



Career Paths in Structural Engineering: What We Can Learn from the SE3 (Structural Engineering Engagement and Equity) Report

Prof. Christina McCoy SE, RA, Oklahoma State University

Professor McCoy is a licensed Structural Engineer and Architect. She holds a Bachelor Degree in Architectural Engineering and a Bachelor in Architecture from Oklahoma State University. She holds a Masters of Science in Architecture from the University of Cincinnati and Masters of Civil Engineering (Structural Emphasis) from the University of Kansas. She worked in the structural engineering profession for 10 years before joining the full-time Architectural Engineering faculty at Oklahoma State University School of Architecture.

Prof. Carisa H Ramming P.E., Oklahoma State University

Carisa Ramming is a graduate of Oklahoma State University where she obtained degrees in Architectural Engineering and Civil Engineering Construction Management. She worked in industry for six years as licensed engineer and structural consultant for Wallace Engineering in Tulsa, OK before returning to Oklahoma State as a visiting faculty member in the School of Architecture. In 2009, Professor Ramming joined the faculty full time as an assistant professor of architectural engineering. Since that time, she has taught classes in structural analysis, timber and steel design, engineering mechanics: statics, building foundations and numerical analysis. Professor Ramming has recently been named Halliburton Outstanding Young Faculty and the Outstanding Teacher for the College of Engineering, Architecture and Technology. She has also published books for Project Lead the Way and a text on Numerical Structural Analysis. Professor Ramming enjoys spending time with the students of CEAT as the advisor of the Architectural Engineering Institute, Tau Beta Pi, Women Inspiring Successful Engineers, and CEAT Student Council.

Diversity and Culture in Structural Engineering: What We Can Learn from the SE3 (Structural Engineering Engagement and Equity) Report

Abstract

In 2016, the Structural Engineers Association of Northern California embarked on a nation-wide survey of structural engineers to assess the cultural climate in the profession. The committee conducting the report was entitled “Structural Engineering Engagement and Equity” (SE3), and the survey results along with the associated report has been termed the “SE3 report”. The report gave insight into several areas, including pay equity, time management, and career development. Since publication of the report, the National Council of Structural Engineers Associations (NCSEA) has formed its own SE3 committee, with the goal of conducting a similar survey biennially; the first survey was issued in 2018. Conclusions from the 2018 SE3 report seek to inform engineering firms as to how to improve work place culture in order address areas of inequity within the profession and understand how to retain talent from a diverse population of engineers. This paper examines how these findings can be used to prepare a similar diverse group of students to enter the workplace with the tools to craft a successful career path. Further, it discusses how engineering management education programs can incorporate the topics highlighted by the NCSEA SE3 committee concerning strategies that firm leadership can implement on the management level to address employee values that the report shows to be undervalued. The survey results highlight the importance of certain employee skills, such as negotiation and stress management. Conclusions also identify the importance of finding a mentor. In addition, the report finds a strong link between the perception of management involvement and communication to job satisfaction. This link is even, perhaps surprisingly, stronger than that between compensation and job satisfaction. Entry-level engineers and managers can both benefit by understanding such implications and others from the report. This knowledge can open up a multitude of strategies to capitalize on the growing interest within the structural engineering profession to recruit and retain talent of all backgrounds.

Introduction: the SE3 report from an engineering management perspective

The mission statement of the 2018 SE3 report is as follows: **“to attract and retain the best talent into our profession, and to ensure all structural engineers have a pathway to success in their careers.”**[1] From an engineering management perspective, this statement encompasses a lot of goals and aspirations that are often more difficult to understand than meets the eye. For instance, why does the committee choose to articulate that it is targeting “all structural engineers”? The meaning behind this is alluding to the reported propensity of women and minorities leaving design and construction related fields at a higher rate than average.[2] In addition, the phrase “pathway to success” can be a daunting one to understand by engineering managers. What are the barriers in the pathway for the diverse range of engineers within the profession? Do they all define “success” in the same terms? How can the management of an engineering firm impact this with the goal to yield more recruitment and retention? In short, the

SE3 report looks at a way we can broaden the impact of how engineers approach engineering management to include a consideration of diversity and inclusion, not merely because it is the “right” thing to do, but because the attraction and retention of a diverse work force allows us to employ the best engineers from all backgrounds, leading to a more robust and talented generation of engineers.

History behind the report

In 2016, the Structural Engineers Association of Northern California embarked on a nation-wide survey of structural engineers to assess the cultural climate in the profession. The committee conducting the report was entitled “Structural Engineering Engagement and Equity” (SE3), and the survey results along with the associated report has been termed the “SE3 report”. [3] The report gave insight into several areas, including pay equity, time management, and career development. The survey aimed to study “how engaged structural engineers around the country are in their profession and how this engagement manifests itself across genders.” It did this by focusing on three key questions:

- 1) Are people within the structural engineering profession generally engaged?
- 2) Of the people who have left the structural engineering profession, what characteristics do they have in common
- 3) Do structural engineers’ experiences vary by gender?

The conclusions from the 2016 report will not be discussed here at length, as the paper focus is primarily the 2018 report. However, the questions are listed here to highlight the intentions of the initial report and thus give context for the 2018 report expectations. The 2016 report also cites similar reports in allied industries that examine the issue of women leaving the work force, such as the 2014 survey issued by the Equity by Design committee of the San Francisco chapter of the American Institute of Architects.[4]

Since publication of the 2016 report, the National Council of Structural Engineers Associations (NCSEA), which operates at a national level, has formed its own SE3 committee, with the goal of conducting a similar survey biennially; the first survey was issued in 2018[1], which is the focus of this paper, and another one is currently underway in 2020. NCSEA chose to define a mission statement as stated in the introduction of this paper, which focusses on the idea of understanding job satisfaction for engineers of all demographics. While the consideration of gender is still very present in the report, the inquiry has expanded to include race identity, sexual orientation, age, position, and geographic location. It is worth stating that the overall focus is job satisfaction and while it is important to understand the specific issues relating to minorities, it is equally important to include the majority perspective, so that the committee can understand the entire cross-section across the structural engineering profession.

How this report can be used in engineering education

The NCSEA has presented this report widely at a variety of professional conferences and symposia. Yet, the outreach to the academic realm has been limited. While the NCSEA’s focus audience appears to be firm leadership teams, the implementation in academia has two prongs:

(1) instruction of engineering management to address the SE3 report concerns and (2) raising awareness at the student level to prepare future engineers for career path expectations and enhancement of vital skills.

For ABET-accredited engineering programs, curriculum development leaders may be searching for the best way to infuse these topics into courses. Furterer [5] explored the development of a course within an engineering management program in the 2018 paper “Developing a Leadership and Diversity Course for an Engineering Management Program”. Furterer’s paper outlines issues of leadership and diversity and how they are explored and studied with students over a semester-long course. However, since the SE3 report is discipline-specific, architectural and civil engineering programs may wish to infuse this subject area into their courses on a smaller scale. Moreover, the subject matter could also be incorporated as a portion of a Leadership and Organizational Behavior course. The ABET student outcomes addressed include the following:

3. an ability to communicate effectively with a range of audiences
5. an ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

This paper will look at key issues of the report as they are presented by NCSEA and from the perspective of engineering educators. The conclusion of this paper proposes a “short course” or workshop outline in order to facilitate implementation in a curriculum at a small scale. It will cover SE3 topics relating to management and organizational leadership and consider their applicability to students in both engineering management and civil/architectural engineering curriculums. As these topics are covered, it is helpful to keep in mind that questions were framed in order to relate each topic to overall job satisfaction and inclination to remain part of the structural engineering work force.

Pay and compensation

The survey did not raise a concern for unequal pay for equal work for a majority of survey respondents. Reference chart below. As can be seen, both men and women show equal pay upon entering the profession. As years of experience grow, the pay gap tends to widen, with men earning more than women. However, survey evaluators found that at all levels except for Principal, the gap is not statistically significant and can be explained by secondary factors. The report gives an example of a secondary factor the finding that men are more likely to have a partner who provides childcare for those who have children, and this is also found to have a net positive effect on income. In other words, men, in general, due to availability of child care, have more time available to devote to working overtime and see a slight bump in average pay due to this factor. It is interesting to note that when looking at the responses across all age groups, the split in caregiving responsibilities seems to be less gender-driven among the younger demographics. In terms of managerial conclusions, this may mean the pay gap will begin to close, but the issue of work-life balance for working parents may become a more widespread priority among all genders in the structural engineering workforce in future years. The survey

does not speculate as to any explanation for the pay gap at principal level being significant between genders.

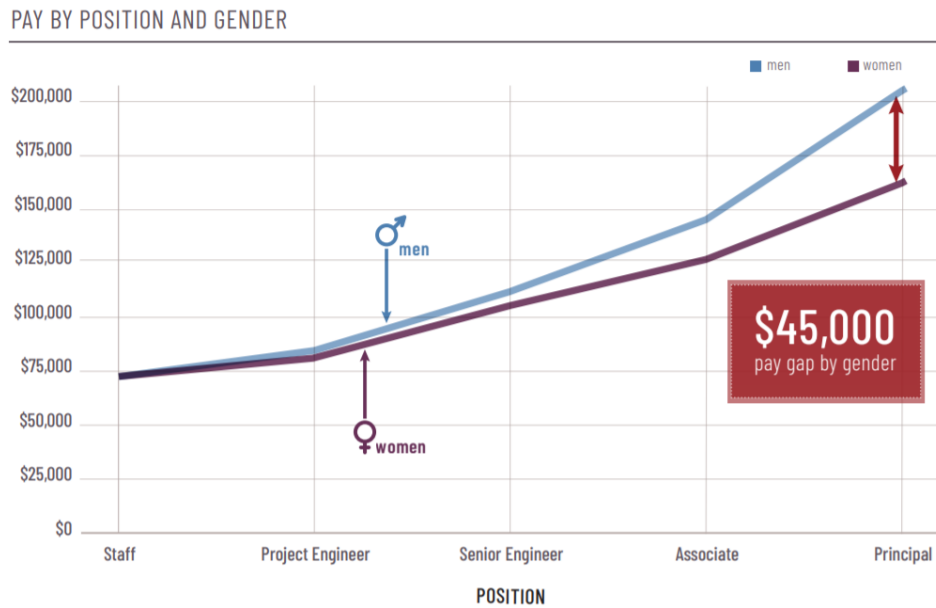


Figure 1: Chart on pay equity in structural engineering as published in the 2018 SE3 Report

Success in negotiation was found by the survey to be, unsurprisingly, linked to higher pay. For all respondents, those who negotiated tended to be higher earners. From the findings, men and women both negotiated nearly the same amount (53% of males negotiate, 49% of females negotiate for higher pay). However, it is shown that males are more successful in their attempts to negotiate: 85% of males report success while 75% of women report success. It is unclear, and likely varies, what this shortfall is due to in women's negotiation attempts. One possible explanation may be a deficiency in skills, while another may owe it to bias of the management. Regardless, within the education scope, it is clear that developing negotiation skills in all students will lead to a greater likelihood of higher pay.

DID YOU NEGOTIATE FOR HIGHER WAGES OR OTHER TYPES OF COMPENSATION?

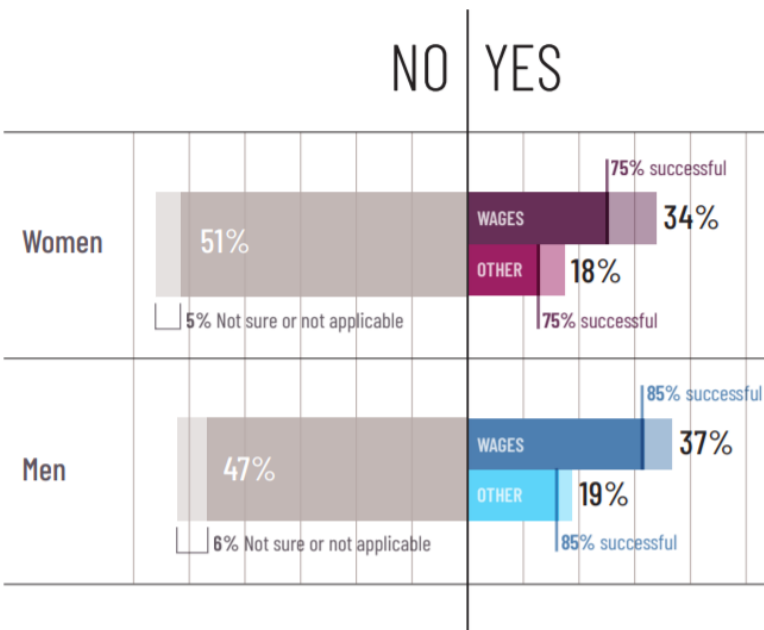


Figure 2: Negotiation efforts broken down by gender, 2018 SE3 Report

Other factors that impact higher pay are worth noting. In addition to having a spouse that provides childcare and working overtime, other factors include geographic location, having a master’s degree, and the nature of daily tasks. The correlation between pay and overall job satisfaction was found to have a small, positive impact.

Work life balance

Of the many job satisfaction categories explored within the SE3 report, job satisfaction with work-life balance was the lowest scoring. It is one of the top reasons people give for considering leaving the profession. Much can be done within engineering management research to learn how to better address the needs of employees in this subject area. The work demand that provided the most dissatisfaction came from workers who reported working 41-50 hours per week. Interestingly, those that reported working 51 hours or more did not seem to follow that trend and were generally not much more dissatisfied than average. The report posits that the reason behind this is those who work in excess of 50 hours per week do so by choice, and are thus not dissatisfied with the work load. The report drew a similar conclusion for Principals, who reported working more than average but were also not more dissatisfied than average.

Satisfaction with the work environment led to a higher (30% more likely) satisfaction with work life balance. So, if people like where they work, they do not mind working more. Satisfaction with daily tasks had a similar link to satisfaction (21% more likely to be satisfied). From a management perspective, this means understanding the individual personalities of people on a team and assigning tasks based on their area of comfort and enthusiasm.

Management strategies to address work life balance include offering flexibility in hours work and working from home, improving work place environment, understanding individual needs, and providing resources for efficient completion of workload. As shown in the survey results, studying solutions to this tricky management issue is a worthwhile topic for firms who want to attract and retain the best engineers. Sarker [6] explores the utilization of technology to address work-life balance, but also acknowledges that this strategy can blur boundaries of personal and profession time, which some employees view negatively. This suggests the technological answer is not one-size-fits-all. Lingard [7] presents a case-study to look at flexibility in work hours as another possible solution by compressing the hours worked per week into fewer days, thus giving a longer weekend with the same amount of time input.

Career development

While some factors of job satisfaction might be out of the control of the engineering manager, there is much that can be done in the area of career development. According to the SE3 study, this can make a huge impact. As the report states, “Effective management, mentorship, and professional development were found to be among the leading indicators of overall career satisfaction.”[1]

Mentorship is a key factor in the development of engineers within their careers. Firms that encourage a culture of mentorship or set up a formal mentorship program will see benefit from these efforts. In terms of job satisfaction, survey participants with a mentor responded to high levels of job satisfaction (84%) compared to participants without a mentor, who responded positively at a rate of 69%. In addition, those without a mentor are twice as likely to plan to leave the profession. Jeffrey Russell wrote of mentorship in the engineering disciplines:

“Effective mentoring of young engineering professionals is a two-way street. A young professional’s energy, new ideas, thirst for information, and willingness to learn give any organization spirit and momentum. In mentoring a young professional, it’s important to provide opportunities for the mentee to take part in team building, brainstorming and planning sessions, and to build relationships throughout the organization. Such processes and experiences are of significant benefit to the mentor as well. Mentoring is perhaps the best way to ensure that one’s intellectual and experiential legacy can be tapped, improved upon, and be of continual benefit to the organization.”[8]

It is beyond the scope of this paper to fully cover the approaches to mentorship that may be taken by an engineering manager; suffice to say it is a crucial topic. From the perspective of students entering the work force as entry level engineers, they may not realize the substantial benefit of seeking out a mentor.

Managerial communication can also impact how an individual feels about their career. Survey respondents show low-scoring feedback (50% positive) in the belief that management communicates expectations for advancement, despite the fact that 75% of Principal-level respondents believe that effective communication on advancement takes place. Clearly, some work needs to be done to close that gap. Respondents were also dissatisfied with the frequency of feedback or reviews. NCSEA has indicated that this is one area where they plan to do further

research and investigation as to how managers can more effectively communicate criteria for advancement.

Engineers also vary slightly in how they define success. Women tend to value position title more, while males tend to value compensation. Generally, successful project outcomes, positive client relationships, respect from staff, and effective management of others scored were commonly associated with success. Interestingly, only about half of respondents indicated that they aspire to become a Principal during their career. Individual reasons for this vary, but firms' abilities to offer alternate career paths is another topic area that the SE3 committee has indicated to dive deeper into in the future.

Retention: is there an issue?

The SE3 report was the first of its kind to take such a deep look into structural engineering. In 2010 Frehill conducted a similar survey across Chemical, Electrical & Computer, Mechanical, and Civil & Architectural disciplines concerning job satisfaction. [9] The survey conducted by those researchers found that the rates that men and women leave the profession in all disciplines were generally equal. However, the focus in this case was recent graduates; the gap widened among more experienced engineers. The study went on to survey reasons why both men and women left engineering. The conclusion was that although both genders had a portion of respondents leaving the profession, the reasoning behind this departure varied between men and women. The SE3 report maintains that more women leave the structural engineering profession when looking at the lifespan of an entire career. It highlights certain "pinch points" at three, ten, and eighteen years where all demographics tend to leave the profession, but where women do so at a higher rate. This could explain how both reports have data that align, but draw different conclusions. Race and ethnicity did not appear to have a significant impact on the tendency to stay in the profession.



Figure 3: SE3 reports "pinch points" at 3, 10, and 18 years of experience

Conclusion: engineering education and the SE3 report

As previously mentioned, the incorporation of this content into existing curriculum has the potential to merit an entirely new class. While a new course could provide the thorough exploration of the many subtopics presented here, some programs may find value in giving an abbreviated overview of the topics over one or two sessions in order to reach a large portion of enrolled students within existing curriculum framework. Such an abbreviated model is presented here. This could be incorporated into a Leadership or Personal Development course within engineering management, or infused into the management or extracurricular content of an architectural or civil engineering program.

The chart below and subsequent descriptions explore brief exercises that could be done and assessed with students to explore these topics. Activities are presented as individual exercises so that facilitators could choose which would fit their circumstances and split activities into one or two meeting times.

Activity	Estimated Timeframe
In-class presentation of topics by instructor	30 minutes
Defining Success Survey	10 minutes
Management Scenarios and Presentations	10 minutes small group + 10 minutes discussion
Student Readings and Presentations	30-60 minutes depending on group size

In-Class Presentation of Topics by Instructor: The SE3 report is very straight-forward and provides many charts and visuals that could be converted into a presentation. This could give an overview of the topics to students. The presentation would discuss topics of job satisfaction and managerial leadership in the context of the SE3 report. Similar to this paper, topics could include work-life balance, pay and compensation, career development, and career development. A special focus on diversity should be included so that students understand that these are applicable topics to all engineers within the profession, but as they assume management roles certain groups might warrant a unique perspective.

Defining Success Survey: A quick exercise to get students' brains focused on career development might be questioning how they individually define "success." As discussed, different groups may see this differently. It could be up to the facilitator whether this survey would include gender, race, and ethnicity polls. The survey could be given on paper or use a digital means that shows instantaneous results such as a survey or quiz app. The purpose of the exercise is to get students to envision what a successful career would look like to them, and also highlight how that vision may vary among peers.

Management Scenarios and Presentations: This is an in-class exercise wherein students are broken into small groups and given short thought exercises to spark discussion. An example exercise could be as follows: "You are a division manager and firm leadership has asked you to come up with a way to facilitate mentorship within the company. What framework would you

suggest, and how would you pair or group mentorship relationships?" Another scenario could be "You are an engineering manager and a female engineer wants to discuss an upcoming promotion opportunity with you. She is an intelligent engineer and competent employee, but does not put in the same number of hours as her peers. What criteria do you give her to advise her on the path to promotion?" While there might not be a "right" answer to many of these questions, the discussion will highlight the issues that engineering managers in the field grapple with day to day.

Student Readings and Presentations: This exercise would ideally be in a second session of two workshops. Readings on subtopics could be assigned to students in the first session and students could give a small in-class presentation on the findings in the second session. Readings could include the SE3 report itself, or more managerial-driven research such as the reading list below.

- R. Singh, et al "Stemming the tide: Predicting women engineers' intentions to leave,"[2]
- J. Keen and A. Salvatorelli, "Discrepancies between Female Student Perception and Reality of the Engineering Industry"[10]
- E. N. Leong *et al.*, "Gender and Racial Diversity in the Structural Engineering Profession"[11]
- J. S. Russell, "Mentoring in Engineering" [8]

The SE3 report goes beyond the topics of diversity and inclusion to address key issues relating to job satisfaction for all structural engineers. Indeed, work done to understand why women and minorities leave the profession will help bolster a declining talent pool, but it may also help to understand job satisfaction across the board. Results could be expected to be similar among other engineering disciplines, but this has yet to be explored. This is one area of study that could be expanded. Other areas that merit focused is best practices for addressing work-life balance, managerial communication strategies, and tactics used to prompt an employee's emotional investment into a company. From an engineering management perspective, understanding what is being done well and reinforcing it while giving attention to where improvement can be made will better the skill set of future engineering leadership.

Bibliography

- [1] R. D. McClure, Sabrina; Ridd, Jennifer, Francis, Lauren; Chaudhry, Yasmin; Wachter, Maryanne, "2018 Survey Report," in "SE3," National Council of Engineers Association, 2018. [Online]. Available: https://6051d912-ed55-49bc-bc85-80def0220396.filesusr.com/ugd/9158d2_ff7b1858cd48406ebc35b62fb375cc9c.pdf
- [2] R. Singh, N. Fouad, M. Fitzpatrick, J. Liu, K. Cappaert, and C. Figuereido, "Stemming the tide: Predicting women engineers' intentions to leave," *Journal of Vocational Behavior*, vol. 83, pp. 281–294, 12/01 2013, doi: 10.1016/j.jvb.2013.05.007.
- [3] A. Sommer, "2016 Survey Report," in "SE3," Structural Engineers Association of Northern California, San Francisco, CA, 2016. [Online]. Available: https://6051d912-ed55-49bc-bc85-80def0220396.filesusr.com/ugd/9158d2_0bfbb0cc6f8741c693125b4e22948b39.pdf

- [4] A. S. Pitts, Rosa; Evenhouse, Eirik; Hu, Ruohnan, "2014 Equity in Architecture Survey Report and Key Outcomes," in "EQxD," AIA San Francisco, San Francisco, CA, 2015. [Online]. Available: https://issuu.com/rsheng2/docs/equityinarch2014_finalreport
- [5] S. Furterer, L., "Developing a Leadership and Diversity Course for an Engineering Management Program," Salt Lake City, Utah, 2018/06/23. [Online]. Available: <https://peer.asee.org/30290>.
- [6] S. Sarker, X. Xiao, S. Sarker, and M. Ahuja, "Managing Employees' Use of Mobile Technologies to Minimize Work-Life Balance Impacts," *MIS Quarterly Executive*, Article vol. 11, no. 4, pp. 143-157, 2012. [Online]. Available: <https://search.ebscohost.com/login.aspx?direct=true&db=buh&AN=83863565&site=ehost-live>.
- [7] H. Lingard, K. Brown, L. Bradley, C. Bailey, and K. Townsend, "Improving Employees' Work-Life Balance in the Construction Industry: Project Alliance Case Study," *Journal of Construction Engineering and Management*, vol. 133, no. 10, pp. 807-815, 2007/10/01 2007, doi: 10.1061/(ASCE)0733-9364(2007)133:10(807).
- [8] J. S. Russell, "Mentoring in Engineering," *Leadership and Management in Engineering*, vol. 6, no. 1, pp. 34-37, 2006, doi: 10.1061/(asce)1532-6748(2006)6:1(34).
- [9] L. Frehill, "Satisfaction," *Mechanical Engineering*, vol. 132, no. 01, pp. 38-41, 2010, doi: 10.1115/1.2010-jan-4.
- [10] J. Keen and A. Salvatorelli, "Discrepancies between Female Student Perception and Reality of the Engineering Industry," *Journal of Architectural Engineering*, vol. 22, no. 3, p. 04016011, 2016, doi: 10.1061/(asce)ae.1943-5568.0000221.
- [11] E. N. Leong *et al.*, "Gender and Racial Diversity in the Structural Engineering Profession," *Structures Congress 2013*, pp. 885-896, doi: doi:10.1061/9780784412848.078.