# Developing Leadership Skills of Undergraduate Engineering Students: Perspectives from engineering faculty

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## Abstract

The engineering education community (motivated by internal and external factors) has begun to focus on leadership abilities of college students in engineering fields via reports from ABET, the National Academy of Engineering, and the National Research Council. These reports have directed criticism toward higher education institutions for their lack of success in instilling leadership abilities within recent engineering graduates. Recognizing the importance of leadership development among undergraduate engineering students, researchers in the current study interviewed twelve engineering faculty at a Midwestern university about ways that leadership might be incorporated into engineering curricula given the current environment of engineering and engineering faculty's roles and responsibilities. An idea emerging from the interviews includes an integration of leadership topics into current courses and in capstone courses. Faculty also noted the importance of real-life experiences and extracurricular activities in students' leadership development. Additional barriers to incorporating leadership into undergraduate engineering experiences are discussed.


## Introduction

In addition to technical competencies, professional skills (e.g., communication and teamwork) have been identified to be important in the development of well-rounded engineering students who will be drivers of innovation in a changing global society. One of the skills being recognized formally in a variety of programs at both undergraduate and graduate levels is leadership, a skill that allows an individual to cope effectively with change in systems or organizations (Kotter, 1990). Promoted in the form of minors, formal undergraduate degree programs, formal graduate degree programs, and graduate courses, leadership has been identified as a skill that needs to be included in the curricula for future engineers (Cox et al., 2009).

Studies of leaders and their abilities to lead date back several centuries. However, leadership as a science has been studied in most social science fields and extensively in business (Schein, 1992; Bolman and Deal, 2003; Northouse, 2007; Kouzes & Posner, 1998) and higher education (Cohen and March, 1986; Birnbaum, 1992). Recently the engineering education community (motivated by internal and external factors) has begun to focus on leadership abilities of college students in engineering fields via reports from ABET (2001), the National Academy of Engineering (NAE, 2004) and the National Research Council (NRC, 2006). Across these reports, a criticism has been directed toward higher education institutions for their lack of success in instilling leadership abilities within recent engineering graduates.

While there is a dire need to be informed of engineering students' abilities to lead, three very important impediments in looking at and incorporating leadership in engineering curriculum remain. The first obstacle is the need for standardized surveys specifically designed to explore the leadership attributes of college students across various institution types. The second is related to engineering education specifically. There are no empirical studies targeting leadership attributes of college students in engineering fields. Thus, the literature lacks any survey instrument or an operational definition of leadership as an observable and measureable attribute within the context of engineering. Finally, most engineering faculty have not been trained formally to teach leadership and have not explored ways to include leadership in their courses. Understanding their views about leadership is essential, if leadership is to be incorporated effectively into engineering plans of study.

Recognizing the importance of leadership development among undergraduate engineering students, researchers in the current study interviewed twelve engineering faculty at a Midwestern university about ways that leadership might be incorporated into engineering curricula given the current environment of engineering and engineering faculty's roles and responsibilities. Authors synthesize responses from the sample of faculty and suggest ways that leadership might be incorporated into engineering curricula formally and informally.

## Literature Review and Background

### *Engineering Undergraduates and Leadership*

Although limited empirical studies of leadership in engineering education have been conducted, leadership abilities of engineering undergraduates have been the focus of studies in the last two decades. The main focus of such studies has been on the definition of leadership (Farr, Walesh, & Forsythe, 1997), the differentiating elements between leadership and management (Torr & Ofori, 2008), and the incorporation of leadership into the curriculum (Bogus & Rounds, 2006; Bowman & Farr, 2000; Riley, Horman, & Messner, 2008). Farr and his colleagues (1997) rightfully claimed that "developing a concise definition of leadership for people involved in technical engineering management is difficult" (p. 38). Thus, there are many definitions of leadership and many ways to incorporate the development of these skills into the undergraduate engineering education curriculum.

Bayless, Mitchell, and Robe (2009) identify seven engineering programs that incorporate leadership aspects into their curriculum. A listing of the program, the program type (e.g., minor, major, or certificate), and a description of how leadership is incorporated into these programs are listed in Table 1.

There are some similarities and differences across the programs. Five of the seven programs are located at universities in the Midwest. All of the programs are offered in colleges of engineering or technology. Enrollment in the programs is mostly selective, and some programs offer stipends for students. Many of the programs are affiliated with international experiences or leadership-based experiential projects that are explicitly different from the experiences offered within a traditional engineering program.

Despite the development of these programs, limited information about the usefulness of such courses has been explored. As a result of this, several questions remain. What is the best way to introduce a diverse group of engineering students to leadership concepts? What impact will these programs have on students' leadership development? How can higher education institutions best incorporate leadership into the curriculum?

| Location | Name | Type | How Leadership is Incorporated in the Program |
|---|---|---|---|
| Iowa State University's College of Engineering | Engineering Leadership Program | Four-year degree | Students engage in learning communities and participate in a variety of experiences throughout their four years, including seminars, portfolio development, and projects. |
| Indiana University-Purdue University Indianapolis' School of Engineering and Technology | Organizational Leadership and Supervision | Associate of Science degree, Bachelor of Science degree, or specialized certificates | Students complete coursework with a primary focus on leadership in organizations. |
| Ohio State University's College of Engineering | Robe Leadership Institute | Institute with a variety of resources for staff and students | Students are selected to participate in a fall seminar about leadership and are given modest stipends. During this time, they have access to Institute resources. |
| Pennsylvania State University's School of Engineering Design, Technology, and Professional Programs | Engineering Leadership Development Minor | Minor consisting of 18 credits | Students take on-campus courses in leadership and engage in international leadership projects. |
| University of Central Florida's College of Engineering and Computer Science | Leadership Institute | Nine month experience for students | Students engage in a series of self-assessment and experiential leadership experiences. Thirty students receive $1500 scholarships to engage in the program, which is sponsored by industry. |
| University of Maryland's A. James Clark School of Engineering | Minor in Engineering Leadership Development | Minor consisting of 16 credits | Students complete coursework with emphases on communication, global awareness, project management, and leadership. |
| University of Michigan's College of Engineering | Engineering Global Leaders Honors Program | Selected coursework of approximately 30 hours leading to a B.S. and M.S. degree. | Students complete coursework in foreign language, a cultural core, and a business core. Students complete a synthesis project between this bachelor's and master's programs. |

**Table 1. Overview of undergraduate initiatives that incorporate leadership in their curriculum**

*Overview of Leadership Instruments*

Until recently studies focusing on leadership in the higher education (specifically on students) community lacked a sound instrument to explore, describe, or evaluate college students' leadership attributes. There have been attempts (Kouzes & Posner, 1998; Posner, 2004), however, to form standardized instruments to explore college students' leadership abilities. While the literature on leadership abilities of colleges students keeps growing and might be applicable to general college student populations (Komives, Lucas, and McMahon, 2007; Kouzes and Posner, 2008; Posner, 2004), literature pertaining specifically to engineering students is limited at best and is in need of exploration.

One of the validated instruments designed to measure leadership skills of college students is the student version of the Leadership Practices Inventory (SLPI), which was developed by Kouzes and Posner (1998). One limitation of their study was that the participants who responded to the questionnaire during the development and the validation stages were students who already held leadership positions (i.e., fraternity and sorority officers, resident assistants, and hospitality students). While this method is valid and useful in developing the survey, the applicability of the survey to a more diverse student population is open to discussion.

In addition to Kouzes and Posner, Komives and her colleagues (2005, 2006) introduced the Leadership Identity Development Model (LID), which focused on the development of leadership identity. Komives et al. interviewed thirteen purposefully selected students who were recommended to the group for their relational leadership abilities. The sample included eight White, four African-American, and one Asian-American student from one institution. Each student was interviewed three times by the same interviewer. The research team followed Seidman's (1991) "three-interview series" model where three separate and in-depth interviews were conducted, focusing on (1) life history, (2) the details of the experience, and (3) reflection on meaning. As in the Kouzes and Posner study, Komives et al. surveyed and interviewed students who held leadership positions or were identified to possess leadership skills.

Although some institutions have established formal initiatives to expose engineering students to leadership (Cox et al. 2009), and instruments have been developed to explore the leadership identities and abilities of students, some issues remain. Among these is a primary focus on the development of leadership skills among students who have already demonstrated leadership potential or have identified themselves to be leaders early in their engineering educations. In addition, missing are suggestions for involving faculty who are not trained formally in leadership within curricular initiatives for their students. Such studies will help to engage a larger engineering community in conversations about ways that students can acquire leadership skills during their undergraduate engineering experiences. The current study addresses both of these concerns about leadership in engineering education.

## Research Study

The purpose of this qualitative research study is to identify the perceptions of engineering faculty about efforts needed from colleges and universities to develop the leadership skills of undergraduate engineering students. The leadership development efforts of higher education institutions were a part of a larger study that focused on multiple attributes related to NAE's (2004) *Engineer of 2020*.

*Participants*

The research team recruited twenty-four engineering faculty members at a Midwestern university via e-mail to invite them to participate in this research study. Faculty were selected because of their involvement in undergraduate student development and their demonstrated engagement with "Engineer of 2020" attributes. Participants were selected from thirteen engineering disciplines and were diverse relative to rank, gender, and ethnicity.

Twelve faculty agreed to be interviewed for the study. The sample included five females and seven male faculty members. Levels of industrial experience ranged from none to about fifteen years. Additional descriptive information about the sample is provided in Table 2.

*Data Collection and Analysis*

Data within this study were collected qualitatively via semi-structured interviews. The interview protocol consisted of seventeen open-ended questions that focused on leadership; change; and synthesizing engineering, business, and social perspectives. After the development of the interview protocol, interview questions and an informed consent form were submitted to the university Institutional Review Board for approval.

Of the seventeen protocol questions, responses from one question, "How do you think

| ID | Gender | Rank | Ph.D. Field | Industry exp (yrs) | Self-Reported Leadership Style |
|---|---|---|---|---|---|
| 01 | M | Professor | Environmental engineering | 10 | Participatory (others' participation is important; tries to set the vision; does not have to receive credit for success) |
| 02 | F | Associate Professor | Electrical engineering and computer science | None | Flexible, adaptive, and inconsistent |
| 03 | F | Professor | Civil engineering | 1 (after B.S.) | A mixture of consensus-building and decision-making |
| 04 | M | Assistant Professor | Mechanical engineering | None | Hands-on and an enabler |
| 05 | M | Professor | Chemical engineering | 15 | Hands-off; tries to recruit or hire the best people to work for him; clearly defines people's roles in an organization or in a group. |
| 06 | F | Professor | Aeronautical and astronautical engineering | No number provided | Not dictatorial; nudges everyone onto the same page |
| 07 | M | Professor | Chemical engineering | None mentioned | Contextual; classical when clearly put in charge and more collegial at other times |
| 08 | F | Professor | Veterinary medicine and surgery | 17 | Visionary; pays less attention to details, strong-headed; has difficulty listening sometimes, but aware of this issue. |
| 09 | M | Associate Professor | Mechanical engineering | 1 | Builds consensus among different constituents |
| 10 | M | Assistant Professor | Mechanical engineering | None | Tries not to control them (students) |
| 11 | M | Associate Professor | Aeronautics and astronautics | 12 | Offers guidance but keeps a focus on his own project |
| 12 | F | Professor | Environmental science and engineering | None | Very democratic; values input from everyone in her unit |

**Table 2. Profiles of engineering faculty participants.**

higher education institutions can help (engineering) students in the development of leadership?," was of interest in this paper. Additionally, the respondents were also asked to provide their own "operational" definitions of leadership at the beginning of the interview. Interviewers purposely did not lead respondents via the suggestion of degree programs or courses. In this way, project researchers anticipated that participants would provide innovative responses about the inclusion of leadership elements in undergraduate engineering students' experiences.

Interviews were recorded digitally, voice recordings were transcribed for each respondent, and responses to the question were coded for recurring themes. A constant comparative method was used to highlight the similar or different views of the respondents regarding the incorporation of leadership in a higher education engineering context.

## Results

Before reporting on the faculty's perceptions on inclusion of leadership elements into the experiences of undergraduate students, it is important to briefly explore the meanings attributed to leadership by faculty members. The faculty members defined leadership with adjectives (e.g., visionary and creative) and with verbs (e.g., empower). Although faculty were more likely to emphasize the characteristics of engineers in their definitions, industry experts

connected leadership definitions to action- oriented elements (i.e., having good decision-making skills and being proactive) (Cox, Cekic, Zhu, & Capobianco, 2009).

Based on aforementioned operational definitions of leadership, the reflections of the faculty members provided some common themes related to the possible addition of leadership courses and the roles of interdisciplinarity and capstone courses in leadership development for engineering students. Participants also identified potential barriers to incorporating leadership in a standard engineering curriculum. None of the participating faculty members thought that introducing more courses into the curriculum was a good idea. They specifically noted that the engineering curriculum was already full. To include new elements, faculty thought that some of the existing ones had to be taken out. Encouragement of interdisciplinary activities was emphasized by most of the respondents, who proposed that a more flexible curriculum might provide options for students to select such courses that are taught outside of traditional engineering disciplines. Moreover, the inclusion of leadership elements in senior design courses and the importance of extracurricular activities, hands-on practical experiences, and study abroad programs were the emerging themes from the participants' responses.

Other important points the participants widely talked about but saw as barriers to the inclusion of professional skills include an inflexible curriculum, the limited education of the engineering faculty in these areas, and structural changes that might encourage faculty to spend more time in development of leadership skills of the students. Such structural changes might include changes in faculty members' thoughts about the importance of professional skill development, tenure process, and rewards for teaching versus conducting research at research universities. Additional details are provided in the following sections.

### *Course additions*

One of the most prevalent ideas across faculty was that the engineering curriculum is too full to include additional courses that will develop leadership skills. This view is also expressed in earlier literature on leadership and leadership development. Bowman and Farr (2000) argued that many in engineering fields agree that "formal leader development must be incorporated into engineering education programs…however; the means of achieving the objectives within tightly constrained curricula are debated" (p. 16). Along those lines, one of the faculty members clearly expressed that it's difficult to add more to her plate in terms of coursework or curriculum. "It just increases the cost of education, the time of education, and all of that". Another faculty member expressed his concerns about adding more courses into the curriculum by saying:

> Well, you don't want to add a course for every new topic because you'd never graduate. You know, as we all know, you know, the information that our students are dealing with probably doubles every, I don't know, three years or so. And you know, so, the relevancy of things that they learn changes so fast.

Yet another faculty member commented:

> I mean, a kind of problem that we have is that all these other things that should be in their curriculum but there's only a finite length of time. So a more radical thing would be you know, developing like a five year program. And I know some universities have done that where there'll be like some type of internship. I don't know whether that would work here or not.

Another faculty member argued that "we can't keep adding course after course after course. That doesn't make any sense". But she suggested exploring alternative avenues, and thought, "We have to think about how we can do things differently to help develop some of that". Since none of the faculty members supported the idea of adding more courses, a question remained about other ways that the leadership skills of undergraduates could be developed. Some alternate suggestions are presented in the following sections.

### *Integration*

Integrating elements of leadership into current courses (i.e., engaging in course redesign instead if adding new curriculum) was one of the suggestions provided by faculty. One of the faculty members expressed his concerns and emphasized that he had thought about the ways to improve undergraduate engineering education. He said, "I would reconfigure, I don't know if totally redesign, but reconfigure the curriculum and include non-engineering faculty. And I would reach out into the liberal arts as well. I would start with chemistry, physics, and math". Another faculty member suggested providing opportunities for students to practice their leadership skills. He said, "So for leadership, I think one of the key things is to somehow position

students, all students, to take on leadership roles. In some cases you may almost have to force it because they may not be comfortable with it. But I think that's the best thing we could do".

One of the faculty members explained how she incorporated elements of leadership development in her course so that she could help students to build those skills. She said:

> For example, like with our project having a rotating leadership. So I'm not really changing the structure of the course. All I'm doing is saying, "Well I want this student to be a leader for part of it, but I want you to rotate to have someone else do that role to someone else." And a lot of times the first person that does it is someone who is kind of a natural leader. They take it on, okay. Well the person that follows them has seen kind of that natural leader do it now some. So it should help them get an idea. But it doesn't really cost us anything in terms of we don't have to add another course in leadership necessarily. But what would help is for us to kind of frame out for students, you know, what are different leadership styles. And when might you want to use different leadership styles. It doesn't require a whole class to tell them that. But I think if we had something that we could kind of frame that out for them, and then give them opportunity to do it, to exercise. It's kind of like any sport, basketball, football, whatever, you know. I could tell them all day long, but what they really need is practice at it. They need to exercise those skills and try things. They're gonna' fail sometimes, that's okay. But you get back up you try it again, hopefully you succeed next time, and you learn from that experience; failure or success.

*Capstone courses*

One of the most talked about ways to incorporate and to integrate leadership development elements in the curriculum was via the senior design (capstone) courses that each school or department requires their undergraduate students to take. Communication and presentation skills that could be sharpened via teamwork were mentioned frequently and were thought to be one of the most important ways to incorporate leadership development elements into the curriculum. One faculty member noted that some of the elements of leadership development can be included in design course: She specifically noted:

> So and maybe in like the design, curriculum design courses, projects, - I don't know if there'll be a way of introducing that within the technical context, I'm not sure how to do that, but maybe as far as um, you know in most of the technical courses traditionally there'll be, you know, some material taught, there'll be a problem set, and pretty much textbook problems. I would like to see more open- ended problems.

Another faculty member emphasized the teamwork included in design courses. He said, "We have some more design courses; they make drawings and they do calculations, they stop there. That's not good. Projects and team projects, actually, work in teams, yeah. And learn how to communicate efficiently, and how to lead a team", was what he expected to see more. However, the attitudes toward the capstone and design courses were not uniform. Although some faculty are satisfied with the way these courses are conducted, others demand more communication, teamwork, or presentation skills. One of the faculty members explained, "We do add little things. Our design courses are very different than they were ten years ago, let's say. So those are the things, you know, as you evolve, you make small type changes". Another faculty member supported the claim and argued that there are relatively more elements of leadership in design courses compared to previous decades. The faculty member gave an example how to incorporate leadership development elements in capstone courses.

> One of the things that we try to do [is like] with our sophomore design course is have teams of four students, [is to have the students] rotate leadership role each kind of segment of the class so that it requires everybody to take that leadership role on for at least part of the project. And so that's part of my concern. I don't think we do that very well.

In addition to design courses, the faculty members also argued that providing real life experiences during undergraduate education would help in the development of leadership skills of undergraduate students.

*Real life experiences*

Faculty members focused on co-op programs, internships, and study abroad programs and their valuable contributions to leadership development. One of the respondents emphasized the need to engage students in professional development opportunities outside of the regular classroom; however, he also recognized the challenges one might have to overcome to

establish such programs in today's larger research university. He explained:

> If I was setting up a program to develop these skills, I would try to get a program that challenges them in ways that classrooms can't. And that's hard to solve [on a] – especially in a larger university thing because faculty time in particular is not geared or rewarded or as much for doing a lot of outside the classroom, or outside the research lab stuff.

Another faculty member thought that leadership was not just transfer of knowledge but was more related to learning from the experiences or oneself and others. She said, "So in my view, these things are not necessarily so much like a basic knowledge that needs to be crammed into people. It's more like practice". This also shows that many faculty members also are not in agreement with the definition of leadership or with the need of leadership for every undergraduate student. Another faculty member focused on internships and claimed that leadership and communication skills are culturally relative and can change from institution to institution. He explained:

> But when you talk about a culture, or how they would work with different company, you can't teach those – those things they're gonna' have to experience. And so when you look at the students after they come back, it's a life changing experience for them.

Another faculty member also described the cultural elements and how students learn more than the technical aspects of engineering during their co-op and internship experiences. He explained:

> And a co-op experience should lead to increasing responsibility and increasing difficulty of the assignments so that by time you're done you're doing the work of entry-level engineers. The difficulty with internships is they tend to be one shot, and may not lead to that increased responsibility. But even if they don't, they're still useful. For example, having somebody go in and do CAD programming for 12 weeks, they're gonna' end up walking out of there knowing how to do CAD programming much better than from a class in that, and they'll see and they will learn tricks that are current that they didn't learn in class. They will learn in addition a lot about showing up on time, interacting with people, and doing communication that they don't get in class.

The need for hands-on experience was also apparent in the comments of another faculty member. These experiences, the faculty member claimed, can provide students with a different frame of mind.

> So I think getting them experiences, that's the first thing. And helping them have the framework of things that they could try and test and say, "Well, okay, I think I'm in a situation, let me try this and see what happens."And practicing and you know learning how to do it, I think that's a lot of the key, is just get practice at it.

*Extracurricular activities (student organizations, work, and providing opportunities)*

Another point raised by the faculty members during the interviews was the importance of extracurricular activities (e.g., student government, student organizations, fraternities and sororities and on and off campus work). One of the faculty members emphasized that "those non-course options in addition to the courses are really important". Some of those non-course options are expounded upon below.

> If you talk about leadership, there are a number of student organizations for students to get involved in. And I think a lot of our engineering students are actively involved in those organizations. I've forgotten a number of engineering wide organizations now, but there's a large number.

The faculty member provided specific examples about the possible effects of student organizations and argued that such opportunities provided real-life situations for students to take advantage of and to develop their leadership skills. He continues:

> I think that he learned more on how to work with people in his fraternity than he did in any course, and I think he learned more through being house manager, okay, practical things like the septic tank is overflowing. What do we do?

One faculty member expressed his strong advocacy for extracurricular activities and said that he is "highly in favor of the extracurricular and – now in class, we can do things and we tend to do a lot of this, making sure that they work in teams; making sure that they are using the appropriate tools. Often it's computers, okay. I would like to see more of it". Furthermore, work experiences were also deemed im-

portant in gaining experience in problem solving and leading. He used a student's experiences as an example.

> He worked part-time at Chile's as a busboy. And he's learned more about, you know, people who are busboys, waitress and waiters, and how people treat them than he ever did before that. And, before he did that he never paid any attention to what kind of tip I gave, and now he's paying a lot of attention.

There was more than empathy involved in working at a job, according to the faculty member. He also advised students to work jobs even if they did not need the money. The experience and the opportunity were invaluable. He said:

> I have told students, that for example, that they're working at McDonald's. They should start coming in early, staying late, showing that they're responsible, get assigned to closing the thing, and work up to becoming a crew leader. Okay? That's a practical leadership experience that will help them get hired as an engineer. But we have too many students that have not.

Another important point was the contribution of community service. One of the faculty members hoped that higher education institutions would start requiring their students to become more involved in community service activities. He specifically said that "community service is a very good thing for our students, and I hope higher education will do and a lot of them are requiring students to do community service. Which I think is very important".

*Barriers to Implementation*

In additional to presenting ways that leadership might be added to the engineering curriculum, faculty offered comments about potential barriers for faculty implementation of leadership concepts in their courses. Among these include extra training for faculty about leadership and the implementation of leadership activities in their courses and disagreement across faculty about the importance of incorporating leadership in engineering courses. One faculty member said, "You know some faculty will say; 'well now all students don't need to be leaders'. I disagree with that personally, but that's not how all of the faculty feel. So trying to help them recognize the importance of that is part of the mission as well". However, another faculty member disagreed and commented that not all the majors might need leadership training or the skills. She said:

> So perhaps in computer science you don't need the social fabric interwoven. If you're gonna' sit and do programs all day, you know the software, do you really need to know all the social stuff? Probably not.

Yet another faculty member focused on the average student rather than the ones that are already have the leadership or the social skills inherently. She commented:

> What I'm concerned about is a lot of the other students who don't have that natural leadership ability coming in. A lot of times they don't. They're not put in a position where they have to develop or exercise leadership skills. They kinda' just follow along other people.

Along with the differences in the views of the faculty, the faculty members thought that there has to be significant changes in faculty mentality, curriculum construction, and structural elements of higher education institutions. Almost all of the faculty members thought that incorporation of leadership components into the curriculum would require a different mentality among faculty and changes in the promotion and tenure processes. One of the faculty members said, "Faculty time in particular is not geared or rewarded or as much for doing a lot of outside the classroom, or outside the research lab stuff". Yet another faculty member commented, "So now you're talking about changing the engineering faculty's mind. Good luck. [sarcastically]…they all have tenure. You can't change this. We don't want to change." Another faculty member also focused on the needed change in the faculty culture by saying:

> And some of it's just time, money, and you know faculty – the way faculty either promote it or you know it's emphasized at an institution. So you know what you're talking about here is primarily undergraduate education, and it takes time to do these things right? Okay, so, yeah, so there's a culture change that may – that's just a difficult thing to do

While the faculty pointed out the need for change, they also accepted that the faculty members would need help to develop such programs and incorporate them into the curriculum. One faculty member commented:

> I think in general you have a willing group of faculty who recognize you know sometimes you can get in an environment where you know they're gonna' do this for 50 years. I

think we have a very willing faculty if they knew what to do, what the right things to do were.

Another faculty member commented that she would welcome the help, and gradually there would be a change in the faculty members' thinking. She said, "I don't think I have that skill. I sort of act intuitively. I have one person at a time. I'm not sure I'm having a huge impact in terms of being able to help a lot of people." Another faculty member agreed and he said that you "have to have administrators that [have] an interest in developing these skill sets in number one …because you can talk about the students but you need to also have faculty that have these attributes to teach the students".

Inflexibility in the curricular process was seen as another roadblock. The concerns of the faculty focused on interdisciplinary education. In terms of including general education courses one of the faculty commented:

> I would bring in the general education component. And that's more complicated because those aren't prescribed courses, so I don't know exactly how to do that, but we you know we have a very narrow – we have a very small list of physics, chemistry and math courses that engineering students have to take.

The flexibility in the curriculum was a big issue for most of the faculty, and one of the faculty members said:

> And so, you know, those kinds of things, um, flexibility in the curriculum so that we could change credits between the universities evenly. Not that we want to do that, but that would just be an example of we have a wonderful new freshman engineering department, but I'm not sure how much of those things are getting transmitted through the schools at which the students go up.

However, for this goal to be accomplished there has to be a better relationship between the departments and schools of a higher education institution. The same faculty member also offered a possible solution:

> I think it would be good for engineering to be partners with the rest of the university. And so … there's a fine balance between leading and partnering. And sometimes it's better to be a partner than a leader. And I think when you're developing curriculum at a university, partnerships and teamwork are better than leading. 'Cause leading means that somebody's following, and if you're all leaders, the other leaders aren't gonna' want to follow. So the only way you can all be leaders is in a partnership.

Another faculty member provided a summary to the possible handicaps a faculty member might have and also offered possible solutions. She said:

> It's not that we're unaware of trying to give our students all of these things. But the demands on us are such that institutionally we're set up in a structure that doesn't lend itself to those – to some of those kinds of things. And so we don't always know how to best do it. And um, we want to do a lot of different design building tests, but design building test classes, interdisciplinary classes, all of those take a lot of effort. Not that we're against effort, but planning, more flexibility in the curriculum. And it also takes more support.

In this sense, the faculty should not be left alone. There are issues that the institutions can undertake to help faculty in terms of faculty development and curricular change. This demand from the institution was apparent in one of the comments of a faculty member who said:

> I think there's things we can do better. And then there's some things that are gonna' be more the institutional level. And then there's some things that although I'd love to see down the road, you know every student gets a scholarship to travel abroad as part of their class, that probably financially will never happen.

The same concerns were evident in another faculty member's comments. He specifically gave an example that would apply to him and that he had to deal with.

> So for example over the last six to ten years, I've changed my delivery a lot. And so I have to bring a lot more visual elements, movies, and stuff like that. But I have no IT support to help me with that. Okay and so, it's like, you know, those are institutional recognitions of some of the kinds of things that you may need. So we can't talk about just what they need and how we're gonna' deliver it and stuff without understanding that the institution has to be willing to change too.

Dealing with the faculty and achieving a consensus was tied to structural elements by another faculty member. She said:

> If we want to move to something bigger I think you have a certain percentage of the faculty that's willing to do that, if they can get – now this is a terrible time economically to talk about that, but if you could get you know more support structure to make some of these things happen. And that's where I personally run into trouble because there's – I just don't have any more time. And so um, that's where it gets hard.

## Discussion and Conclusion

Faculty responses are not surprising give their varied experiences and their multiple leadership styles. Although there was no one model proposed for incorporating leadership into the engineering curriculum or one common definition of leadership, several comments from faculty might provide insight into propositions for schools and colleges of engineering.

First, rather than focusing on the development of leadership majors or minors that are housed in colleges of engineering, engineering administrators might think of ways to leverage relationships with other programs that emphasize leadership development. This might involve an interdisciplinary relationship between engineering, business, education, other social sciences, or the humanities. In this way, students might obtain additional specializations in leadership that are aligned with their future careers. Housing such programs outside of engineering might also reduce the stress that faculty feel to teach new technical content in their disciplines.

Second, a concern of engineering faculty is the numerous responsibilities that they have to manage. Depending on the primary roles of faculty, little time is left for faculty, especially pre-tenured faculty, to learn content that is not aligned with their research areas. For this reason, leadership experts might develop modules or other short courses that would help faculty learn how to incorporate and possibly teach leadership in their current courses. Such modules would be essential since faculty are the catalysts for introducing new content in engineering courses. One respondent summarizes this idea:

> Yeah. Well so maybe this goes back to leadership but the first thing is lead by example. And so you have to have faculty that are open and willing to embrace change. And that they set the example in their teaching methods, in their classes, in their expectations of students that they're always getting feedback on how the students are and how they're doing, and what can we do better or different to change that?

Third, although some faculty recognize the importance of introducing leadership to all students in their courses, some have not explored ways to expose all students to leadership principles in their courses. One way to do this is to allow students to rotate roles as they work in teams. Although teaming is a natural part of engineering courses, formal discussions of leadership roles and ideas about reflective leadership are not explicitly introduced. Leadership experts might prepare activities that allow students to engage in leadership exercises. These exercises could be coupled with real-world cases or could become supplements to current engineering curricula. In this way, students might engage in rich, intense conversations about their current ideas of leadership and about the roles of leadership in their activities.

Fourth,, academic administrators could examine explicitly the placement of leadership in the faculty reward structure. Primarily seen as a service, administrators might find others ways to place leadership in a promotion and tenure packet. For example, faulty who introduce leadership concepts in their courses might be encouraged to write about this inclusion in their teaching statement. Faculty might also include assessments of leadership in ABET accreditation documents and other publications focused on pedagogical innovations. Faculty also might conduct research on undergraduate students' college experiences related to leadership development. Only a limited number of studies provide evidence of changes in students' leadership and interpersonal skills during college (Pascarella &Terenzini, 2005). The authors note that research points "to increases in social competence but none permits an estimation of the magnitude of the change" (p. 225).

Finally, to further help faculty, general higher education literature on how college affects students can be scanned, and a short handbook can be provided for engineering faculty to direct them to resources or publications that already exist about ways to incorporate formal leadership in college courses and to connect students to informal leadership experiences that might help them to develop leadership skills.

Findings from the current study can inform engineering stakeholders about ways that leadership can be added to engineering curricula. Faculty perspectives could be used to create survey items about leadership that incorporate some of the suggestions and concerns of engineering faculty. Also, this work could provide a

foundation for other work that explores ways to operationalize leadership within an engineering context.

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