# Engineering with Engineers: Fostering Engineering Identity through Industry Immersion

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## Abstract

The National Science Foundation (NSF) Revolutionizing Engineering and Computer Science Departments (RED) program awarded a five-year grant to the Mechanical Engineering Department at a private, mid-sized university in July 2017. This grant supports the development of a program where students and faculty are immersed in a culture of doing engineering with industry engineers that, in turn, will help students and faculty develop stronger engineering identities. This culture of "Engineering with Engineers" is being cultivated through changes in four essential areas: a shared department vision, faculty, curriculum, and supportive policies. A theme unifying these changes is a significant connection to industry. This paper reviews the actions taken to develop this culture based on the four essential areas of change. It also provides insights on lessons learned thus far and plans to reach long term goals in the coming years.


## Introduction

In 2017, the Mechanical Engineering Department at Seattle University was awarded a National Science Foundation grant to revolutionize the department. The project leverages the department's small size and close ties with industry to create a culture of "Engineering with Engineers."

This paper summaries the current status of the five-year project and is an updated version of the NSF Grantees Poster papers presented at the 2018 and 2019 ASEE Annual Conferences [1], [2]. The project background and objective are unchanged; hence, the first two sections of the paper are taken from the 2019 paper. The Project Description section describes the four areas of change [1], [2] and describes goals and progress to date in each of the four areas. The remaining sections discuss ongoing evaluation, research, and long-term goals.

## Background

Identity influences who people think they are, what they think they can do and be, and where and with whom they think they belong [3] - [6]. People's identity shapes the experiences they embrace, and reciprocally, those experiences shape their identities [7] - [9]. People behave consistently with their identities [10], [11], choosing behaviors with meanings that match their self-conceptions [12], [13]. When people identify with an esteemed group, they feel better about themselves and, in turn, they feel better about the group [14], [15]. If people strongly identify with a group, they are steadfast, defending the group, staying in the group, and supporting the group [16].

In education, identity influences whether people feel they belong in a program and what they believe they can achieve. It has been shown to influence what goals are pursued and the level and type of effort put towards those goals [11]. Research also shows that identity and fit are important factors affecting persistence in STEM fields [7]. When people perceive a fit between themselves and their fields, they persist longer in those fields [17] - [19]. Hence, identity is a determining factor in one pursuing, persisting, and persevering in engineering [11], [20].

The development of identity is a social process. People's thoughts and behaviors are shaped through relationships and reflected appraisals with others [4], [16], [21]. Identities are further derived through associations, affiliations, and identifications with groups [17], [22]. Tonso [23] observes that identity development is an enculturated process where identities are acquired through "community-based interactions" and Beam et al. [20] concur that social contexts affect identity. In engineering education, situated learning is central to identity development [23]. Therefore, this social process of identity development can be realized through the culture of an engineering program. Cultivating a culture of doing engineering can result in graduates who not only are prepared technically and professionally with a practical, realistic understanding of what it is to be an engineer, but also who identify with and are committed to the engineering profession.

**Objective**

The project's objective is to develop a mechanical engineering program where students and faculty are immersed in a culture of doing engineering with practicing engineers from industry that in turn fosters students' engineering identities. The culture of a program plays a significant role in effective, innovative STEM education [24], [25]. The culture of "Engineering with Engineers" is being built through the interactions of students, faculty, and industry, through participation in engineering-related activities, and through reinforcement of shared similarities. We are studying how this new culture affects the identities of students and faculty, and how these enriched identities affect students' engagement in and commitment to engineering.

**Project Description**

Culture is shaped, in part, by the identities of those in the culture. It is negotiated, co-created and reinforced through communication and social interactions [26]. It develops organically from the behaviors of a group through association and shared experiences [27]. It is also important to know that culture in an educational setting is influenced by the priorities of the institution or department. Hence, we are creating this new culture of "Engineering with Engineers" in two ways. First, a variety of actions are being implemented to support these types of shared experiences to cultivate this new culture. Second, a number of changes to the structure and priorities of the program are being pursued.

To organize the actions and changes needed for this new culture, we follow the best practices recommended by Henderson et al. [28]. These include having coordinated efforts applied over extended periods of time, providing regular feedback and opportunities for reflection, changing faculty conceptions (e.g., their identities), providing incentives for change, and enacting policy changes from the ground up. From an extensive review of articles on facilitating change in STEM education, Henderson et al. indicated four areas of change: shared vision, reflective faculty, relevant curriculum and pedagogy, and supportive policies. In the following sections, actions taken to realize changes in each of these areas are summarized.

*Shared Vision: Building a Culture that Cultivates Identities as Engineers*

*Goal:*
Through interaction and discussion, the faculty agreed to establish a culture of "Engineering with Engineers." Specifically, the mechanical engineering department will be a hub of engineering activity where faculty, students, and industry can share experiences and ideas. The department also will forge relationships with key professional societies and utilize those relationships to create ties with local industries. As a small department with only nine full-time faculty, the goal is for all faculty to be involved in this project and to change this culture together.

*Current status:*
a. <u>Obtained a shared vision.</u> Because a shared vision is an important foundation for a culture, significant efforts were devoted to obtaining a shared vision of "Engineering with Engineers." Focusing on how "Engineering with Engineering" could improve undergraduate education united the faculty. Brainstorming produced ideas that led to new curriculum. In the "critical doing" of developing this new curriculum, faculty examined the current system, identified issues to be addressed, and built the shared vision. Students' input on the meaning of "Engineering with Engineers" also was solicited.

b. <u>Revised department mission.</u> A department vision day was held for faculty to discuss and update the department mission. Through a three-step process, faculty identified issues with the previous mission statement and three aspects -*pride, distinctiveness, and engineering with engineers*- to be included in the new mission statement. By addressing a set of questions for each aspect, faculty worked together to revise the mission statement as follows:

"[The mission of the SU Mechanical Engineering Department is to] Provide a technically rigorous design-focused education in a collaborative environment that emphasizes individual attention and connections to industry, while preparing students to help create a more just and humane world."

More details on the three step-process and questions asked in each aspect can be found in Ref. [2].

c. <u>Began confronting issues related to inclusion.</u> The department undergoes annual review by external evaluators Inverness Research. The 2019 review revealed instances where students did not feel included. These situations involved faculty, staff, and students. Since becoming aware of the situations, the department has spent considerable time addressing inclusivity. All faculty attended microaggression and inclusion training (see below). Inclusion training has been added to the new vertically integrated design project courses (see below) that will be required of all students. One faculty piloted a syllabus that includes a policy on microaggressions and harassment. The Department has prompted University's Center for Teaching and Learning to lead the establishment of a university-wide policy.

d. Created ME Student Advisory Council. The department created the student advisory council to open a path for creating a shared vision with students. Department chair meets with the students twice per quarter. The council's input is taken in two ways: 1) members are invited to choose the topics of discussion to inform the chair of issues concerning students; 2) the council is asked to review faculty initiatives, such as curricular changes, course delivery, and advising practices. The meetings help identify student issues and provide student feedback with a short turnaround time.

e. Revised student advising. Because each student must meet with their assigned faculty advisor three times a year, these meetings and relationships are key to the cultivation of the culture and to students' perceptions of themselves as engineers. Concerned that we were missing an opportunity to connect students to the program and to engineering, the faculty focused on the advising process. Discussions centered on what ABET, the University, the College, and the faculty think advising should be. We determined what advising should achieve, and we delineated the actions the department, the advisors, and the students should take to make advising successful. Ultimately, faculty advisors agreed on a checklist for the advising appointment that ensures a high standard of faculty advising. See the Appendix for this checklist.

*Reflective Faculty: Strengthening Interaction with Industry & Understanding Diversity and Inclusivity*

*Goal:*
To strengthen faculty's connection to industry and aid their ability to facilitate student connections, faculty will participate in an industry immersion experience during the summer where they work with practicing engineers and learn current industry practices. Additionally, faculty will acquire relevant industrial and teacher trainings. Ultimately, faculty will see their role, or identity, as moving students towards becoming practicing engineers who create a "more just and humane world." Students, too, will reflect on their identities as engineers and how those relate to their education and career paths. To bridge course work and industry practices, an Industry Advisor with extensive experience in industry and passion for engineering education will be on campus one day a week to provide insights to faculty and students.

*Current status:*
a. Faculty industry immersion. The grant provides opportunities for each faculty member to spend one summer month in industry. Thus far, two faculty members have participated in the summer industry immersion program.

In 2018, a faculty member worked on a specific project at a local company. The faculty member provided the solutions that improved company processes, while he learned the practice and culture of the company. In 2019, another faculty member worked for a global company. Rather than work on a specific project, she visited six different locations including a research center and two factories and spoke to employees at all levels. With a broad view of the company's operation, she identified characteristics needed to persist and succeed, such as being comfortable with ambiguity, being a self-learner/starter, communicating effectively across audiences, and utilizing data. Both shared their experiences with other faculty members when they returned, providing knowledge, examples, and program directions. Additionally, relationships with companies for potential future collaborations were developed or strengthened.

Overall, the faculty immersion program has broadened faculty's views and strengthened their ties to industry. The rest of the faculty will join the immersion program in the coming summers, and they are in the process of identifying their industry partners.

b. Faculty training. Faculty have attended multiple training courses since the beginning of the project. For example, Prof. Michael Prince led a workshop on problem-based learning to ensure faculty possess the tools to bringing more authentic problems to their classroom. The Center of Faculty Development and the Project Center led trainings on microaggressions and diversity. All Mechanical Engineering faculty attended at least one of these workshops as an effort to work towards a more inclusive culture.

c. Industry Advisor. The Industry Advisor has extensive experience in industry and is passionate about sharing experience with students. He is available on campus every Friday. Responsibilities of the industry advisor include:

- assisting in building a culture and environment of "doing engineering."
- strengthening the connection among the department, students, and industry.
- providing students with mentoring and career advice and industry-relevant experiences.
- supporting design competitions sponsored by industry.
- helping find co-ops and/or internships for students.
- hosting events such as portfolio workshops and resume reviews.

In addition, the Industry Advisor found a company sponsor for a design challenge. About a dozen teams are participating and the Industry Advisor and the faculty serve as consultants for the teams. The Mechanical Engineering Student Club is engaged in promoting the challenge.

*Relevant Curriculum and Pedagogy: Maintaining Strong Connections with Industry and Incorporating Industry Practice into the Program*

*Goal:*
Across the mechanical engineering curriculum, there will be connections to industry and student engagement in activities that reflect what a practicing engineer might do. Such connections and activities require pedagogic changes to existing courses as well as the implementation of a series of new courses with components related to industry practice. In addition to curriculum changes, the department encourages and sponsors regular seminars, field trips, social events, and design challenges to connect the program and industry more closely.

*Current status:*
a. Curriculum revision. To implement the department shared vision of "Engineering with Engineers," faculty first examined the previous curriculum and identified several ways to strengthen it and to include industry. The process of "critical doing" actively involved faculty and students in the design of the new curriculum. Details on the process of developing our new curriculum can be found in Ref. [2].

The University approved the changes for implementation in Fall 2019. Additions to the curriculum included the vertically integrated design course, data acquisition courses, and the senior design course sequence.

1. Vertically integrated design project courses (VIDP). Historically, the program has a strong senior design course sequence where seniors work in teams on real projects sponsored and mentored by industry for an entire academic year. Senior design provides valuable experience doing hands-on engineering with practicing engineers. The first three years of the program, however, are missing real industry design experience. As remedy, a separate design course sequence, where freshmen, sophomores, and juniors can have similar experiences working on authentic design projects was added to the curriculum. Each year integrated teams consisting of freshmen, sophomores and juniors will work on engineering projects. Through these experiential learning courses students will learn and practice skills such as design principles, team dynamics, project management, communication, etc. Furthermore, having a team that consists of freshmen, sophomores, and juniors working on the same project naturally fosters the community feeling and enhances the sense of belonging. The first VIDP courses will be offered in the spring of 2020 and the assessments of these courses will be reported in the future.

2. Data acquisition courses. The department combined the electrical engineering and instrumentation courses into a single two-term sequence. In the past, students took a circuits course one term and an instrumentation course the next. With this approach, students do not see the connection between the electrical engineering content and its application to mechanical engineering. In the new sequence, the electrical engineering and instrumentation are taught side-by-side. Student learn an electrical engineering concept and apply it to a mechanical engineering problem in the same week. The course also incorporates labs from other classes. For example, one of the instrumentation projects is to design and build a system to measure the strain on a cantilevered beam and compare it to theory. The content of that particular lab was developed with the instructor for the machine elements course. Similarly, there are labs that address theory in the fluids and heat transfer courses. The goal is to provide an integrated experience for students where they learn electrical engineering concepts, apply the concepts to instrumentation and use those principles to make measurement that support their learning in other courses.

3. Changes to the senior design course sequence. The program's senior design course sequence has had great success in connecting seniors and industry for more than 25 years. To simulate industry, we changed the vocabulary and removed traditional academic schedules. The vocabulary change mimics the language of industry rather than the language of school (see Table 1); the removal of academic schedules empowers students to take responsibility for their own project planning. For example, students are "engineers"; the "syllabus" is replaced by a "project engineer guideline"; faculty advisors are "consultants"; and the grading becomes the "performance review." Instructors of the courses (i.e., managers) do not set deadlines anymore. Instead, each design team sets their milestones and determines their own deliverables. There are scheduled status check-ins to ensure each design team is making sufficient progress.

The department also has abandoned using an academic Learning Management System for administering and managing the design projects. All teams, industry reps, and faculty now communicate and share information using Microsoft Teams, a platform commonly used in industry for communication and file sharing.

In addition, the Department changed how projects are funded. In the past the College allocated a fixed amount to each design team, resulting in design teams creating artificial budgets to meet the allocated amount. Under the new budgeting scheme, the college allocates a fix amount to be distributed among all design teams. Teams propose budgets to the "mechanical engineering division." If the total amount exceeds the available funds, then the Department works with all of the teams to adjust the budgets. This approach has worked well and encourages teams to provide realistic budget for their projects.

This change was first implemented in fall 2018.

Table 1. Example of vocabulary used in academia and industry (in no particular order).

| Doing school with teachers | | Doing engineering with engineers | |
|---|---|---|---|
| Hours | Class | Professional responsibilities | Performance evaluations |
| Lectures | Cover | Project briefs | Schedules |
| Due dates | Grades | Supervisors | Promotions |
| Papers | Students | Deadlines | Credentials |
| Learning objectives | Topics | Reports | Pro-bono |
| Tests | Homework | Hiring | Job requirements |
| Assessment | Rubrics | Raises | Resumes |
| Accreditation | Curriculum | Work teams | Work history |
| Registration | Credits | Offices | Meetings |
| Syllabus | Tuitions | Debriefings | |

b. Innovative teaching. Faculty are willing to attempt innovative teaching approaches. One instructor inverted her classes and several adopted active learning exercises. Two worked with practicing engineers on in-class projects. Course instructors and practicing engineers worked together to scope open-ended projects. For example, in the Heat Transfer course, the instructor and a practicing engineer proposed performing an energy audit to identify how a community senior housing complex might minimize their heating expense. Students visited the site and, with the guidance from the practicing engineer, took relevant measurements to build their energy models. Students exercised the heat transfer knowledge they learned in class and applied it to the real-world problem. At the end of the project, students presented their recommendations on how the senior housing complex can save energy to the practicing engineer and community members. Most of the students appreciated this project and considered it the highlight of their learning experience in heat transfer.

c. Industry seminars and socials. Speakers from various companies including Kenworth and Boeing were on campus to share their experiences. Receptions and happy hours encouraged students and alumni to connect with others, develop their professional skills, and build community.

d. Makerspace. The student-centered makerspace was updated with several new 3D printers, a laser cutter, and additional tools. Students are maintaining the equipment, holding open hours, and using the makerspace for various projects.

*Supportive Policies: Changing Expectations in Departmental Reviews*

*Goal:*
Culture takes time to grow organically and changes cannot be forced. Building a shared vision warrants a solid foundation for the project. Reflective faculty and changes to curriculum create pathways for change. Activities that bring faculty, students and industry together enhance the community-based interactions and, in turn, cultivate the culture of doing engineering. Supportive policy will play a role in motivating and sustaining changes.

*Current status.*
A number of changes to the structure and priorities of the program are being implemented:

a. Changes to the annual performance reviews. To incentivize and motivate faculty, performance reviews recognize and commend faculty's engagement with industry, changing culture, and curricular and pedagogical revisions. For example, the work done to enhance industry connections and efforts to enhance "Engineering with Engineers" are considered in the department faculty's annual performance reviews. Policies on tenure and promotion standards are being proposed at the university level through the ADVANCE grant sponsored by NSF [29].

b. Raising institutional support for the grant. The team of RED PIs met with the new Provost to raise his awareness of the grant. The Department Chair updates the Dean frequently to assure his continued support. There will be more conversations with other administrators to enhance awareness of the project and gain solid support for the changes.

**Evaluation and research**

*Goal:*
During this project, changes to the program and to student and faculty identities are evaluated through interviews, surveys, portfolios, reflections, and audio and/or video documentaries. All students and faculty in the program are invited to participate in these evaluation activities and responses are tracked every year to document the changes.

The three main research questions this project aims to study are:
1. How have the identities of the students and faculty changed?
2. How has the departmental culture changed?
3. What happened in response to the changes made and the changes that occurred?

*Current status:*
a. Identity surveys and Implicit Association Tests (IATs). To track how student's identity changes, we are using both the explicit identity surveys and the IATs. Baseline explicit identity surveys for existing mechanical engineering students were conducted and results presented in the 2018 ASEE annual conference [30]. Additionally, baseline engineering and gender identity data

were collected via Implicit Association Tests (IATs) and results were presented in the 2019 ASEE annual conference [31]. Each year we administer both explicit identity surveys and IATs. Results of these identity studies will be presented in future conferences.

b. Alumni and senior exit surveys. Tools to track the impact of students' experiences after they leave the program were developed and administered in 2019.

c. Growth in professional skills. To document the impact of the changes to senior design on students' professional thinking and skills, a pre-post assessment was developed. The pre-test was administered at the start of the 2019-20 senior design sequence. The post will be administered in June 2020.

d. Reflections. Some faculty have added short reflection activities to their classes, both to add meaning and personal understanding to the coursework and to document students' growth.

e. Portfolios. The Department piloted the use of portfolios with a small sample of students to gain insights on students' knowledge on portfolio construction and help set goals on future portfolio activities. Subsequently, the Department hosted Portfolio Week for all students. The Industry Advisor since has hosted several workshops to help students build their portfolios. As with reflections, the process of creating and curating one's portfolio both develops and documents identities.

f. External evaluator interviews. An external evaluation team is monitoring the process and progress of culture change in the department by interviewing faculty and students in the department. From these interviews, the external evaluator provided their suggestions related to the subject of culture change. The change process is also being documented via audio and videos of faculty interviews.

**Long-Term Directions and Goals**

Through myriad changes in the four essential areas of shared vision, reflective faculty, relevant curriculum and pedagogy, and supportive policies, Seattle University's Mechanical Engineering Department is changing their culture. Unifying these changes is a connection with industry and a focus on identity.

A focus on identity encourages reflection and a larger discussion about how students and faculty see themselves, their education, and their profession, and how experiences uniquely affect underrepresented or marginalized students. Researchers have suggested that culture is especially important for women to persist in a field [23], [30]. A culture of "Engineering with Engineers" could result in graduates who not only are prepared technically and professionally with a practical, realistic understanding of what it is to be an engineer, but who also identify with and are committed to the engineering profession. Hence, results of the study are hoped to lead to a clearer understanding of the changes that promote engineering identities, particularly in women, and how such identities affect students' sense of belonging in a program and their persistence in the major.

It is our hope that this project will enact changes in incentives and training that promote industry engagement and build strong industry-education connections and that this conversation about engineering identity can lead to a better understanding of how best to create an inclusive educational system.

**Acknowledgement**

This project was funded by the NSF IUSE/PFE: RED grant #1730354.

**References**

[1] Y.-L. Han, K. E. Cook, T. R. Shuman, G. Mason, and J. Turns, "Engineering with Engineers: Revolutionizing Engineering Education through Industry Immersion and a Focus on Identity," *Proceedings of American Society for Engineering Education Annual Conferenc*e, Salt Lake City, UT: ASEE 2018.

[2] Y.-L. Han, K. E. Cook, G. Mason, T. R. Shuman, and J. Turns, "Engineering with Engineers: Revolutionizing a Mechanical Engineering Department through Industry Immersion and a Focus on Identity," *Proceedings of American Society for Engineering Education Annual Conference,* Tampa, FL: ASEE 2019.

[3] K. Deaux, "Reconstructing social identity," *Personality and Social Psychology Bulletin,* vol. 19, pp. 4-12, 1993.

[4] S. Stryker, and P. J. Burke, "The past, present, and future of an identity theory," *Social Psychological Quarterly*, vol. 63(4), pp. 284-297, 2000.

[5] E. H. Erikson, *Identity and the life cycle*. New York: International Universities Press, 1959.

[6] M. B. Brewer, "The social self: On being the same and different at the same time," *Personality and Social Psychology Bulletin*, vol. 17, pp. 475-482, 1991.

[7] J. E. Dutton, J. M. Dukerich, and C. V. Harquail, "Organizational Images and Member Identification," *Administrative Science Quarterly*, vol. 39(2), pp. 239-263, 1994.

[8] G. H. Mead, *Mind, Self, and Society*. Chicago: University of Chicago Press, 1934.

[9] S. Stryker, *Symbolic Interactionism: A Social Structural Version*. Menlo Park, CA: Benjamin/Cummings, 1980.

[10] J. D. Lee, "More Than Ability: Gender and Personal Relationships Influence Science and Technology Involvement," *Sociology of Education*, vol. 75(4), pp. 349-37, 2002.

[11] B. R. Schlenker, "Identity and self-identification.," in *The Self in Social Life*, B. Schlenker, Ed. New York: McGraw-Hill, 1985.

[12] J. D. Lee, "Which Kids Can "Become" Scientists? Effects of Gender, Self-Concepts, and Perceptions of Scientists," *Social Psychology Quarterly*, vol. 61(3), pp. 199-219, 1998.

[13] O. Pierrakos, T. K. Beam, J. Constantz, A. Johri, and R. Anderson, "On the development of a professional identity: Engineering persisters vs. engineering switchers," *Proceedings of Annual Frontiers in Education Conference*, San Antonio, TX: FIE, 2009.

[14] R. B. Cialdini, R. J. Borden, A. Thorne, M. R. Walker, S. Freeman, and L. R. Sloan, “Basking in reflected glory: Three (football) field studies,” *Journal of Personality and Social Psychology,* vol. 34, pp. 366-375, 1976.

[15] H. Tajfel, and J. C. Turner, “The social identity theory of inter-group behavior,” in *Psychology of Intergroup Relations*, S. Worchel, & W. G. Austin, Eds. Chicago, IL: Nelson-Hall, 1986, pp. 33-48.

[16] R. Spears, B. Doosje, and N. Ellemers, “Self-stereotyping in the face of threats to group status and distinctiveness: The role of group identification,” *Personality and Social Psychology Bulletin,* vol. 23, pp. 538–553, 1997.

[17] S. E. Cross and N. V. Vick, “The Interdependent Self-Construal and Social Support: The Case of Persistence,” *Personality and Social Psychology Bulletin*, vol. 27(7), pp.820-832, 2001.

[18] A.L. Kristof, “Person-Organization Fit: An Integrative Review of its Conceptualizations, Measurement, and Implications,” *Personnel Psychology*, vol. 49(1), pp.1-49, 1996.

[19] O. Pierrakos, N. A. Curtis, R. D. Anderson, “How salient is the identity of engineering students? On the use of the Engineering Student Identity Survey,” *Proceedings of Frontiers in Education Conference*, Erie, PA: FIE, 2016.

[20] T. K. Beam, O. Pierrakos, J. Constanz, A. Johri, and R. Anderson, “Preliminary findings on freshmen engineering students' professional identity: Implications for recruitment and retention,” *Proceedings of American Society for Engineering Education Annual Conference*. Washington, DC: ASEE, 2009.

[21] C. H. Cooley, *Human nature and the social order*. New York, NY: Scribners, 1902.

[22] K. E. Scheibe, “Historical perspectives on the presented self,” in *The Self in Social Life*, B. Schlenker, Ed. New York: McGraw-Hill, 1985.

[23] K. Tonso, “Enacting practices: Engineer identities in engineering education,” in *Engineering Professionalism: Engineering Practices in Work and Education*, U. Jørgensen and S. Brodersen Eds. Rotterdam, The Netherlands: Sense Publishers, 2016, pp. 85-104.

[24] C. Henderson and M. H. Dancy, “Increasing the Impact and Diffusion of STEM Education Innovations”, *Increasing the impact and diffusion of STEM education innovations,* Washington, DC: National Academy of Engineering, 2011. [Online]. Available: https://www.nae.edu/File.aspx?id=36304. [Accessed: 15- Nov- 2016].

[25] M. Besterfield-Sacre, M. F. Cox, M. Borrego, K. Beddoes and J. Zhu, “Changing Engineering Education: Views of U.S. Faculty, Chairs, and Deans,” *Journal of Engineering Education*, vol. 103(2), pp. 193–219, 2014.

[26] J. N. Martin and T. K. Nakayama, *Intercultural Communication in Contexts*, New York: McGraw-Hill, 2010.

[27] J. Lave and E. Wenger, *Situated learning: Legitimate peripheral participation*, Cambridge UK: Cambridge University Press, 1991.

[28] C. Henderson, A. Beach, and N. Finkelstein, “Facilitating change in undergraduate STEM instructional practices: An analytic review of the literature,” *Journal of Research in Science Teaching,* vol. 48(8), pp. 952-984, 2011.

[29] Award Abstract #1629875, "ADVANCE Institutional Transformation at Seattle University". Washington DC: National Science Foundation, [Online]. Available: https://www.nsf.gov/awardsearch/showAward?AWD_ID=1629875&HistoricalAwards=false. [Accessed: 08- Apr- 2018].

[30] K. E. Cook, Y.-L. Han, G. Mason, T. R. Shuman, and J. Turns, "Work-in-Progress: Engineering Identity across the Mechanical Engineering Major", *Proceedings of* A*merican Society for Engineering Education Annual Conference*. Salt Lake City, UT: ASEE 2018.

[31] K. E. Cook, Y.-L. Han, G. Mason, T. R. Shuman, and J. Turns, "Implicit Engineering Identity in the Mechanical Engineering Major". *Proceedings of* A*merican Society for Engineering Education Annual Conference*. Tampa, FL: ASEE 2019.

**Appendix:** Advising Checklist

**Before student arrives** (or in the session if you require long advising appointments)

- ❑ Review their progress (e.g., program evaluation, prior grades, progress to graduation)
- ❑ Review prior advising notes
- ❑ Draft a proposed schedule for the next quarter

**When the student arrives**

- ❑ *Student Care:*
  Greet the student, inquire how the current quarter is going and provide advice where applicable, for example
  - Are they keeping up with classes?
  - Are they enjoying engineering and college? (identify students who are not connecting)
  - Are there things that would help to make them more successful?
- ❑ *Academic Advising:*
  Review their grades, current schedule and update their four-year plan.
  - Do they need academic support?
  - Are they planning to study abroad?
  - FE Exam reminder for seniors – reminder to register and take it
- ❑ *Professional Advising:*
  Ask about their professional development and provide guidance. For example,
  - What are their career goals after graduation?
  - Are they interested in engineering internships or research, in summer or during school year?
  - If they are a senior, how is the job search going?
  - Are they taking advantage of career fairs and networking opportunities?
  - Is their resume up to date? Do they want to develop a portfolio?
- ❑ Do they have any other questions or concerns?

**After the student leaves**

- ❑ Update student's advising notes, academic and professional development plan on SUOnline.
- ❑ Remove their academic advising hold.

**For First-Time Advisees** (freshmen, transfers, new advisees)

- ❑ Introduce self
- ❑ Explain the purpose of advising and that advising is required every quarter
- ❑ Develop an academic graduation plan (4-year plan)
- ❑ Check on their transition to SU. For example,
  - How is it being away from home? Are you enjoying friends and classmates?
  - What is your living situation – is that working for you?
  - Are you able to manage your time?
- ❑ Explain program/graduation requirements
  - ❑ 2.5 GPA requirement.
  - ❑ Requirements for entering senior design
  - ❑ FE exam requirement