Technical Leadership Skills Development Through Interactive Workshops

Prof. Dennis W. Hess, Georgia Institute of Technology

Dennis W. Hess is the Thomas C. DeLoach Jr., Professor of Chemical & Biomolecular Engineering at the Georgia Institute of Technology. His research interests include thin films, surfaces, interfaces, and plasma processing; these studies have resulted in more than 260 archival publications. In 2018, he published a book entitled, "Leadership by Engineers and Scientists (Wiley/AIChE). Professor Hess has a B.S. in Chemistry (Albright College), and M.S. and Ph.D. degrees in Physical Chemistry (Lehigh University). After four years at Fairchild Semiconductor, he served on the faculty in Chemical Engineering at the University of California Berkeley (1977-1991), where he spent 6 years as Assistant Dean in the College of Chemistry and 2 years as Vice Chair in ChE, at Lehigh University (1991-1996) where he was Department Chair, and at the Georgia Institute of Technology (1996-present). At Georgia Tech, he served as Director of the NSF MRSEC for Electronic Materials from 2008 to 2015. He was Editor-in-Chief of ECS Journal of Solid State Science and Technology from 2012 through 2018. He is past President of The Electrochemical Society (1996-97 term). He is a Fellow of the American Chemical Society, the American Association for the Advancement of Science, the American Institute of Chemical Engineers, and the Electrochemical Society. He has received the AIChE Charles M. A. Stine Award, the ECS Solid State Science and Technology Award, the ECS Thomas D. Callinan Award, the ECS Edward Goodrich Acheson Award, and the ECS Henry B. Linford Distinguished Teaching Award.

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Dennis W. Hess
School of Chemical & Biomolecular Engineering
Georgia Institute of Technology
Atlanta, GA 30332-0100

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Engineers and scientists typically aspire toward or are placed in leadership and management positions due to technical competency and exemplary achievements in technical roles and assignments. When first placed in leadership roles, engineers/scientists often conclude that subordinates behave and approach issues illogically, which can lead to inappropriate and damaging leader reactions. Outcomes from initial exposure to leadership or management positions are frequently frustration and anxiety and a desire to return to purely technical tasks. Such reactions arise primarily because the traits and mindsets developed in formal academic training for engineering/science degrees can limit success in leadership roles, where soft/professional or people skills may dominate the approaches required. Indeed, numerous surveys and curriculum outcome assessments promote the need for professional skills development during the educational process [1-6].

Engineers are taught to address complex technical problems using fundamental principles and rubrics that allow progress to be made toward an optimal solution. Technical leadership responsibilities include oversight of technical problem-solving, but in addition, leaders must address the added complexity that exists when engineering/scientific and people problems intersect; these situations are referred to as sociotechnical issues. Effective methods to solve such problems demand a transition in mindset and emphasis.

Many frustrations exist when technically-trained individuals undertake leadership positions. For instance, they are overwhelmed by new and unfamiliar (people) responsibilities; they must delegate many technical responsibilities rather than depend solely on themselves; they feel that they should have all the right answers since their credibility arises from technical knowledge; they believe that they can convince others of their point of view by offering an endless array of details, data, and 'facts'. These limitations can be addressed by enhancing the leader's people skills and thereby focus attention on **others** to: promote interdependence among team members; spend more time listening than speaking; ensure that relevant information is communicated to team members; recognize and deal with others' problems, concerns, and alternative technical and non-technical viewpoints; facilitate others' professional and personal development. That is, effective technical leaders expand their mindset from a sole focus on technical details, goals, and accomplishments to include program and people direction and management.

Engineers/scientists have a most appropriate background to tackle sociotechnical problems. Their approach to these problems should follow that of solving purely technical ones: gather data, evaluate and analyze the information obtained, and draw conclusions. However, on the path to solutions, personal biases, experiences, values, beliefs, priorities, cultures, and personalities of each team or organization member confound effective decision-making and lead to personal and professional conflict. This means that the technical leader must consider the problem(s) in light of both the individuals involved and the engineering or scientific challenges. Unfortunately, academic training does not build awareness of such issues, and therefore does not equip students or postdoctoral scholars with tools to address these situations.

Technical degree programs focus on technical competency, continuous learning, passion for engineering and science, and ability to identify significant problems. Aptitude in these areas is essential but not sufficient for success in technical leadership. Effective leaders also must display specific traits and perform a multitude of other indispensable activities including ethical and professional behavior, resilience, clear communication, change management, risk-taking, team building, conflict management, and decision-making [7,8]. The criticality of these issues and potential ways to expose students to such skill sets has been encouraged by the publication of a Special Issue on Engineering Education: Beyond Technical Skills [7]. ABET also indicates the need for such skill development via Criterion 3 where students must display the ability to function on multidisciplinary teams, understand professional and ethical responsibility, communicate effectively, and understand the impact of engineering solutions in a context that includes global, economic, environmental, and societal issues [8].

Students who have completed co-ops or internships readily distinguish between effective and ineffective leaders. However, they typically do not recognize why lack of essential professional traits and activities cause leadership disasters and employee dissatisfaction. Making this connection is imperative if students are to appreciate the need for and development of soft or professional skills. In addition, students need to know that effective engineering leadership approaches are somewhat fluid in that they depend upon the career stage, personalities involved, and organizational culture within specific situations [9].

Leadership Course or Workshop Content and Methodology

The lack of leadership training and awareness in technically-trained individuals can be addressed by interactive courses or workshops; topics and approaches to fill this void are described in this section. A course (1-3 credits) allows detailed presentation of leadership background material as it relates to students with technical mindsets and offers scenarios that occur frequently in early- to mid-career positions that can be discussed within small groups or as a class; a guide or template, complete with numerous homework and discussion questions for such a course is available [10,11]. Workshops of 3-4 hours in length can be offered that cover the same introductory material but with considerably less depth and many fewer topical areas and examples/scenarios. A leadership seminar that meets each week during a semester or quarter can achieve the same results. In all venues, there are two important aspects that must be conveyed to students. First, they need to understand why the purely technical mindset is generally problematic when functioning effectively as a leader (or manager). Second, they must appreciate why sociotechnical problems are particularly difficult due to individual leader and subordinate traits/characteristics.

Courses or workshops should begin with selected definitions of a leader or leadership to convey the focus of effort required to be effective. Although numerous definitions exist, one that I particularly like, because it sets the stage for nearly all content that follows, is attributed to John Quincy Adams:

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

This quote indicates that a leader's focus should be on others and that titles have nothing to do with being a leader; actions and inspiration identify a leader.

It is also appropriate to distinguish between a leader and a manager, because students frequently believe they are equivalent. Although they have a number of responsibilities and demands in common, significant differences exist. A leader takes risks to move toward an overarching vision but does not specify a particular path, whereas a manager is responsible for ensuring that tasks are completed, standards met, and protocols followed and controlled – risk is generally avoided.

Early in the workshop or course, students should be shown some of the primary reasons for frustration in early (and perhaps later) leadership roles; these have been described above. In addition, students must be reminded of the difference between the technical problems that have been posed in their core courses, where (generally) a single correct answer or approach is sought, and sociotechnical problems that have better or poorer approaches that often depend upon the specific individuals, team or organization, and have few right or wrong answers. Assignments that emphasize self-awareness and self-assessment introduce topics that few students have explored since engineering and science core courses do not address 'people' issues [12,13]. However, self-assessment and self-awareness are imperative, because students should understand how their biases, experiences, priorities and values affect their ability to lead, to react appropriately to stressful situations, and to make decisions. A variety of standardized self-assessment tests are available that students can access to generate more detailed information about their personalities, strengths, and weaknesses [14-17]. Such evaluation and identification are crucial to developing the ability to lead oneself and others. Equally important is the recognition that others (subordinates, peers, bosses) make decisions and react to circumstances according to their unique biases, experiences, priorities, values, and emotions, which will almost certainly differ from those of the leader. That is, individual opinions, reactions, and outbursts that appear illogical typically stem from personal characteristics and circumstances; when such information is gathered and better understood by the leader, appreciation for reactions as well as methods of dealing with responses to situations and developing conflict management approaches are facilitated. Questions (from Ref. 10) that can be used as homework or for small group discussion in self-assessment are:

- What life- or career-changing events or experiences have led to your current situation or goals?
- After reading the list of values offered by C. Roberts (http://www.selfcounseling.com/help/personalsuccess/personalvalues.html),
    - Which 5 values are most important to you?
    - Which 5 values are least important to you?
    - What other (not listed) values are important for you personally and especially for you in a technical career or leadership position?
- Have you taken advantage of or sought opportunities in your professional or personal life to practice leadership within groups?
    - If you have not, what has kept you from seeking such activities?

- If you have, what were your successes and failures?
- What traits are needed for you to be more effective in future leadership efforts?

• Do you have aspirations to be a technical leader/manager at a middle administrative level (e.g., academic department head, division head) or higher (e.g., dean, provost, VP, CEO) at some point in your career?

- Why do you aspire to this goal or why do you want to avoid such positions?
- What do you expect will be the rewards of such positions?
- What do you expect will be the most frustrating part(s) of such positions?

After self-assessment, recognition of destructive habits or beliefs of leaders can be discussed and their impacts on leader effectiveness and efficiency described. These habits include pride, power/control over others, prejudice, micromanagement, lack of respect for others, and conflict avoidance. Comparison and contrast of these habits to those of effective leaders (e.g., respect for others, authenticity, listening skills, development of others, admission of mistakes, praise for others, conflict management) offers insight into how to function as a team/group leader while continuing to be viewed as a technical team member and contributor.

Most students (and many early career engineers/scientists) believe that a technical leader is a highly technically competent individual to whom others go for assistance in the solution of technical problems. Although technical ability is a necessary aspect of successfully overseeing an engineering or scientific team or organization, a large portion of the leader's time is spent interacting with others, only some of whom report to him/her. Therefore, it is important that students understand that the leader must be adept at personal interactions and at building and maintaining relationships. That is, he/she must have emotional intelligence and function as a servant leader. Such characteristics build trust and credibility, both technically and personally.

Emotional intelligence embodies self-awareness, self-management, social awareness, and relationship management [18,19]; technical leaders must therefore determine and acknowledge their emotions and 'hot buttons'. Since we can only control our own behavior, we must do so under stressful situations while recognizing and appreciating why others behave or react differently. Such conduct shows empathy and the desire to understand the emotions, values, and priorities of those around us and allows us to take advantage of these differences to enhance individual and team performance. This approach treats the sociotechnical issues encountered as problems and issues to be resolved and often lowers the frustration and dissatisfaction encountered in technical leadership roles.

Servant leaders focus on the needs, development and well-being of others and share power or control [20,21]. Difficulties in applying this leadership style are typically due to our training where we are taught to be independent and defend our views to avoid 'losing' or being proved wrong. We can often engage others readily by showing sincere interest in their point of view, ensuring that clear communication of similarities and differences in viewpoint has taken place, and by involving them in planning and implementation of new initiatives or changes in direction. This interdependence culture develops openness, trust, responsibility, and accountability and ensures that any issue or direction can be questioned and discussed. Due to the resulting diversity

of views and opinions combined with clear communication and understanding among all participants, the probability of success in solving complex problems and making reasonable decisions increases.

With these leadership fundamentals as background to appreciate and better understand the role and mindset of effective technical leaders, a variety of subjects can now be discussed. For instance, in a formal course, topics such as ethics and professionalism, time management, building trust and credibility, creativity and risk taking, team building and teamwork, establishing a questioning culture, making decisions and managing change, conflict management, communication, and presenting difficult messages, can be covered in various levels of detail; examples of approaches to cover these subjects can be found elsewhere [10].

If a ~2 hour workshop is to constitute student exposure to leadership skills development, limited time can be devoted to specific topics. It is therefore best to discuss frustrations typically encountered in early-career leadership roles, the transition in mindset and approach needed to help alleviate stress and discomfort, effective and ineffective leader habits, and briefly cover emotional intelligence and servant leadership,. A few specific topics can then be covered, according to the focus the workshop presenter desires. In a 3-4 hour workshop, teamwork, ethical and professional behavior, conflict management, negotiation, and managing your boss can be added, since these are topics that students find helpful and to which they readily relate.

One of the most effective ways of developing leadership skills is to invoke problem-based learning; student surveys have indicated that the participants improved substantially across a variety of professional skills [22]. This approach can be implemented in an analogous manner to that used frequently in core engineering courses: interactive discussion of examples and group problem sessions. The focus should be primarily on situations encountered in early- and mid-career leadership or management positions. During my 5 years of presenting courses, short courses, and workshops at universities and professional society meetings, student/attendee evaluations nearly always identify this aspect as the most useful in understanding and implementing leadership fundamentals and especially for leadership development. Furthermore, the discussions demonstrate the fact that a single leadership style or approach does not apply to every situation and individual; an effective leader must adjust his/her style and function as an agile and adaptable sociotechnical problem solver. Even the same leadership dilemma often requires different approaches when the individuals, circumstances, deadlines, and team/organization cultures are different; this is an anathema to technically-trained individuals who want to apply the ‘correct’ rubric for solution to a particular problem type. Such reactions allow a discussion of the need to listen (an activity typically not practiced extensively) to and understand others’ views and opinions.

Leadership scenarios for discussion in courses and workshops arise from a variety of sources, but all of them should represent realistic situations, most of which have been encountered by individuals with technical training. Specifically, examples that I use come primarily from: my experiences in leadership positions in industry, academia, professional societies, journal editorships; experiences of students or former students in internships, co-ops, permanent positions; discussions with or observations of colleagues who have encountered frustrations in

leadership positions; accounts of situations that have been described in newspapers and reports in academia, industry, and national laboratories. Numerous scenario examples can be found in [10].

Discussion of the scenarios is performed in the following way. Background information on the topic (e.g., leadership fundamentals, ethics and professionalism, building trust, creativity, teamwork, running meetings, conflict management, communication, delivering bad news) is presented via 6-8 power point slides. A question or discussion situation is then presented. Attendees are divided into teams of 3-5, depending upon the total number present, and are given 5-7 min to discuss the scenario posed. In a formal course, I promote diversity in ideas, perspectives, and personalities by rotating the team membership once or twice during the semester. One member of each team then reports the approach(es) to addressing the situation described that were discussed in their team; I insist that the 'reporter' vary with each scenario posed to allow each team member several opportunities to present or summarize the team discussion. Only clarification or brief comments from other attendees is permitted during these presentations. After all teams have reported, we discuss the pros and cons of the different approaches offered. This gives me a chance to play 'devils advocate' with certain approaches, and relate specific experiences and outcomes as appropriate to team suggestions. It is critical that even extreme suggestions are considered; in such cases, I ask a number of questions, usually centered around, "What response do you expect from such actions or directions from those above and below you in the food chain?" In this way, I discuss positive and negative consequences of certain approaches to resolve the dilemma without criticizing the suggestions and thereby inhibiting future discussion. After the first few of these activities, (most) students lose their reticence to speak up and I sometimes have to terminate the discussion to move on to new or different leadership concepts.

The best way to indicate the type of scenarios that promote detailed discussion and insight into leadership dilemmas is to offer several examples; these have been taken from [10].

Leadership Scenario Discussions:

• 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?

• When building trust and credibility within your team, discuss the relative importance of:

- Technical competency and accomplishments
- People skills
- Suggest scenarios where one might be more important than the other versus when they would be equally important

• When a team or 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/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.

• 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 rude, 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 would an effective leader deal with such individuals?
- What can a leader do to encourage everyone on the team to help or support each other?

Impact of Workshops/Courses

Over the five years that the leadership courses have been offered to Georgia Tech students, approximately 50 graduate and 90 undergraduate students have completed the courses. To date, I have performed only informal assessment of the outcomes. At the beginning of each course, a homework assignment asks what the student hopes to gain from this course. Nearly all students simply state that they want to learn more about being a leader; specifics are missing in almost every case, suggesting that they are not certain what leadership entails nor what is required to improve. After completion of the course, one of the evaluation questions asks students for their perception of the utility of the course. Primary responses have been: my awareness of the importance and practice of soft skills improved substantially; this has been useful for my job search/interviews; I feel more confident regarding how to work in teams; we learned from each other due to the discussion-based nature of the course; the leadership scenarios we discussed were extremely useful; this course should be required for all engineering students.

I have also given several workshops (2-4 hours) to more than 130 undergraduate and graduate students at Georgia Tech and at other universities. A brief questionnaire asked about the most useful aspect of the workshop; in almost every case, the primary aspects mentioned were: discussion of the scenarios posed and discussion of ineffective and effective habits of leaders. In addition, I asked if their view of the skill set needed to be an effective technical leader had changed as a result of the workshop and essentially everyone indicated that it had.

I have also offered workshops at professional society meetings over the past few years where the attendees (~160) comprised graduate students, postdocs, and faculty members, as well as industrial and national laboratory employees. In these cases, I typically ask the attendees to fill out a brief pre-workshop questionnaire to gain knowledge of their experience level in leadership activities and their current job title; leadership experience ranged from 0 to 10 years. Consistent with the student workshops, the attendees felt that the content was very useful for their current and (anticipated) future positions and that the scenario discussions were very productive. When

asked if their views of the skill set needed for effective technical leadership changed as a result of the workshop, the response was overwhelmingly *yes*.

Nearly all early career faculty members who attended workshops felt the content was extremely useful because they had no idea how to run a group and deal with conflict and motivation among group members. Two individuals who had at least 10 years of industrial experience noted that the content was helpful, but the pace of the workshop was a bit slow; of course, this is consistent with the content being directed at student and early career engineers. Industrial attendees with 0-3 years of experience in leadership or management roles indicated that the workshop was extremely helpful, addressed many of their questions about these positions, and offered ways to approach difficult conversations or interactions. Interestingly, one individual who had more than 5 years of experience as a team leader in industry sent me a note several months after the workshop. His remarks indicated that after he returned to his team, he began to more frequently show appreciation for team members and their accomplishments, and ask more questions rather than give directives. His subsequent statement was: "It works!"

I expect to gather additional information in a more systematic and detailed manner over the next few years. In particular, I intend to contact a number of students ~5 years after graduation to inquire if and how their career accomplishments have been enhanced by the leadership course or workshop. I expect to have analogous conversations with the supervisors of these individuals to find out if the employees transitioned well into leadership or management roles. Such results will supply more in depth information and insight regarding outcomes and offer ways that the effectiveness of the courses/workshops can be improved.

Concluding Comments

In addition to displaying technical competency, effective technical leaders build personal and professional relationships, share power, listen to others with widely divergent views/opinions, and develop those around them to facilitate success. Such demands require soft or professional skills that have not been stressed or perhaps even mentioned in engineering or science programs. Equally detrimental is the fact that many of our educational approaches seek virtually complete independence and risk aversion by describing situations where the undisputed 'correct' answer is always possible. Frustration and anxiety are therefore typical outcomes in early-career leadership positions, stemming in large part from the mindset and traits imparted where data, facts, and logic represent the only cornerstones for success.

Awareness of the necessary traits and ways to develop emotional intelligence and servant leadership to facilitate success in leader or manager positions can be imparted to students through interactive courses and workshops. Problem-based learning is paramount in leadership training to demonstrate that 'correct' or even good answers are sometimes not possible, but decisions must be made to move the project and team forward. By considering and discussing realistic leadership or management scenarios that require decisions or responses where ambiguity reigns due to the sociotechnical problems encountered, early-career engineers and scientists can recognize and are better able to address such issues without being debilitated by frustration and anxiety.

References

[1] S. Kumar and J. K. Hsiao, "Engineers Learn "Soft Skills the Hard Way": Planting a Seed of Leadership in Engineering Classes", *Leadership and Management in Engineering*, vol. 7(1), 18-23, 2007.

[2] M. F. Cox, O. Cekic, B. Ahn, and J. Zhu, "Engineering Professionals' Expectations of Undergraduate Engineering Students", *Leadership and Management in Engineering*, vol. 12(2), 60-70, 2012.

[3] H. J. Passow, "Which ABET Competencies do Engineering Graduates Find Most Important in Their Work?", *Journal of Engineering Education*, vol. 101(1), pp. 95-118, 2012.

[4] T. A. Steelman and J. J. McDonnell, "Look for the Leaders", *Nature*, vol. 547, pp. 483-483 (27 July), 2017.

[5] P. Wankat, "Perspective: Teaching Professional Skills", *AIChE Journal*, vol. 63(7), 2511-2519, 2017.

[6] C. Horth, "Without Soft Skills, Technical Education is Stuck in the Past", *Industry Week*, May 29, 2018, https://www.industryweek.com/talent/article/22025722/without-soft-skills-technical-education-is-stuck-in-the-past (accessed 20 February, 2020).

[7] "Engineering Education: Beyond Technical Skills", *International Journal of Engineering Education*, vol. 30(6), 2014.

[8] ABET https://www.abet.org/approved-criteria-for-the-2018-2019-review-cycle/ (accessed 20 February, 2020).

[9] D. Reeve, C. Rottmann, and R. Sacks, "The Ebb and Flow of Engineering Leadership Orientations", 122nd ASEE Annual Conference & Exposition, pp. 26.15109.1-26.1519.16, 2015.

[10] D. W. Hess, *Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World*, Hoboken, NJ, Wiley/AIChE, 2018.

[11] D. W. Hess, "Leadership Skills Awareness and Development via Interactive Engineering Courses or Workshops", *Chemical Engineering Education*, vol. 53(1), pp. 33-41, Winter, 2019.

[12] D. Hess, *Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World*, Hoboken, NJ, Wiley/AIChE, 2018, pp. 40-42 and Appendices A and B.

[13] A. N. F. Versypt, "Self-evaluation and Reflection for Professional Development of ChE Students", *Chemical Engineering Education*, vol. 53(3), pp. 157-161, Summer, 2019.

[14] Kolbe Group: https://secure.kolbe.com/k2/show_takeIndex/IndexType_A (accessed 7 January, 2020).

[15] Myers-Briggs Personality Test: http://www.onlinepersonalitytests.org/mbti/ (accessed 7 January, 2020).

[16] Big Five Personality Test: https://www.outofservice.com/bigfive/ (accessed 7 January, 2020).

[17] Leadership 360º Assessment: https://www.outofservice.com/bigfive/ (accessed 7 January, 2020).

[18] T. Bradberry and J. Greaves, *Emotional Intelligence 2.0*, San Diego, CA, TalentSmart, 2009.

[19] D. Goleman, *Emotional Intelligence: Why It Can Matter More Than IQ*, New York, NY, Bantam Books, 2006.

[20] R. Greenleaf, *Servant Leadership: A Journey in the Nature of Legitimate Power and Greatness*, Mahwah, NJ, Paulist Press, 2002.

[21] S. Sinek, *Leaders Eat Last: Why Some Teams Pull Together and Others Don't*, New York, NY, Portfolio/Penguin, 2017.

[22] U. Beagon, D. Niall, and E. N. Fhloinn, "Problem-based Learning: Student Perceptions of Its Value in Developing Professional Skills for Engineering Practice", *European Journal of Engineering Education*, vol. 44(6), pp. 850-865, 2019.