Leadership by Engineers and Scientists: Professional Skills Needed to Succeed in a Changing World

by D.W. Hess

John Wiley & Sons. 240 pp. ISBN-13: 978-1119436591. Amazon: eTextbook: $51.19; Hardcover $63.51

Bad Blood: Secrets and Lies in a Silicon Valley Startup

by J. Carreyrou

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The basic premise of Ference Marton's Variation Theory[1] is that learning best takes place when we experience differences relative to the background of sameness. In that vein, I juxtapose two fascinating books published in Summer 2018 that tell very different stories around the same theme—technical leadership. Technical leadership is an area of emerging interest among engineering educators, as evidenced by recent calls for professional formation of engineering students to extend beyond technical competence and develop the knowledge, skills, and attitudes that allow them to tackle the sociotechnical work of the profession.[2] By sociotechnical work, I mean what Hess describes (although he does not use the term per se) as the complex workplace situations "with numerous interacting causes and effects due to technical and people issues" (p. 18), "where the trade-offs between technical issues and moral issues are ubiquitous" (p 55).

Dennis Hess's comprehensive textbook evolved out of undergraduate and graduate chemical engineering classes he developed at the Georgia Institute of Technology. He nominally organizes the book in two parts: (I) introduction to technical leadership (6 chapters) and (II) putting leadership principles into practice (7 chapters). He draws on literature from business and management as well as popular literature and his rich personal experiences as a leader. His book can be used by instructors either as a textbook for a dedicated course on technical leadership or as a reference to integrate these topics elsewhere in the curriculum.

The tone of the book is set immediately in Chapter 1, "Examples of routine problems and decisions faced by technical leaders," where Hess illustrates the role of leaders as problem solvers, but not of purely technical but rather of sociotechnical problems. The chapter centers on five vignettes where no single correct answer is provided but rather a path and reasoning process for obtaining information and making decisions is developed. It sets forth the organizing strategy Hess uses throughout which is based on describing the foundational attributes and principles of leadership and defining leaders as the way individuals interpret and apply these foundational principles to problem solve in the wide array of workplace situations. In this way, he describes the leader as someone who is dynamic, with expertise that can be adapted to resolve complex problems.

Hess follows with a 40-page chapter that comprehensively describes a set of "technical leadership fundamentals" that are then elaborated upon in smaller bites in topic-specific chapters that follow. These later chapters cover a wide breadth, including the four remaining chapters in Part I, ethics and professionalism (chapter 3), time management (chapter 4), building trust and credibility (chapter 5), and risk taking, creativity, and confidence (chapter 6); and the seven chapters of Part II, leadership through questions (Chapter 7), vision (Chapter 8), teaming (Chapter 9), running effective meetings, making decisions, and managing change (Chapter 10), conflict (Chapter 11), communication (Chapter 12), and presenting difficult messages (Chapter 13). After the first two chapters, the chapters are essentially self-contained and can be read in any order. This feature presents an advantage to an instructor who is interested in integrating chapter-specific information into another class (*e.g.*, senior design), but has the drawback that some themes keep showing up in these interconnected topics (*e.g.*, the need for the leader to build and maintain trust) that can feel repetitive.

The structure of each chapter supports Hess's pedagogical objectives. He begins with a few pertinent quotes to generate interest [one of my favorites is, "Faced with the choice of changing one's mind and proving there is no need to do so, almost everybody gets busy on the proof" – John Kenneth Galbraith (p 164)]. The quotes are followed by a practical vignette that situates the topic. In most chapters, a scenario is presented at the beginning of the chapter and resolved at the end after the content is presented. The vignette is followed by expository prose, references, and a set of five to 20 provocative open-ended homework questions. Hess provides relief from his dense prose with periodically interspersed

discussion questions [*e.g.*, In Chapter 8, Creating a Vision, "Do you consider Steve Jobs to be a leader based on the various effective and ineffective traits and characteristics that we have discussed?" (p. 131)] and some well-placed "nerd" humor (which I say with complete admiration). The prose is most effective in those parts that are illustrated by real cases such as DuPont's emerging safety culture (cultural change), the Challenger incident (creating a questioning culture), strategies of Amazon CEO Jeff Bezos (running an effective meeting), President Abraham Lincoln (team building), the Intel trinity of Moore, Noyce, and Grove (team building), and Intel's pivot from memory chips to microprocessors (managing change). While Hess does a good job in balancing the gender representation in his more generic vignettes, the historical examples above all strikingly illustrate leaders who are white males. If this book is used in class, it would be good to have an explicit discussion about the lack of leaders from underrepresented groups depicted in the historical cases.

Hess's book is a valuable resource on ABET's new leadership outcome that includes less familiar aspects of leadership (*e.g.*, risk taking, conflict, managing change, presenting difficult messages). For example, he identifies effective risk taking as a critical attribute of a leader. In addition to connecting aversion to risk to personal characteristics such as ego or imposter syndrome, he points to the "solved example problem" in lecture as contributing to graduates who are adverse to risk taking. He reasons that since many instructors do not take risks to show the "dirty" part of problem solving (*i.e.*, confusion and failure), they model a version of expertise where answers are sure and always successful—essentially modeling a low-risk environment. In this way, he connects an undesirable leadership characteristic to the central practices and structures of the engineering educational system. Hess's book also provides a valuable resource for several other ABET-stated outcomes (*e.g.*, ethics, communication, teaming).

Throughout the text, Hess emphasizes that productive engineering work depends on how individuals are organized to work together. Along those lines, he describes the need for a leader to transcend from independent to interdependent "so that they can learn from and take advantage of different opinions and viewpoints" (p. 39) where diverse backgrounds and personalities lead to "varied outlooks and attitudes [that] often inspire new directions or identify and anticipate difficulties" (p. 144). In Chapter 9 (teaming), he elaborates that the "collective intelligence" of a team is more than the sum of the individuals' IQs, but rather the ability for the team to think and create in ways no individual could by herself. Again we can consider the impact of our educational systems, contrasting this view of technical competency with the common academic value of developing Ph.D. students to become "independent researchers."

Bad Blood is a page-turner by investigative reporter John Carreyrou telling the story of Elizabeth Holmes, founder and CEO of the biomedical start-up company Theranos. Holmes dropped out of the chemical engineering program at Stanford University after one year to follow the path of her idol (and fellow dropout) Steve Jobs, and create what she envisioned as "the iPhone of health care" by producing a device that could provide hundreds of instant and painless tests run on a few drops of blood collected from a fingertip prick.

At first blush, Theranos, using the script of Silicon Valley computer start-ups, was a wildly successful "unicorn" biotechnology company that obtained more than $700 million in funding on a valuation of $9 billion. However, Carreyrou depicts a delicate house of cards built on a range of lies from fabricating and falsifying data to constructing an entirely nonfunctional "mock lab" to impress visiting Vice President Joe Biden. Under Holmes's direction, Theranos ignored medical product proficiency testing standards creating a new protocol she claimed was necessary for their state-of-the-art technology. Yet, most tests actually used standard Siemens instrumentation either by diluting the small fingertip samples to create the necessary volume (which was inherently unreliable), or in many cases, using a conventional venous draw instead. More than a million customers were led to make important medical decisions based on information from unreliable technology and questionable laboratory practices.

The toxic work environment created by Holmes is a case study of failed technical leadership. Workers were sequestered and subject to only need-to-know information while facing obsessive secrecy, intimidation, and, in several cases, legal bullying from the top litigator in Silicon Valley. In Holmes's Theranos, there was no place for doubter, questioner, or critical inquiry. In essence, Holmes is depicted as the opposite of Hess's "servant leader," lacking any apparent self-awareness and self-reflection that is so critical. As opposed to being risk adverse, we could call Holmes risk indulgent. And rather than being resilient and using failure as a learning opportunity, she responded to skeptical questions and genuine concerns as a challenge to the vision itself and responded to undesirable laboratory data simply by fabricating an alternative truth.

From the start, Carreyrou immerses us in an interlocking tangle of technical, ethical, legal, and social issues. He does well to broadly describe the technology and how the technical choices are embedded into sociocultural practices of this workplace. For example, he describes the tactical transition of the novel "Edison" device from a technology based on microfluidics to that using robotic handling of micropipettes as based on time-to-market pressures. He identifies social pressures placed on the technical expert of major client Walgreens—Kevin Hunter—which essentially rendered him unable to pursue his suspicions about the technology. It is explained as a combination of top Walgreens executives' "fear of missing out" on the next big market opportunity coupled with

persistent positioning by Holmes to reduce and then remove Hunter's influence. Finally, within this mangle, two young engineers, Erika Cheung and Tyler Schultz, demonstrate a steadfast ethical stance that leads to their whistle-blowing, and, as Carreyrou describes it, to the ultimate collapse of the house of cards. It also had a toll on the whistle-blowers, including the estrangement of the latter from his grandfather, former secretary of state and Theranos board member George Schultz. This story poignantly illuminates both the human and technical consequences of failed technical leadership.

Developing an awareness and understanding of effective leadership in the context of complex sociotechnical systems is an important outcome to an undergraduate chemical engineering education. *Leadership by Engineers* describes a broad array of individual characteristics that need to be cultivated in a leader. In contrast, *Bad Blood* provides a case study of how those characteristics interact with the culture within which they are embedded. While these books do not provide all the answers, they are an indispensable start to developing this understanding.

REFERENCES

1. Marton F & Säljö R (1976) On qualitative differences in learning: I—Outcome and process. *British Journal of Educational Psychology* 46(1):4.
2. American Society for Engineering Education (2013) *Transforming Undergraduate Education in Engineering (TUEE) Phase I: Synthesizing and Integrating Industry Perspectives*. (American Society for Engineering Education, Arlington, VA). ❒