

Leadership: Industry Needs for Entry-Level Engineering Positions

Beth L. Hartmann and Charles T. Jahren
Iowa State University

Abstract

This paper presents the results of a study that sought to identify and highlight what the most prominent competencies companies are seeking when they use the word *leadership* in job descriptions for entry-level, full-time engineering positions. Seven years of job posting data was analyzed to first understand the frequency and use of the word leadership in job descriptions. Using a systematic approach, six participants from engineering companies hiring students from a Midwestern university were selected and interviewed. Emerging themes from the interviews include the following leadership competencies: initiative/confidence, communication, interpersonal interactions, teamwork, and engagement. The goal of this ongoing research is to assist engineering programs to assess, refine, and develop curricula, advising materials and methods to best prepare students for industry.

Keywords: leadership, ABET, engineering education

Leadership: Industry Needs for Entry-level Engineering Positions

Engineering industry representatives have identified leadership skills as necessary for engineers entering today's workforce. Some companies have specifically included the word *leadership* in entry-level job descriptions. However, few go so far to define what this means. While there is a clear demand signal being sent from industry for engineering programs to create graduates with leadership skills, it is incumbent on members of academia to understand what leadership means to industry and to develop curricula to incorporate appropriate materials and activities into the undergraduate engineering programs to create engineering leaders.

The purpose of this case study was to explore what are the most prominent competencies companies are seeking when they use the word leadership in job descriptions. We first investigated job postings to understand the trends and the current landscape of positions requiring leadership. We then selected job postings for those positions advertised exclusively for construction engineering and electrical engineering majors and interviewed key personnel in

companies hiring these groups of jobseekers. Finally, we synthesized responses from our interviews into five themes. The emerging themes outlined in this study have the potential to help to shape engineering leadership curricula.

Background

Engineering Leadership Definition

There is a plethora of literature about leadership and important qualities needed, including the most basic, such as knowledge of self, emotional intelligence, motivation, etc. (Goleman, 1998; Goleman, Byatzis, & McKee, 2002; etc.), however, defining *engineering leadership* is in relatively early stages. Although industry and academia concur that leadership skills are essential for engineering graduates, no agreement has been made regarding a single definition for engineering leadership (Schuhmann, 2010, p.61). Some argue that engineering leadership is no different than leadership, while others believe engineering leadership must include an element of engineering design. To understand the current landscape, three definitions of engineering leadership discovered during a review of current literature are provided. The first definition provides an explanation geared at effectively leading others, while the other two describe the process to help understanding about how engineering leadership can be achieved.

"Engineering Leadership is the ability to lead a group of engineers and technical personnel responsible for creating, designing, developing, implementing, and evaluating products, systems, or services" (Crumpton-Young et al., 2010, p. 10).

"Engineering leadership is the process of envisioning, designing, developing, and supporting new products and services to a set of requirements, within budget, and to a schedule with acceptable levels of risk to support the strategic objectives of an organization" (Shaw, 2003).

The Gordon-MIT Engineering Leadership Program defined engineering leadership as "the technical leadership of change: the *innovative* conception, design and *implementation* of new products/processes/projects/materials/molecules/software/ systems, supported by

the invention of enabling technologies, to meet the needs of customers and society." (Bernard M. Gordon-MIT Engineering Leadership Program, 2011)

While an effort persists to adequately define engineering leadership, numerous academic institutions are currently delivering education and training to develop engineering leaders through formal programs and/or activities embedded into existing curricula.

Engineering Leadership Programs

The effort to highlight the need for leadership in engineering education has been ongoing since the 1990s. As stated earlier, representatives from academia and industry continue to search for a common definition of engineering leadership. This work has been performed to primarily assist undergraduate, graduate, and professional programs by highlighting some of the prominent engineering leadership expectations in the hiring process as they develop leadership curricula for engineering students and professionals.

Graham, Crawley & Mendelsohn (2009) identified over forty engineering leadership programs globally. Their report "aims to provide insight into current provision, highlight international variations in approach and identify examples of good practice." With many more programs in existence, no two are alike.

Need for Leadership

Leadership has been emphasized in various engineering reports, including ABET (2011) and the National Academy of Engineering (NAE, 2004, 2005). While many cite a need for engineers to have leadership skills (Arethya & Kalkhoff, 2010; Bowman & Farr, 2000; Cox, et al, 2010; Crumpton-Young et al., 2010; Farr & Forsythe, 1997; Graham, et al, 2009; Schuhmann, 2010), only 3 of the 28 engineering programs used the term leadership in their Program Criteria under the Accreditation Board for Engineering and Technology (ABET) Criteria for 2014-2015. From review of the *Criteria for Accrediting Engineering Programs* from the ABET website, leadership is only used four times: once in reference to Institutional Support and Leadership, the other three times in the description for Program Criteria for (1) Civil, (2) Construction, and (3) Engineering

Management and Similarly Named Engineering Programs (ABET, 2013). Additionally, Seemiller and Murray (2013) found that engineering programs contained the least amount of “Student Leadership Competencies” of the 18 categories of academic programs they reviewed.

While not explicitly stated in the ABET program criteria for most engineering majors, many posit that leadership is embedded into many of the ABET (a) through (k) student outcomes; researchers have mapped leadership knowledge, values, attitudes, skills, and abilities to these outcomes, as well as other lists (Farr & Forsythe, 1997; Bowman & Farr, 2000; Brumm, Hanneman & Mickelson, 2006; Passow, 2012; Yaacoub, Husseini & Choueiki, 2011; Schuhmann, 2014). A number of programs have also involved members of industry to help shape their curricular and extracurricular activities; however, limited studies have been performed to define the meaning of leadership when used in a job description.

One study did review job descriptions for soft skills required by industry. Yaacoub, Husseini & Choueiki (2011) performed a quantitative content analysis approach with job descriptions posted on various career websites. While they did not specifically identify any of these skills as leadership skills, the researchers mapped the descriptions to sixty different soft skills identified by Phani (2007) to ABET (a) through (k) outcomes.

In addition to the aforementioned efforts, in 2011 supporters of engineering leadership development and education created the Leadership Development Constituent Committee within the American Society for Engineering Education (ASEE). With over 300 members in 2014, the group received Division status and was renamed the Engineering Leadership Development Division. With an impetus to study and understand this need for engineers to possess leadership skills, more papers are being presented at the annual ASEE conference each year with a goal to share best practices (Pitts, McGonagle & Klosterman, 2013; Warnick, 2014). Meanwhile, interested parties have also published books dedicated to topics about leadership for engineers and engineering educators (Bennett & Millam, 2013; Gordon, 2012).

Research Study

The purpose of this qualitative research study is to identify the most important leadership competencies undergraduates seeking full-time employment should possess when applying for positions. The study was conducted at a land-grant institution in the American Midwest. The institution serves over 32,000 students and has roughly 6,300 faculty and staff members. The institution’s College of Engineering contains eight academic departments and offers 12 majors. The college hosts one of the largest indoor career fairs in the nation, with approximately of 300 companies represented and 3,000 to 6,000 students and alumni in attendance each semester.

Full-Time, Entry-Level Engineering Job Postings

Year	All	Leadership	%
2006-2007	929	117	12.6
2007-2008	920	119	12.9
2008-2009	502	69	13.8
2009-2010	405	49	12.1
2010-2011	1079	136	12.6
2011-2012	1555	212	13.6
2012-2013	1845	280	15.2
Total	7235	982	13.6

Table 1

In the study’s first phase, data from full-time job postings posted in the university’s career management system from August 1, 2006, through July 31, 2013, was analyzed to identify companies explicitly citing leadership in job descriptions. In the second phase, one-on-one interviews were conducted with representatives of six companies to determine which competencies companies most desire from applicants when using leadership in a job description.

Phase I: Job Description Analysis

Phase I of the study was a review of full-time, entry-level job postings for all engineering majors at the aforementioned university. In this phase, we analyzed job postings and specific job descriptions to identify companies meeting the criteria for inclusion in Phase II of the study. Using this methodical approach, we were able to select participants using *purposeful selection* (Light et al., 1990, p. 53). The goals of purposeful selection in this study were to identify typical companies that hired within disciplines that represented extreme cases – construction engineering and electrical engineering. A discussion of the selection of these

two majors is provided later in the study.

Engineering Job Posting Review

Engineering career services personnel provided job posting information from August 1, 2006, through 31 July 2013. For the seven-year period, a total of 16,173 jobs were posted in the system for all students and alumni in the college of engineering. After filtering out positions for underclassmen, Master’s/PhD students, and alumni, 7,235 job postings remained, of which 982 (13.6%) contained the word leadership in the job description. Table 1 provides a detailed breakdown of these job descriptions and leadership job descriptions by year. It was noted that these numbers include positions posted for specific engineering majors, as well as those posted for “All Majors” and “College of Engineering.”

The data was further evaluated to identify job descriptions posted for a single engineering major as opposed to job postings that target more than one major. For the purposes of this study, these announcements will be referred to as targeted job postings. Isolating these job descriptions enabled the identification of companies with needs for specific engineering disciplines. During this

Targeted Job Postings

Year	Construction Engineering		Electrical Engineering	
	All ConE	Leadership ConE	All EE	Leadership EE
2006-2007	34	5	56	4
2007-2008	20	2	89	12
2008-2009	10	2	37	2
2009-2010	7	1	26	1
2010-2011	18	1	77	9
2011-2012	21	1	112	13
2012-2013	32	3	88	10
Total	142	15	485	51

Table 2

review, it was noted that the total number of positions posted for a targeted engineering major was 1,555 for the same seven-year period, with only 177 (11.4%) including the word leadership.

Only construction engineering (ConE) and electrical engineering (EE) postings were selected for study for two main reasons. First, ConE has leadership included specifically in the ABET program criteria; EE does not. Second, we perceived these two majors, ConE and EE, on opposite ends of a spectrum that addresses practical content to theoretical content, respectively. The thought was that by studying these two majors any differences in industry preference would be more clearly recognized. Table 2 illustrates the number of targeted ConE and EE job postings, as well as the subsets of those postings containing the word leadership. Overall, companies hiring both ConE and EE candidates included leadership in 10.5% of their respective job postings. This low number may suggest that the majority of the companies are seeking applicants with leadership competencies, but do not explicitly use the word leadership in their job descriptions.

Job Description Investigation

The 66 job descriptions were analyzed to locate the word leadership in the job description and classify its general meaning into groups. Six categories were identified. The 15 ConE and 51 EE job descriptions were further reviewed to identify companies to be targeted for participation in the Phase II interviews.

Categories of job descriptions. The job postings were placed into the following categories: (1) applicant skills, abilities, and/or capabilities (2) influence or role the applicant will play, (3) job title, (4) development of applicant, and (5) company description and/or qualities. Categorization was performed by a graduate research assistant and validated by the first author. Those job postings falling into the first two categories were considered for further study, since they are specific to the applicant qualifications and immediate influence/role in the company.

Applicant skills. This category includes job descriptions highlighting a need for leadership skills, abilities, and capabilities. The job descriptions contained phrases similar to the following: "Must have excellent leadership skills and capability of supervising others; and must be able to work closely with others."

Influence/role. Positions categorized in this area outlined the role the applicant would play if selected for the position. One sample of this is: "Provide leadership to the project team."

Job title. The job descriptions placed into this grouping included the word leadership as in, "Manufacturing Leadership Development Engineer," or similar.

Development. Positions placed into this category included statements like, "During your two year training

Categories of Leadership in ConE Positions

Category	Number of Postings
Applicant skills	5
Influence/role	5
Job title	0
Development	1
Company qualities	4
Total	15

Table 3

program with [Company], you will develop a core understanding of [Company] business systems and culture that will help prepare you for a leadership role within the company."

Company qualities. Job postings listed in this category included language referring to leadership as part of the company or how the applicant would interface with others. These positions included phrases such as, "Our unique business strategy provides us with an unmatched leadership position and ability to build and sustain loyalty to our brands."

Construction engineering job description review. Eleven companies posted the fifteen full-time positions in the targeted ConE leadership data set. These job postings were separated into the categories described earlier and are summarized in Table 3.

Once the job description information was reviewed and catalogued, it was determined that ten construction engineering companies met the requirements for Phase II of the study. These companies were those with jobs in the applicant skills and influence/role categories. Again, the uses of leadership in the other categories were not about the applicant's qualifications or immediate impact to the

company.

Electrical engineering job description review.

The comprehensive review of the 51 positions targeted for EE seniors was performed to categorize the use of the word leadership in these postings. Thirty companies were attributed to these postings, ranging from one to six postings per company. Applicant skills and influence/role contributed the largest numbers of postings. The breakdown of the 51 job postings can be seen in Table 4.

From this review, companies with job descriptions in the first two categories were identified for possible interviews. Twenty-five companies met these criteria, with eighteen posting job descriptions categorized in the applicant skills category and seven in the influence/role category. Those companies with job postings in the applicant skills category were highlighted as preferred for interviews, since this category appears to be more closely related to the research question.

Phase II: Identifying Leadership Competencies

The companies identified in Phase I of the study

Categories of Leadership in EE Positions

Category	Number of Postings
Applicant skills	21
Influence/role	14
Job title	6
Development	7
Company qualities	3
Total	51

Table 4

were contacted for possible participation in the interview portion of the study. Through email, each company was asked to identify one person with the most knowledge about the job posting(s), meaning of leadership, hiring practices, and the needs of the company. From these initial contacts, three participants were selected for each of the cases – construction engineering and electrical engineering companies.

Qualitative Data Collection

The first author utilized the nine steps for interviewing, as described by Creswell (2013, pp. 163-166). Using a four-item interview protocol, the first author conducted interviews with six industry personnel involved in hiring and/or supervising entry-level engineers. One-on-one, semi-structured interviews were conducted at each company's location to gather qualitative data to answer the question, "What do companies hiring full-time entry-level engineers mean by the word leadership when used in a job description?" A sub-question we hoped to discover was, "What differences exist between what hiring representatives of construction engineering and electrical engineering graduates want?"

Exploratory questions were tested with two members of an industrial advisory board who hire entry-level engineers at a large Midwestern university. This effort allowed the interviewer to have a better understanding of how the questions were being interpreted and better prepare for the interviews.

We began the interviews by asking participants about their employment at the company, including job title, job responsibilities, and number of years with the company. These questions helped to build rapport between the interviewer and participant before the protocol questions. Interviewees included personnel with experience in human resources, engineering, or both. Additional information about the participants is presented in Table 5.

Participants were then asked about what they are looking for when meeting, interviewing, and reviewing resumes for applicants for entry-level engineering positions. The semi-structured interview format allowed the interviewer to ask appropriate follow-up questions as each conversation unfolded. With interviewee consent, interviews were digitally recorded and lasted 45-60 minutes each.

Qualitative Data Analysis

Interviews were transcribed for each participant. Each participant reviewed his or her transcript and performed a member check for accuracy. The first author read revised transcripts and listened to interview tapes before uploading the transcripts to NVivo for Mac (Version 10.1.0) software. The "analytic option" utilized aligns closely with the categorizing strategies described by Maxwell (2013, p. 105). The transcripts were also manually coded, evaluated, and analyzed by two independent reviewers.

Industry Personnel Interviewed

Industry and gender	Job title	Years at company
Construction		
Female	Human Resources Director	9
Female	Director of Learning and Development	8.5
Female	Human Resources Manager	2.5
Electrical		
Male	Application Engineering Manager	15.5
Female	Human Resources Representative	25
Male	Manager of Substation Engineering	15.5

Table 5

All coders used "open coding" (Corbin & Strauss, 2007, pp. 195-204) to develop their own themes. An examination of all reviewer codes and notes prompted numerous discussions and more refined coding. Through this iterative process, final codes and observations were achieved.

Analysis of the transcripts revealed that employers define leadership in many ways; no two participants described it in an identical way. Each participant articulated several competencies desired by employers for applicants for entry-level engineering positions. An initial review of transcripts was conducted to identify each distinct attribute, skill, or ability discussed by the participants. During this review fifty items were captured as potential themes. Through an iterative process of analysis and discussion with the independent coders, themes were combined and refined.

Five themes clearly emerged: initiative/confidence, communication, interpersonal interactions, teamwork, and engagement. All six participants identified these five themes, also known as leadership competencies, during their interviews. The trustworthiness of these findings was achieved through acquiring rich data (verbatim transcripts), respondent validation (member checks), and the use of three coders (primary researcher and two independent reviewers).

Emerging leadership themes and examples.

The five themes identified as the most important are discussed in more detail for a deeper understanding. Additionally, one or two sample participant quotes for each theme is included in this section.

Initiative/confidence. Five of the six interviewees used the word "initiative" several times during their interview. The other participant talked about "stepping up" and "going that extra step." All participants cited "confidence" and/or "self-confidence." Additionally, all interviewees included "ask[ing] questions" when discussing initiative and/or confidence. One participant stated, "To me I think leadership is initiative -- having the confidence to step up to the plate and do what is necessary, engage individuals

to become a team and work towards a common goal" (Company 3).

Communication. All interviewees discussed the importance of communication skills. Included in this theme were written, oral, non-verbal, and listening skills, as well as the ability to conduct crucial conversations. The quotes below are characteristic of other qualitative data used to create this theme:

Leadership is mainly from the front, stepping out modeling the way, leading by example, so in this case what possess good written and oral communication skills it is having the ability to be a straight talker to be a part of the team upfront and some cases for a new leader entry level employee that has taken some risk. (Company 6)

But even in their communication to subcontractors, to owners -- we live in a plugged in world so they have to be able to craft a sentence [laughs] they have to be able to make sense, they have to be able to put words together that make sense to convey their message. (Company 5)

Interpersonal interactions. All six participants identified "people skills" as required. Five of the six specifically included a discussion about "relationship building," three identified conflict resolution, while two participants identified accountability to the team/company. It was noted that the three companies citing the ability to resolve conflict were all hiring construction engineers. This is the only notable difference between ConE and EE discovered during the interviews. The following quotes represent the statements used to categorize comments into this theme.

Project managers are constantly talking to subcontractors, they need to know how to push them to get things done without breaking a relationship and that's not something that's easily taught. (Company 1)

Sometimes the project engineers and project managers

Crosswalk of Other Works to Leadership Themes From this Work

Derived Themes from this Study	Gordon- MIT Leadership Capabilities	ISU Workplace Competencies	Maxwell 21 Qualities of Leadership	ABET Criterion 3. Student Outcomes
Initiative/Confidence	(1) The Attitudes of Leadership	Initiative	Initiative, Courage	Embedded in (a), (b), (c), (d), (e), (g), (i), (k) per Brumm, et al
Communication	(2) Relating	Communication	Communication	(g) An ability to communicate effectively
Interpersonal Interactions	(2) Relating	Not specifically addressed	Relationships, Character, Charisma, Listening	Combination of (d) An ability to function in multidisciplinary teams and (g) An ability to communicate effectively
Teamwork	(2) Relating	Teamwork	Relationships, Listening	(d) An ability to function on multidisciplinary teams
Engagement	(1) The Attitudes of Leadership	Not specially addressed	Commitment, Responsibility	Not specifically addressed

Table 6

are looked at to be the experts when like I said before they might be much younger than the individuals that they're dealing with. But having the kind of a quiet resolve to just soak in everything that's going on I think about the best solution and then be able to express that is one of things that I found seems to work best and they've even said in the interns have said it from their exit interviewers. That those are the traits that they appreciate a lot from their PMs is the ability to listen to all sides but yet to be able to come to a consensus, build consensus and then move on from that. (Company 3)

Teamwork. All participants mentioned teamwork and/or being a team player as a requirement to leadership. This theme captures comments about accountability to the team, collaboration, and building consensus. The quote provided represents the qualitative data for this theme:

We are looking for basic GPA, some initiative, self-confidence; they are a team player, those types of components... Not thinking they have all the answers so knowing that the person next to you might be able to help you out or you might have something that can help them out not always having to be the one in charge doing the cool thing that sometimes the grunt work is part of the team that gets you to that next level. Being able to communicate with each other and know how your work affects the other persons' work so that you know that you are in it together. (Company 2)

Engagement. This theme captures discussions about being engaged in extracurricular activities and volunteer service, as well as at work if hired. Five participants specifically discussed involvement in student organizations and fraternities/sororities. Three interviewees highlighted caring and social responsibilities. The following quote is illustrative of the comments used to create this theme:

We will look at that they have done maybe it is more

than their GPA. We would look at the additional work or things that they have been involved with on their resume and how does that fit in [Company 5] is showing our leadership. It is showing them being engaged, it is showing them that they care, the social responsibilities of whatever they are doing they. Are giving back? It also shows us this is a person who tends to be engaged. (Company 5)

Findings

Our initial findings suggest that when companies use the word leadership in a job description for full-time entry-level engineering positions, they have a primary goal to seek individuals with strong communication, teamwork, and interpersonal interaction skills. Through their resumes, interviews, and internships, engineering undergraduates must also show the potential employers they possess initiative and confidence, as well as are engaged in extracurricular and/or volunteer activities. The study also revealed one notable difference in what construction engineering and electrical engineering companies are seeking; construction engineering firms emphasized "conflict resolution skills" as an additional proficiency in interpersonal interactions. These competencies, while not engineering specific, were identified as the most important leadership capabilities for new graduates to possess when seeking employment in entry-level, engineering positions.

To fully develop our understanding of our findings, we mapped our themes to other works. While Schumann, et al (2014) developed a crosswalk from ABET (a) through (k), correlating it to Bowman and Farr (2000), MIT Leadership Capabilities (2011), and their findings, we structured our crosswalk starting with our themes as the basis to the framework.

Our crosswalk shown in Table 6 highlights the connections between our themes and the Gordon-MIT

Leadership Capabilities, ISU Workplace Competencies (Brumm, et al, 2006), and a popular press leadership book, *The 21 Indispensable Qualities of a Leader* (Maxwell, 1999), as well as the ABET Student Outcomes.

Stakeholders of the MIT program through consensus developed the Gordon-MIT Leadership Capabilities (2011). The document has evolved over time into its current form. The capabilities are organized into six main categories: (1) The Attitudes of Leadership; (2) Relating; (3) Making Sense of Context; (4) Visioning; (5) Delivering on the Vision; and (6) Technical Knowledge and Reasoning (Gordon-MIT, 2011).

Brumm, Hanneman & Mickelson (2006) presented a mapping of "workplace competencies" to the ABET Student Outcomes. Their work specifically addressed developing and assessing competencies through internships and cooperative learning experiences at Iowa State University (ISU). Working with 212 stakeholders, the authors identified fourteen "ISU Competencies" and mapped them to the ABET (a) through (k) Students Outcomes. While their study did not address leadership specifically, there are indications that many competencies may have a connection to leadership.

We also compare our findings to John C. Maxwell's (1999) *The 21 Indispensable Qualities of a Leader*, from the popular press. Maxwell presents 21 "character qualities" an individual must possess in order to effectively lead others.

This range of literature – university program/industry work, peer reviewed journal article, and bestseller leadership book – highlights the numerous and varied definitions for leadership. As many other authors have done, we mapped our findings to the ABET Student Outcomes, since this is a common metric for engineering programs. It was noted that two of the six Gordon-MIT leadership capabilities highlighted the findings of this study. Likewise, nine of the twenty-one Maxwell

qualities were highlighted in the comparison. The authors acknowledge the missing items did not emerge as themes during the interviews, however, this does not suggest that they are not important nor absent from our study, but only that they did not emerge as the most important qualities highlighted by the interviewees in this context.

The categories presented in Table 6 confirm that many employers may be seeking new graduates with leadership competencies without explicitly using the word leadership in their job descriptions. Additionally, this comparison helps highlight that leadership may be implied in many of the ABET (a) through (k) criteria.

Limitations and Future Research

Limitations to this study include the small number of interviews performed. This includes the total number of interviews, as well as the number in each of the disciplines studied. This study did not allow us to explore other themes that were mentioned by only two or three participants, however, the small number did allow us to gain a deeper understanding of the most important leadership competencies in this context.

Our future studies will use these findings to develop and administer a quantitative survey instrument for industry personnel involved with hiring entry-level engineers for positions in all disciplines of engineering. Job title information will also be captured to determine if responses differ based on type of position of respondents.

Through our mapping and reviewing the keywords in the initial job descriptions, we have confirmed our initial beliefs that most or all companies are seeking employees with leadership skills without specifically using the word leadership in their job description. Confirmation of this premise offers the potential for more survey participants.

Conclusion

This study sought to identify the most important leadership competencies that engineering undergraduates should possess when applying for full-time engineering positions. Using qualitative research methods, we identified five themes that were common across construction engineering and electrical engineering companies and also confirmed no major differences between what representatives in each discipline desired from applicants. Of the engineering undergraduates seeking full-time positions, companies strongly favor those applicants with communication, teamwork, and interpersonal interaction skills, and also those who display initiative and confidence, and engagement in extracurricular and volunteer activities, to other leadership competencies.

Discovering and understanding what companies hiring full-time, entry-level engineers are seeking with regard to leadership is the first step to ensure undergraduate engineering programs adequately address this need. From

this work, we can begin to assess, refine, and develop curricula and advising materials and methods to best prepare our students for industry.

References

- Accreditation Board for Engineering and Technology (ABET). (2013). *Criteria for Accrediting Engineering Programs: Effective for reviews during the 2014-2015 accreditation cycle*. Baltimore: ABET.
- Bennett, R. & Millam, E. (2012). *Leadership for engineers. The magic of mindset*. NY: McGraw-Hill.
- Bernard M. Gordon-MIT Engineering Leadership Program, Capabilities of Effective Engineering Leaders (June 2011). Version 3.6, Retrieved online from <http://web.mit.edu/gordonelp/leadershipcapabilities.pdf>
- Bowman, B., J. Farr, (2000), "Embedding Leadership in Civil Engineering Education", *Journal of Professional Issues in Engineering Education and Practice*, 126(1), 16-20.
- Brumm, T. J., Hanneman, L.F., & Mickelson, S. K. (2006). Assessing and Developing Program Outcomes through Workplace Competencies*. *International Journal of Engineering Education*, 22 (1), 123-129.
- Corbin, J., & Strauss, A. (2007). *Basics of qualitative research: Techniques and procedures for developing grounded theory*. Thousand Oaks, CA: Sage.
- Cox, M. F., Cekic, O., & Adams, S. G. (2010). Developing Leadership Skills of Undergraduate Engineering Students: Perspectives from Engineering Faculty. *Journal of STEM Education: Innovations and Research*, 11(3), 22-33.
- Creswell, J.W. (2013). *Qualitative inquiry & research design: Choosing among five approaches*. Thousand Oaks, CA: Sage.
- Crumpton-Young, L., McCauley-Bush, P., Rabelo, L., Meza, K., Ferreras, A., Rodriguez, B., Millan, A., Miranda, D., & Kelarestani, M. (2010). Engineering Leadership Development Programs a Look at What Is Needed and What Is Being Done. *Journal of STEM Education: Innovations and Research*, 11(3), 10-21.
- Farr, J. V., Walesh, S. G., & Forsythe, G. B. (1997). Leadership development for engineering managers. *Journal of Management in Engineering*, 13(4), 38.
- Goleman, D. (1998). What Makes a Leader?. *Harvard Business Review*, 76(6), 93-102.
- Goleman, D., Boyatzis, R. & McKee, A. (2002). *Primal leadership*. Boston: Harvard Business School Press.
- Gordon, B. M. (2012). *Toward a new engineering education consensus: Ideas from industry and academia for inculcating and fostering leadership skills*. Danvers, MA: The Gordon Foundation.
- Graham, R., Crawley, E., & Mendelsohn, B. (2009). *Engineering leadership education: A snapshot of international good practice*. Bernard M. Gordon MIT Leadership Program, 2009.
- Light, R. J., Singer, J., & Willett, J. (1990). *By design: Conducting research on higher education*. Cambridge, MA: Harvard University Press.
- Maxwell, J. A. (2013) *Qualitative research design: An interactive approach* (3rd ed.). Thousand Oaks, CA: Sage
- Maxwell, J. C. (1999) *The 21 indispensable qualities of a leader: Becoming the person others will want to follow*. Nashville, TN: Thomas Nelson, Inc.
- National Academy of Engineering (NAE). (2004). *The Engineer of 2020: Visions of engineering in the new century*, Washington, DC: National Academies Press.
- National Academy of Engineering (NAE). (2005). *Educating the Engineer of 2020: Adapting engineering education to the new century*, Washington, DC: National Academies Press.
- Passow, H. J. (2012). "Which ABET Competencies Do Engineering Graduates Find Most Important in their Work?" *Journal of Engineering Education*, 101(1), 95-118.
- Pitts, S., McGonagle, S., Klosterman, S.W. (2013). *Developing Engineering Leaders using Engineering Leadership Capabilities and Leadership Labs*, ASEE Conference, June 2013.
- Schuhmann, R. J. (2010). Engineering Leadership Education -- The Search for Definition and a Curricular Approach. *Journal of STEM Education: Innovations & Research*, 11(3/4), 61-69.
- Schuhmann, R. J., Magarian, J. N., Huttner-Loan, E. (2014). A Method for Assessing Engineering Leadership Content in the Engineering Curriculum: A First Look at Civil Engineering Project Management Courses. 2014 ASEE Conference, June 2014.
- Seemiller, C., & Murray, T. (2013). The Common Language of Leadership. *Journal of Leadership Studies*, 7(1), 33-45. doi: 10.1002/jls.21277
- Shaw, Wade H. (2003). *Engineering Leadership*. 2003 IEEE Colloquia Tour, April 2003
- Phani, C. S. (2007, January 8). The top 60 soft skills at work. Retrieved September 8, 2013, from Rediff News: <http://www.rediff.com/getahead/2007/jan/08soft.htm>
- Warnick, G. M. (2014). An Experiential Learning Approach to Develop Leadership Competencies in Engineering and Technology Students, ASEE Conference, June 2014.
- Yaacoub, H. K., Husseini, F., & Choueiki, Z. (2011). Engineering soft skills: a comparative study between the GCC area demands and the ABET requirements. *Competition Forum*, 9(1), 88.

Beth L. Hartmann is a senior lecturer in the Construction Engineering in the Department of Civil, Construction and Environmental Engineering at Iowa State University. A retired U.S. Navy Civil Engineer Corps officer (O-5), she currently teaches the design-build capstone course for civil and construction engineering students and construction engineering learning community. Hartmann received her Bachelor of Art in Architecture and her Master of Science in Civil Engineering with an emphasis in Construction Engineering and Management from Iowa State University in 1989 and 1996, respectively. She is pursuing a PhD in Civil Engineering with an emphasis in engineering leadership education.



Charles T. Jahren is the W. A. Klinger Teaching Professor and the Assistant Chair for Construction Engineering in the Department of Civil, Construction and Environmental Engineering at Iowa State University. He earned his Bachelor of Science in Civil Engineering and his Master of Business Administration from the University of Minnesota and his PhD in Civil Engineering from Purdue University. His teaching interests include construction equipment, cost estimating and construction process design. His research interests include highway and heavy construction methods, road maintenance methods and innovations in construction process administration.

