.
- **d** Prepare a short (~250 word) memo to the President of CFXCI that requests a shutdown of the manufacturing facility while the cause of the release is identified and corrected.

8 Select a technical project for which you have been responsible or involved during your time in an internship, co-op, permanent employment, or university research. Formulate a 5-min presentation (with or without ppt slides) that explains this project and its significance to the following groups or individuals:
- **a** Your peer group
- **b** Head of the technical group to whom your boss reports
- **c** Vice President of Marketing for your company
- **d** Journalist for the *Wall Street Journal*
- **e** Your daughter's 6th grade class.

13

Presenting Difficult Messages

Things will absolutely go wrong. In a healthy team, as soon as things go wrong, that information should be surfaced. Trying to hide or obscure bad news creates an environment of distrust or lack of transparency.

Steven Sinofsky

If you're going to tell people the truth, you'd better make them laugh. Otherwise, they'll kill you.

George Bernard Shaw

Bad news isn't wine. It doesn't improve with age.

Colin Powell

One of your team members has not produced the quality or quantity of work or effort expected. During her monthly performance review, you point out these shortcomings to her and ask her to describe her view of this situation. She responds that she feels she is productive, that she is being held to a higher standard than are others, and that neither she nor her work is valued or respected. How do you respond to these statements? [Suggested approaches at end of chapter]

Delivering bad news to others is an extremely distasteful task for most of us, but is necessary if we are to be responsible, truthful, and effective leaders. If you enjoy giving others bad news, you should avoid leadership positions – your disposition and mindset are inappropriate for those jobs. Despite a desire to sidestep such activities, every leader will encounter situations where they must have unpleasant conversations with either

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subordinates or bosses. For instance at some point in your career, you will likely have to:

- Indicate to one of your employees that he/she was not selected for a promotion
- Tell a subordinate that their idea is not worth pursuing
- State that no raises will be awarded this year
- Inform team members that the team is being disbanded
- Declare that the employee's co-workers do not want to work with him/her
- Convey that there will be a 25% reduction in your staff
- Notify someone that they are fired
- Discuss unacceptable performance with a subordinate
- Indicate that the funding for a current project is canceled
- Explain to your boss that your team cannot meet their assigned deadlines/goals
- Explain to your boss that additional resources/costs are required due to mistakes.

Our reticence for these tasks has several origins. We do not want to be the "bad guy" who destroys someone's ambitions or delivers disconcerting news. Rather, we want to feel that others like and enjoy interacting with us. We are concerned about how the other person will react – perhaps in anger, frustration, or even violence. We feel that we may not do a good job of presenting the information, which will result in the deterioration of an already bad situation. We do not want to be blamed for circumstances beyond our control. As a result, we sometimes delay presenting the news or worse yet, try to give the appearance that the situation is not as terrible as it appears. Sadly, there are seldom good ways to handle these conversations, but there are poor ways to proceed. Much has been written on this particular communication skill; several references that offer insight into how such conversations can be handled are given in Refs. [1–6].

Discussion Question

Due to frustration, leaders sometimes make inappropriate negative comments to subordinates regarding their performance. What is wrong with the following remarks that have been made to employees (*from* Alison Green, in *U.S. News & World Report*, 21 August 2013)? How would an effective leader bring up the types of issues listed below in a discussion or performance appraisal?

- You are lucky to even have a job.
- I received an anonymous report.
- That's a dumb idea.
- What's wrong with you?
- You're so much better at this than Bob is.

Formal delivery of bad news to employees should not be a surprise to them. An effective leader offers regular – as often as needed, which may be weekly or monthly – feedback to his/her subordinates, generally via individual discussions. If consequences are ultimately necessary, the employees will thus already be aware of the concerns. The leader should offer specific input and suggestions regarding what aspects of the employee's performance should be improved and how this might be achieved. General comments (e.g. you have a bad attitude) are not helpful and may incite strong resistance; detailed examples (e.g. your emotional outbursts at committee meetings when decisions do not go your way are disruptive) should be offered. One way to initiate such discussions without confrontation is to begin the conversation by asking the employee their own impression of their performance and/or behavior. This can be accomplished without an intimidating face-to-face interaction by having the employee perform a self-evaluation that is sent to you prior to your discussion. That is, the employee documents his/her accomplishments, strengths, weakness, and goals (Appendix A). Subsequent dialogue with the leader allows better knowledge of the employee's situation and attitude about his/her performance and priorities, and demonstrates concern for and interest in the employee. The information contained in the evaluation may also allow you to initiate the face-to-face conversation with praise and appreciation for outstanding performance in (hopefully) some aspects of the employee's responsibilities, and indicate the importance of their contributions to team success. These methods open the door for discussions about how the employee feels improvement can be achieved.

Genuine and helpful negative and positive feedback facilitates employee success and advancement. However, feedback should not be a one-way street. The technical leader should solicit feedback during such sessions to find out where the leader can improve or better enable employee achievements and thereby improve their and the leader's effectiveness. Such discussions demonstrate the leader's interest in improving everyone's performance. At times, the mutual feedback may be difficult for both the leader and employee to hear, but honest, nonconfrontational discussion of critical issues and behavior builds trust and respect and thus improves the relationship between individuals. Overall, such efforts are a major part of professional development and are required if the leader, individual, and team desire continuous improvement.

13.1 Positive Approaches to Offering Negative Messages

The following approach describes specific ways to effectively present sensitive or negative news to others. Remember that no one likes to get bad news, so it is unlikely that the person will leave your conversation

feeling good about themselves, the team/organization, or you. Such conversations are never easy for either the employee or the leader, but the proper attitude and approach can at least soften the blow somewhat. The leader should ensure that his/her remarks are necessary, fair to everyone involved, thoughtful, and respectful.

Sometimes the situation that must be addressed has been generated by administrative layers above you; that is, you are the messenger rather than the instigator. In that case, you must understand the background along with the specific issues that led to the outcome you now must convey (e.g. priorities have changed and the project under your supervision is being eliminated). Unless you can clearly describe the situation(s) and process that occurred, you will give the impression that the decision or change is arbitrary or that the negative outcome is unimportant to you. Of course, such information is also necessary if the decision/change originated with you.

To be as effective as possible when delivering bad news, you must know your audience. That is, some individuals to whom you must deliver bad news prefer to have the "hammer lowered" so that the discussion is concluded as quickly as possible and they can address the situation. Others need to have the news presented carefully with great empathy to seamlessly allow their reaction and further discussion. An effective leader knows and understands the differences between his/her employees and tailors the conversation to best suit the individual. The discussion should be treated in the same way as any other (technical) presentation: Practice, practice, practice. Anticipate responses, rebuttals, and questions to your message in order to minimize the number and variety of concerns or misunderstandings.

Because you are delivering bad news, it is common to want to delay the meeting because you are uncomfortable initiating this conversation. When the decisions that precipitated the discussion that requires the meeting have already been made, it is important to hold the discussion quickly for several reasons. First, rumors regarding the events leading up to the decision and thus possible outcomes may already exist. Second, the individual with whom you must speak may ask you if they are affected by the rumor that they heard. You will now need to respond by either telling them the outcome at that time or say that you want to have a meeting with them to discuss this further, thereby confirming to them that they will not like the result. Delay may also give the impression that you have shirked your responsibility to the employee or to your boss by not keeping them informed, and therefore lack the courage and responsibility to perform your duties as leader.

The message presented should be short and to the point; do not ramble but cover salient issues. You must be confident, authentic, and focused as

you deliver the news. Unless the message affects the entire team/group in the same way (e.g. project termination, company sold, company closing, raises canceled), the conversation should be a private, one-on-one discussion. Begin with any good message/news or compliments applicable (e.g. recognize particularly noteworthy accomplishments/progress, how well the employee functions on the team) to establish as positive an atmosphere/attitude as possible. Be certain to show respect and compassion for the employee(s), maintain his/her dignity, and empathize with their situation. If you begin the discussion of bad news with a statement indicating that the employee's performance is unacceptable or that substantial improvement is necessary, this puts the employee on the defensive and you are likely to receive excuses, finger-pointing, and claims that they are a victim, in return. Couching the situation in the framework of wanting to assist the employee in achieving his/her goals is beneficial and demonstrates that you want the person to be successful. That is, you could indicate that certain behavior or attitudes detract from the accomplishments and limit potential opportunities to advance and/or succeed in their future/current role. Try to connect the aspirations and goals of the employee to the vision or mission of the team or organization so that they clearly see and appreciate their role in the project or process. Describe the issue(s) clearly and offer all the information that you can in a truthful manner. Do not try to diminish the severity of the message; this attitude brings your credibility into question.

Under certain circumstances, you may not be able to divulge all the information that you have due to proprietary restrictions. You should be forthcoming with this fact to let others know that you are unable to offer all details at this time, but will address those concerns as soon as possible. Indicate openly why this result has arisen so that the employees have context for the news they receive.

Ask the employee(s) his/her view of the situation. To ensure a connection with them, acknowledge their concerns and make certain that you understand their viewpoint. You must be prepared for an emotional or angry reaction; in this case, recognize their emotions and anger without judgement, since the news is either new to them or they have anticipated the outcome. In either case, they may be argumentative. Respond calmly after allowing the employee to vent. The best approach when emotions have taken over the conversation is to say as little as possible, but make clear that you are willing to discuss any aspects of their concerns so that you can better understand the situation. Do not hesitate to say that you do not know the answers to some questions, but that you will give answers as soon as you have them. Ask what solution/path forward the employee envisions (or, if termination is the result, what assistance you can offer); **Listen Carefully** and respond calmly. Establish a plan of

action or correction if termination is not the result, and show confidence that the problem can be addressed effectively, but be up-front and clear about what is needed and the consequences if this result is not achieved. When performance improvement or behavior modification are needed, the improvement plan along with subsequent evaluation and discussion is critical. Follow-up is needed to demonstrate credibility as per Kouzes and Posner's DWYSYWD [7]: "do what you say you will do."

When initially supplying feedback to subordinates to correct behavior or indicate that performance improvement is necessary, a conversation typically represents the appropriate way to begin. Start the conversation by indicating the situation to be discussed and make clear that you want to understand their behavior or performance better. Invoke questions to facilitate discussion; i.e. ask them to describe their view of the situation and what suggestions they have or changes they envision. The discussion should be documented to establish a record of when this behavior/performance was brought to the employee's attention. This conversation should serve as a warning that you feel improvement is needed and an indication that you want to work with him/her to resolve the issues. At this time, an improvement plan should be formulated. When a second conversation is required because improvement has not occurred, the leader must make clear the consequences of continuing along the current path. It is important at this juncture that the leader adhere to whatever protocols are in place within the organization to ensure that the employee is treated fairly and that standards of information transfer are followed in the event that more drastic measures must be enacted. Again, documentation of the key issues discussed and the agreed upon solution(s) is needed. A copy of this document should be given to the employee for his/her signature to establish that this information was transmitted on a particular date. Memories are often inaccurate and interpretations of what was said are even more ambiguous many months after the conversation. This practice indicates to the employee that you want to ensure the accuracy of your account of the discussion and that you are willing to include their remarks or rebuttal in this evaluation. Such procedures are also important if challenges to the evaluation occur or if a decision of termination ultimately results.

13.2 Summary

Every leader will need to convey difficult news to those above and below him/her at some point in their tenure. Although tasks such as delivering negative performance reviews, describing salary reductions, or conveying

terminations are unpleasant, they are part of the responsibilities that are borne by leaders. These conversations must be clear and to the point. Background and reasons for the decision should be offered to avoid misunderstanding and the feeling that the result was arbitrary or indecisive. The employee must be afforded respect and dignity during these discussions. If termination is the outcome described, the leader should offer any personal or organizational assistance possible. Whether the conversation is intended for termination or to convey the need for performance improvement, allow the person to vent and display frustration while you remain calm. The conversations should be practiced as in any presentation, with anticipation of responses or rebuttals considered carefully. Discussion details must be documented and offered to the employee with a request for additions, changes, or clarifications; this process ensures accuracy and demonstrates fairness to the employee. An action plan for correction/improvement should be formulated with a clear indication of the consequences of not meeting the agreed-upon goals. One-on-one performance evaluations and discussions should be used to obtain input/feedback regarding the leader's performance in addition to that of the employee. These conversations should offer insight into and directions for professional development for both parties.

References

1 Quick Base Inc. (2011). Delivering difficult messages the right way. http://quickbase.intuit.com/blog/2011/11/29/delivering-difficult-messages-the-right-way/ (accessed 20 November 2017).
2 Bies, R. (2012). The 10 commandments for delivering bad news. *Forbes*. http://www.forbes.com/sites/forbesleadershipforum/2012/05/30/10-commandments-for-delivering-bad-news (accessed 20 November 2017).
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4 McCarthy, D. (2013). 10 employee conversations that managers hate to have. http://smartblogs.com/leadership/2013/06/27/10-employee-conversations-that-managers-hate-to-have (accessed 20 November 2017).
5 McCarthy, D. (2013). how to confront an employee performance problem. http://www.greatleadershipbydan.com/2013/04/how-to-confront-employee-performance.html (accessed 20 November 2017).
6 Kasprzak, L. (2015). *Chemical Engineering Progress* (April), p. 23.
7 Kouzes, J.M. and Posner, B.Z. 2010). *The Truth about Leadership*. San Francisco, CA: Jossey-Bass.

The leader needs to affirm the employee's feelings, indicate clearly that she and her work are valued, but describe specific examples where performance is lacking and what acceptable effort and accomplishments are necessary; general comments are not appropriate. Offer to assist her efforts to gain perspective on performance either personally, or identify (with her assistance) a mentor who can interact closely with her and make suggestions regarding how to improve. Through discussions with her, set specific and realistic goals with appropriate time frames so that she understands expectations. Both you and she must agree to the goals set as well as consequences if she does not meet these goals – this may be best handled with a written document that both of you sign. Do not micromanage her efforts – she needs to learn independence and responsibility and only her own management of her time and effort will accomplish that.

Homework Questions

1 Select three of the bulleted items on the list of difficult conversations that leaders often have with subordinates or bosses (beginning of this chapter) and offer a scenario for each explaining how you could carry out this conversation in an effective manner.

2 Select three of the bulleted items on the list of difficult conversations that leaders often have with subordinates (beginning of this chapter) and imagine that you are the person (subordinate) receiving the bad news. How will **you** respond to these situations?

3 Your boss informs you that the productivity of your group is not consistent with expectations. She indicates that you have 6 months to turn this trend around or the number of team members and funding will be reduced. How should you present this information to your team and how do you plan a path forward?

4 Several years ago, you left a successful position at a large company to start your own venture. You recruited 15 excellent highly dedicated technical and business employees and embarked on a challenging path with great vigor and hope. At this stage in its life, it appears that the company may need to close. You need to call a meeting of your employees to discuss this dire situation. How do you handle this discussion?

5 You are one of two Division Heads at your organization. The other Division Head has been hostile and extremely competitive with you

since you assumed your current position. As a result, you have avoided interactions with him to the extent possible. His Division is currently struggling. Your boss feels that you could help him overcome many of his difficulties and so asks you to work with him. How do you respond to this request and to subsequent interactions with the other Division Head?

6 Approximately 1 year ago, your supervisor indicated that because of your outstanding performance, you would receive a promotion and a significant raise when the next administrative position opened. You found out that a new position was about to open, but before you had a chance to discuss this with your supervisor, an announcement was released that one of your co-workers was selected for this position. You request and are granted a meeting with your supervisor to discuss this situation. How do you discuss this surprising result with your supervisor and how might this decision affect your current position?

7 A mid-career engineer who has had a most successful career to date begins to display emotional outbursts at team meetings. This has caused considerable damage to the collegiality, cohesiveness, and morale of the team and you have had a number of complaints from other team members. How should you address this situation with the mid-career engineer?

8 One of your team members was asked to perform studies and submit a report describing his evaluation of a new technology that is being considered for implementation in your organization. The report was poorly done both because some of the necessary control studies were missing and because the report was lacking clarity and justifiable conclusions. You know that the employee has recently had problems with his marriage. How do you discuss the unacceptable project performance with this employee?

9 One of your team members posts a scathing negative review of your research results which is unfairly formulated because of an incorrect assumption that your team member has made with respect to your work.

- **a** In what way and to whom should you respond regarding this criticism?
- **b** Would your response be different if the criticism originated with your boss?

Appendix A

Self Evaluation and Assessment

Rate yourself in the following categories and explain your choice:
1 = poor; 2 = fair; 3 = average; 4 = good; 5 = outstanding

Technical skills: e.g. experiments; modeling; reproducibility; equipment set-up, operation, maintenance; data interpretation.
Presentation skills and effectiveness: Oral; written.
Depth of technical knowledge: Specific project/field; relevant literature.
Breadth of technical knowledge: Fields outside project; science and engineering in general.
Work ethic: Accomplishments; motivation to complete or further the effort.
Efficiency/productivity: Time management; multitasking.
Independence: Critical thinking; know when to ask for help; creativity.
Leadership: Role model; shows vision.
Teamwork: Help/support team or organization members.
Areas for improvement: *Goals for next 3, 6, 12 months:* project(s); professional development; personal development. *Goals* for next 5 years.

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Appendix B

List of Personal Values

Achievement	Friendships	Physical challenge
Advancement and promotion	Growth	Pleasure
Adventure	Having a family	Power and authority
Affection (love and caring)	Helping other people	Privacy
Arts	Helping society	Public service
Challenging problems	Honesty	Purity
Change and variety	Independence	Quality of what I take part in
Close relationships	Influencing others	Quality relationships
Community	Inner harmony	Recognition (respect from others, status)
Competence	Integrity	Religion
Competition	Intellectual status	Reputation
Cooperation	Involvement	Responsibility and accountability
Country	Job tranquility	Security
Creativity	Knowledge	Self-respect
Decisiveness	Leadership	Serenity
Democracy	Location	Sophistication
Ecological awareness	Loyalty	Stability
Economic security	Market position	Status
Effectiveness	Meaningful work	Supervising others

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Efficiency	Merit	Time freedom
Ethical practice	Money	Truth
Excellence	Nature	Wealth
Excitement	Being around people who are open and honest	Wisdom
Fame	Order (tranquility, stability, conformity)	Work under pressure
Fast living	Personal development	Work with others
Financial gain	Freedom	Working alone

Source: From Roberts, C. *Fifth Discipline Fieldbook*. www.selfcounseling.com (accessed 21 November 2017).

Appendix C

Codes of Ethics

C.1 American Chemical Society (The Chemical Professional's Code of Conduct)[1]

Chemical professionals acknowledge their responsibilities to:

The Public

Chemical professionals have a professional responsibility to serve the public interest and safety and to further knowledge of science. They should actively be concerned with the health and safety of co-workers, consumers, and the community. Public comments on scientific matters should be made with care and accuracy, without unsubstantiated, exaggerated, or premature statements.

The Science of Chemistry

Chemical professionals should seek to advance chemical science, understand the limitations of their knowledge, and respect the truth. Chemists should ensure that their scientific contributions, and those of their collaborators, are thorough, accurate, and unbiased in design, implementation, and presentation.

1 https://www.acs.org/content/acs/en/careers/career-services/ethics/the-chemical-professionals-code-of-conduct.html?_ga=2.140320433.303018571.1510830852-194104537.1433860387 (accessed 21 November 2017).

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The Profession

Chemical professionals should strive to remain current with developments in their field, share ideas and information, keep accurate and complete laboratory records, maintain integrity in all conduct and publications, and give due credit to the contributions of others. Conflicts of interest and scientific misconduct, such as fabrication, falsification, and plagiarism, are incompatible with this Code.

The Employer

Chemical professionals should promote and protect the legitimate interests of their employers, perform work honestly and competently, fulfill obligations, and safeguard proprietary and confidential business information.

Employees

Chemical professionals, as employers, should treat subordinates with respect for their professionalism and concern for their well-being, without bias. Employers should provide them with a safe, congenial working environment, fair compensation, opportunities for advancement, and proper acknowledgment of their scientific contributions.

Students

Chemical professionals should regard the tutelage of students as a trust conferred by society for the promotion of the student's learning and professional development. Each student should be treated fairly, respectfully, and without exploitation.

Associates

Chemical professionals should treat associates with respect, regardless of the level of their formal education, encourage them, learn with them, share ideas honestly, and give credit for their contributions.

Clients

Chemical professionals should serve clients faithfully and incorruptibly, respect confidentiality, advise honestly, and charge fairly.

The Environment

Chemical professionals should strive to understand and anticipate the environmental consequences of their work. They have a responsibility to minimize pollution and to protect the environment.

C.2 American Institute of Chemical Engineers (Code of Ethics)[2]

Members of the American Institute of Chemical Engineers shall uphold and advance the integrity, honor, and dignity of the engineering profession by being honest and impartial and serving with fidelity their employers, their clients, and the public; striving to increase the competence and prestige of the engineering profession; and using their knowledge and skill for the enhancement of human welfare. To achieve these goals, members shall:

1) Hold paramount the safety, health, and welfare of the public and protect the environment in performance of their professional duties.
2) Formally advise their employers or clients (and consider further disclosure, if warranted) if they perceive that a consequence of their duties will adversely affect the present or future health or safety of their colleagues or the public.
3) Accept responsibility for their actions, seek and heed critical review of their work, and offer objective criticism of the work of others.
4) Issue statements or present information only in an objective and truthful manner.
5) Act in professional matters for each employer or client as faithful agents or trustees, avoiding conflicts of interest and never breaching confidentiality.
6) Treat all colleagues and co-workers fairly and respectfully, recognizing their unique contributions and capabilities by fostering an environment of equity, diversity, and inclusion.
7) Perform professional services only in areas of their competence.
8) Build their professional reputations on the merits of their services.
9) Continue their professional development throughout their careers, and provide opportunities for the professional development of those under their supervision.
10) Never tolerate harassment.
11) Conduct themselves in a fair, honorable, and respectful manner.

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2 https://www.aiche.org/about/code-ethics (accessed 21 November 2017).

C.3 American Physical Society (Guidelines for Professional Conduct)[3]

Each physicist is a citizen of the community of science. Each shares responsibility for the welfare of this community. Science is best advanced when there is mutual trust, based upon honest behavior, throughout the community. Acts of deception, or any other acts that deliberately compromise the advancement of science, are unacceptable. Honesty must be regarded as the cornerstone of ethics in science. Professional integrity in the formulation, conduct, and reporting of physics activities reflects not only on the reputations of individual physicists and their organizations, but also on the image and credibility of the physics profession as perceived by scientific colleagues, government, and the public. It is important that the tradition of ethical behavior be carefully maintained and transmitted with enthusiasm to future generations.

The following are the minimal standards of ethical behavior relating to several critical aspects of the physics profession. Physicists have an individual and a collective responsibility to ensure that there is no compromise with these guidelines.

Research Results

The results of research should be recorded and maintained in a form that allows analysis and review. Research data should be immediately available to scientific collaborators. Following publication, the data should be retained for a reasonable period in order to be available promptly and completely to responsible scientists. Exceptions may be appropriate in certain circumstances in order to preserve privacy, to assure patent protection, or for similar reasons.

Fabrication of data or selective reporting of data with the intent to mislead or deceive is an egregious departure from the expected norms of scientific conduct, as is the theft of data or research results from others.

Publication and Authorship Practices

Authorship should be limited to those who have made a significant contribution to the concept, design, execution, or interpretation of the research study. All those who have made significant contributions should be offered the opportunity to be listed as authors. Other individuals who have contributed to the study should be acknowledged, but

3 https://www.aps.org/policy/statements/02_2.cfm (accessed 21 November 2017).

not identified as authors. The sources of financial support for the project should be disclosed.

Plagiarism constitutes unethical scientific behavior and is never acceptable. Proper acknowledgement of the work of others used in a research project must always be given. Further, it is the obligation of each author to provide prompt retractions or corrections of errors in published works.

Peer Review

Peer review provides advice concerning research proposals, the publication of research results, and career advancement of colleagues. It is an essential component of the scientific process.

Peer review can serve its intended function only if the members of the scientific community are prepared to provide thorough, fair, and objective evaluations based on requisite expertise. Although peer review can be difficult and time-consuming, scientists have an obligation to participate in the process.

Privileged information or ideas that are obtained through peer review must be kept confidential and not used for competitive gain.

Reviewers should disclose conflicts of interest resulting from direct competitive, collaborative, or other relationships with any of the authors, and avoid cases in which such conflicts preclude an objective evaluation.

Conflict of Interest

There are many professional activities of physicists that have the potential for a conflict of interest. Any professional relationship or action that may result in a conflict of interest must be fully disclosed. When objectivity and effectiveness cannot be maintained, the activity should be avoided or discontinued.

It should be recognized that honest error is an integral part of the scientific enterprise. It is not unethical to be wrong, provided that errors are promptly acknowledged and corrected when they are detected.

C.3.1 Supplementary Guidelines on Responsibilities of Coauthors and Collaborators (Adopted by Council on 10 November 2002)

(This statement includes language from the "Report of the Investigation Committee on the Possibility of Scientific Misconduct in the Work of Hendrick Schoen and Coauthors," M. Beasley, S. Datta, H. Kogelnik, H. Kroemer, D. Monroe, 25 September 2002—internal Bell Laboratories

report, Bell Labs, Lucent Technologies. The language is used with the permission of Bell Labs.)

All collaborators share some degree of responsibility for any paper they coauthor. Some coauthors have responsibility for the entire paper as an accurate, verifiable, report of the research. These include, for example, coauthors who are accountable for the integrity of the critical data reported in the paper, carry out the analysis, write the manuscript, present major findings at conferences, or provide scientific leadership for junior colleagues.

Coauthors who make specific, limited, contributions to a paper are responsible for them, but may have only limited responsibility for other results. While not all coauthors may be familiar with all aspects of the research presented in their paper, all collaborations should have in place an appropriate process for reviewing and ensuring the accuracy and validity of the reported results, and all coauthors should be aware of this process.

Every coauthor should have the opportunity to review the manuscript before its submission. All coauthors have an obligation to provide prompt retractions or correction of errors in published works. Any individual unwilling or unable to accept appropriate responsibility for a paper should not be a coauthor.

C.3.2 Supplementary Guideline on Research Results (Adopted by Council on 10 November 2002)

Collaborations are expected to have a process to archive and verify the research record; to facilitate internal communication and allow all authors to be fully aware of the entire work; and respond to questions concerning the joint work and enable other responsible scientists to share the data. All members of a collaboration should be familiar with, and understand, the process.

C.3.3 Supplementary Guideline on References in Publications (Adopted by Council on 30 April 2004)

Authors have an obligation to their colleagues and the physics community to include a set of references that communicates the precedents, sources, and context of the reported work. Proper referencing gives credit to those whose research has informed or led to the work in question, helps to avoid duplication of effort, and increases the value of a paper by guiding the reader to related materials. It is the responsibility of authors to have surveyed prior work in the area and to include relevant references.

Proper and complete referencing is an essential part of any physics research publication. Deliberate omission of a pertinent author or reference is unethical and unacceptable.

C.4 American Society of Mechanical Engineers (Code of Ethics of Engineers)[4]

C.4.1 The Fundamental Principles

Engineers uphold and advance the integrity, honor, and dignity of the engineering profession by:

I) Using their knowledge and skill for the enhancement of human welfare;
II) Being honest and impartial, and serving with fidelity the public, their employers, and clients; and
III) Striving to increase the competence and prestige of the engineering profession.

C.4.2 The Fundamental Canons

1) Engineers shall hold paramount the safety, health, and welfare of the public in the performance of their professional duties.
2) Engineers shall perform services only in the areas of their competence; they shall build their professional reputation on the merit of their services and shall not compete unfairly with others.
3) Engineers shall continue their professional development throughout their careers and shall provide opportunities for the professional and ethical development of those engineers under their supervision.
4) Engineers shall act in professional matters for each employer or client as faithful agents or trustees, and shall avoid conflicts of interest or the appearance of conflicts of interest.
5) Engineers shall respect the proprietary information and intellectual property rights of others, including charitable organizations and professional societies in the engineering field.
6) Engineers shall associate only with reputable persons or organizations.
7) Engineers shall issue public statements only in an objective and truthful manner and shall avoid any conduct which brings discredit upon the profession.

4 https://community.asme.org/ethics_committee/m/default.aspx (accessed 21 November 2017).

8) Engineers shall consider environmental impact and sustainable development in the performance of their professional duties.
9) Engineers shall not seek ethical sanction against another engineer unless there is good reason to do so under the relevant codes, policies, and procedures governing that engineer's conduct.
10) Engineers who are members of the Society shall endeavor to abide by the Constitution, By-Laws, and Policies of the Society, and they shall disclose knowledge of any matter involving another member's alleged violation of this Code of Ethics or the Society's Conflicts of Interest Policy in a prompt, complete, and truthful manner to the chair of the Ethics Committee.

C.5 Institute of Electrical and Electronics Engineers (Code of Ethics)[5]

We, the members of the IEEE, in recognition of the importance of our technologies in affecting the quality of life throughout the world, and in accepting a personal obligation to our profession, its members, and the communities we serve, do hereby commit ourselves to the highest ethical and professional conduct and agree:

1) to accept responsibility in making decisions consistent with the safety, health, and welfare of the public, and to disclose promptly factors that might endanger the public or the environment;
2) to avoid real or perceived conflicts of interest whenever possible, and to disclose them to affected parties when they do exist;
3) to be honest and realistic in stating claims or estimates based on available data;
4) to reject bribery in all its forms;
5) to improve the understanding of technology; its appropriate application, and potential consequences;
6) to maintain and improve our technical competence and to undertake technological tasks for others only if qualified by training or experience, or after full disclosure of pertinent limitations;
7) to seek, accept, and offer honest criticism of technical work, to acknowledge and correct errors, and to credit properly the contributions of others;

5 https://www.ieee.org/about/corporate/governance/p7–8.html (accessed 21 November 2017).

8) to treat fairly all persons and to not engage in acts of discrimination based on race, religion, gender, disability, age, national origin, sexual orientation, gender identity, or gender expression;
9) to avoid injuring others, their property, reputation, or employment by false or malicious action;
10) to assist colleagues and co-workers in their professional development and to support them in following this code of ethics.

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Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World, First Edition. Dennis W. Hess.

Published 2018 by John Wiley & Sons, Inc.

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