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# Women as Sustainability Leaders in Engineering: Evidence from Industry and Academia

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# WOMEN AS SUSTAINABILITY LEADERS IN ENGINEERING: EVIDENCE FROM INDUSTRY AND ACADEMIA

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## ABSTRACT

Women are underrepresented in engineering education and practice, which limits the quality of the engineering workforce. One way to increase the participation of women in engineering is to emphasize subjects that appeal to them and emphasize skills at which they are especially adept. A subject that may fit this description is sustainability. The purpose of this research is to compare the percentage of women in selected sustainable engineering leadership positions to the percentage of women in general engineering leadership positions, to examine whether the subject of sustainability may help increase participation of women in engineering. Gender data was collected for the "sustainability leader" at 79 of the largest design and construction companies in the U.S. Similar data was also compiled for engineering faculty attending workshops to share best practices for teaching sustainability. The percentage of women in the sustainability leader industry positions is much higher (39%), than the percentage of women in general management positions (8%). The percentage of woman attending the workshops is much higher (32%) than the percentage of woman engineering faculty (12%). Analysis of these results shows a statistically significant positive correlation between the subject of sustainability and increased percentages of women in engineering leadership positions. Increased consideration of sustainability in engineering education and practice could also help address the critical need to attract more women to the field. Recommendations to expand this research are outlined at a career, college, and pre-college level.

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CHAPTER ONE

# INTRODUCTION

Despite achieving equal representation in other professions, women remain seriously underrepresented in engineering, which inhibits the development of the profession (NAE 2001). One way to increase the participation of women in engineering is to emphasize subjects that align with women's interests and skills. The literature, addressed in chapter two, provides compelling anecdotal evidence that sustainability; meeting humans' social, environmental, and economic needs without compromising the ability of future generations to do the same; and other related subjects may be especially appealing to women (Zimmerman and Vanegas 2007; Bielefeldt 2006). Additionally, research has found a strong influence of role models in encouraging women to participate in engineering. The introduction of role models creates a positive feedback loop.

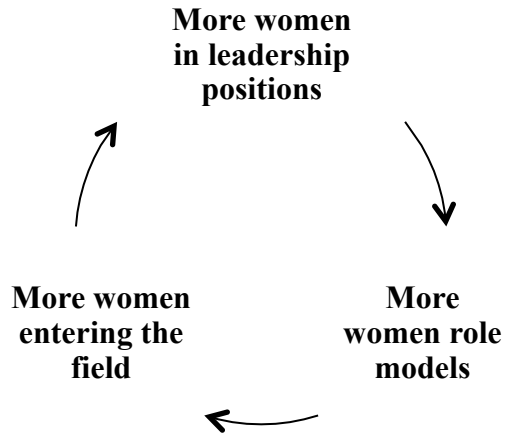


**Figure 1.1: The "women as sustainability leaders" positive feedback loop**

Still, additional studies are needed to confirm any relationship between the subject of sustainability and increased participation of women in engineering. To help address

this need, **the objective of this research is to compare the percentage of women in selected sustainable engineering leadership positions to the percentage of women in general engineering leadership positions.**

Pursuit of this research involved data collection from selected groups in industry and academia. The top 100 design firms and top 100 contracting companies in the U.S. were surveyed to identify the individual leading sustainability efforts at that organization. The methodology to collect this data is found in chapter three. In addition, data was collected on engineering faculty attending workshops to share best practices for teaching sustainable engineering. In both cases, the percentage of women in these sustainability leadership positions is significantly higher than the percentage of women in comparable leadership positions. These findings, found in chapter four, support the theory that increased consideration of sustainability in engineering education and practice could also help address the critical need to attract more women to the field.

To further this finding, a survey was administered to the women identified as sustainability leaders in both academia and industry, which is discussed in chapter five. The surveys helped to refute potential alternative explanations to the correlation and helped to generate ideas for future research. The next steps to strengthen the relationship are outlined in chapter six. Future research is focused at looking at the results of integrating sustainability and engineering concepts to women before they enter college, during college, and into their career.

# CHAPTER TWO

# BACKGROUND

From a young age, women face barriers to pursuing engineering. For example, primary school experiences lead young girls to view the physical sciences as more masculine and the life sciences as more feminine (Clewell 2002). The problem persists into middle school, where it is common for girls to lose interest in both science and math classes (Miller 2003). In high school, girls take fewer Advanced Placement Mathematics and Science courses than boys. Though this gap in course enrollment is shrinking, a prevailing misconception is that boys significantly outperform girls in these courses (Freeman 2004). Prior to college, young women receive minimal encouragement to pursue engineering and often lack role models in the field (Seymour 1999).

The consequence of these and other barriers is disproportionately low enrollment of women in engineering degree programs. In 2008, just 18% of engineering bachelor's degrees were awarded to women (Gibbons 2009). Further, despite efforts to attract more women to engineering, the most recent data shows a 3% *decrease* in the percentage of women receiving engineering degrees over the last 10 years (Gibbons 2009). Consequently, while other professions, including medicine and law, have achieved equal representation of women, engineering remains a predominantly male field (Campbell et al. 2002). Attracting more women to engineering would help the field improve capabilities in crucial skill sets at which women are generally more adept than men. For instance, women generally excel in group affiliation skills like integration and collaboration (N. Chesler and M. Chesler 2002; Gilligan 1993).

*Strategies to increase the percentage of women in engineering*

Various strategies have been applied in attempts to increase the percentage of women in engineering. Effective pre-college strategies include engineering mentoring, internships, workshops, and career field trips (Campbell et al. 2002). Activities like these provide young women with role models, promoting an "if they can do it, then so can I" attitude. Another strategy to increase the percentage of women in engineering is to emphasize subjects in engineering that align with these students' values (Middleton and Perdomo 2008).

*Sustainability as a subject that can help attract women to engineering*

Sustainability seeks to optimize environmental, economic, and social considerations for current and future generations (Brundtland 1987). Sustainable engineering requires problem-solving abilities to balance these considerations: For example, reducing energy consumption and emissions (environmental) while reducing cost (economic) and creating jobs (social). Various organizations call for engineering educators to help their students become proficient in sustainable engineering (NSF 2008; Educating the Engineer of 2020 2005; Vanegas 2004).

Sustainability may also be a subject that can help attract more women to the field of engineering. Generally, women are catalysts for sustainable development (Charkiewicz et al. 1994). Sheila Widnall, the first woman Secretary of the Air Force and now an engineering professor, notes that, "Women are committed to the important values of our times, such as protecting the environment, product safety, and education … They

are going to be a huge force in the solution of human problems." The lack of a perceived connection between engineering and these societal problems is a top barrier to women entering the field (Widnall 2000). The subject of sustainability addresses this barrier, explicitly connecting engineers' contributions to problems such as energy and water resource depletion, climate change, and social inequity.

Some evidence supports a correlation between the subject of sustainability and increased percentages of women in engineering. At the University of Colorado at Boulder, the leadership board of the Engineers Without Borders Program, which emphasizes the social aspect of sustainability, averaged over 50% women for a 5-year period. This was much higher than the percentage of women on the leadership boards for other engineering groups at the university like the American Society of Civil Engineers and American Society of Mechanical Engineers (Bielefeldt 2006). Similar increases in participation of underrepresented populations, including women, have been identified in the "Sustainable Technology and Development" and the "Green Design Institute" engineering groups at Georgia Tech and Carnegie Mellon, respectively (Zimmerman and Vanegas 2007).

*How this research expands the current body of knowledge*

The current body of knowledge, in particular the preliminary findings from Colorado, Georgia Tech, and Carnegie Mellon, help to frame this research. To add to the current body of knowledge, this study is designed to examine a broad sample of academia and industry, focused specifically on women in sustainable engineering *leadership*

positions. Women in leadership positions serve as role models to help attract other women to engineering positions (McIlwee and Robinson 1992; Shalala 2007). While role models are important to engineers in general, women are much more likely than men to choose engineering through the influence of a role model (Seymour 1999).

# CHAPTER THREE

# RESEARCH APPROACH

The objective of this research is to compare the percentage of women in industry and academic sustainable engineering leadership positions to the percentage of women in comparable general engineering positions. The industry leadership population studied was "sustainability leaders" at top design and construction companies. This individual, whose title varied depending on the company, was defined as the one with the most authority in matters related to sustainability. The academic leadership population studied was engineering faculty members attending workshops to share best practices for teaching sustainability.

*Survey of industry leaders*

The top 100 design firms and top 100 contracting companies in the U.S., measured by revenue (Engineering News Record 2009), were surveyed to identify the individual leading sustainability efforts at that company.

1. First, organizations' websites were reviewed. Thirteen of the top 100 design firms and 6 of the construction companies listed on their website the name of their sustainability leader. Depending on the company, this individual had various titles such as "Leader of Sustainable Solutions", "Sustainability Program Manager", "Firm wide Sustainable Design Leader", and "Sustainable Design Coordinator."
2. The remaining companies were contacted via their general contact e-mail. Thirty-one design firms and 27 construction companies responded. Most respondents

provided the name of a sustainability leader, but several responded that there was no such individual at their company. Two weeks after the initial e-mail, a reminder e-mail was sent to unresponsive organizations. This generated responses from another 12 design firms and 6 construction companies.

3. Remaining non-respondents were contacted by phone using either the general information or main headquarters phone number. These calls generated responses from 13 design firms, 3 of which named a sustainability leader and 10 of which stated that there was no such position at the company. Of the 15 construction companies contacted via phone, three named a sustainability leader.

The overall response rate was 68 out of 100 design firms and 55 out of 100 construction companies. In each group, 22 respondents indicated that they did not have a sustainability leader position. In total, 79 sustainability leaders were identified; 46 from design firms and 33 from construction companies.

*Survey of academic leaders*

To complement the survey of industry leaders, data was collected based on attendance at national Center for Sustainable Engineering (CSE) workshops. Established in 2005 through a collaboration between Carnegie Mellon, the University of Texas at Austin, and Arizona State University, the CSE is funded by the National Science Foundation and the Environmental Protection Agency to share best practices for teaching sustainable engineering (CSE 2009). To support their emphasis on improving sustainable engineering education in colleges and universities, CSE holds these two-day workshops

for U.S. engineering faculty who teach or plan to teach sustainable engineering. Attendance data was collected from all three workshops (2006, 2007, and 2009) held by the CSE to date.

*Statistical analysis*

A pooled, two-proportion z-test is appropriate for comparing the percentage of women in the sustainable engineering leadership positions to the percentage of women in general engineering leadership positions. This procedure determines if percentages from two groups significantly differ from each other (Anderson 2009).

Specific applications of this pooled, two-proportion z-test, to this research are shown in Table 4.1 and Table 4.2. The general process for this test is as follows:

- Determine the pooled sample proportion: p = (p1 * n1 + p2 * n2)/(n1 + n2)
    - p1 is the sample proportion from population 1, p2 is the sample proportion from population 2, n1 is the size of sample 1, and n2 is the size of sample 2.
- Determine the standard error of the sampling distribution difference between the two proportions: SE = sqrt{p * (1 - p) * [(1/n1) + (1/n2)]}
- Determine the test statistic z-score: z = (p1 - p2)/SE
- Determine the p-value associated with the test statistic using a normal distribution calculator.

This p-value represents the probability of observing a sample statistic as extreme as the test statistic. Therefore, the lower the p value, the higher the probability of a significant difference between the percentages from the two groups being compared.

# CHAPTER FOUR

# RESULTS AND ANALYSIS

For the industry and academic populations studied, the percentage of women in sustainability leadership positions was much higher than the percentage in similar general leadership positions.

## *Results of industry leaders survey*

Thirty-eight percent of the industry sustainability leaders identified were women; including 16 of 46 (35%) in the design firms, and 14 of 33 (42%) in the construction companies. Full results from the design firms are listed in Appendix A and in Appendix B for the contracting companies. As shown in Figure 4.1, the 38% rate represents a much higher percentage of women than in any other position in the design and construction industry. 2007 statistics from the U.S. Department of Labor show that, of the over 11.5 million people employed by the construction industry, only 9% are women. At 8%, the percentage of women in leadership "construction manager" positions is even lower. In architectural and engineering professions, the overall percentage of women is only slightly higher (14%) and women make up just 12% of those employed as civil engineers. As with the construction managers, the percentage of women in leadership "engineering manager" positions is just 8% (US Department of Labor 2008).

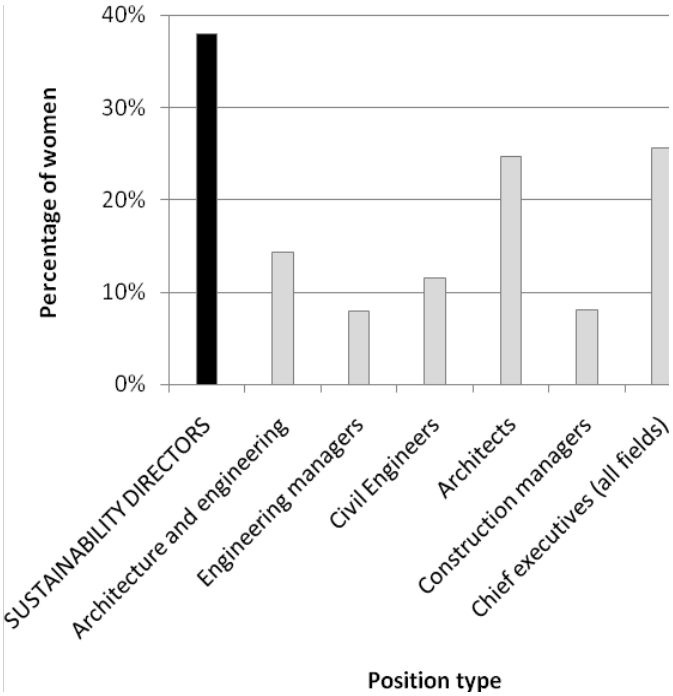


**Figure 4.1: Percentage of women in selected industry positions**

The percentage of women who occupy the sustainability leadership positions is far higher than any other position type in the design and construction industry. In Table 4.1, the summary of the statistical analysis conducted to determine if the results are significant is shown. The analysis compares the proportion of women sustainability leaders to the proportion of women in various design and construction industry positions. A pooled, two-proportion z-test was used to determine the statistical significance. Using this test, the p-values calculated from each proportion comparison was less than 0.01, making the comparison statistically significant at a 99% confidence level. The 99% confidence level shows a statistically significant difference that the proportion of women in sustainability leadership positions is higher than the proportion of women in other design and construction industry positions.

One might question whether the high percentage of women sustainability leaders is a result of these positions being filled from outside the design and construction industry. However, the percentage of women sustainability leaders is still significantly higher (at a 95% confidence interval) than the percentage of women in chief executive positions in all industries, not limited to design and construction.

**Table 4.1: Summary of Industry Statistical Analysis**

| | Sample size (n) | Proportion women | p | SE | Z | p-value | Significance |
|---|---|---|---|---|---|---|---|
| ***Sustainability leaders*** | *79* | *.380* | | | | | |
| ***Other industry positions*** | | | | | | | |
| Architecture and engineering | 2932000 | 0.144 | 0.14 | 0.04 | 5.97 | < .0001 | Yes (at 99%) |
| Engineering managers | 114000 | 0.080 | 0.08 | 0.03 | 9.81 | < .0001 | Yes (at 99%) |
| Civil Engineers | 382000 | 0.115 | 0.12 | 0.04 | 7.37 | < .0001 | Yes (at 99%) |
| Architects | 240000 | 0.247 | 0.25 | 0.05 | 2.74 | 0.006 | Yes (at 99%) |
| Construction managers | 1176000 | 0.081 | 0.08 | 0.03 | 9.73 | < .0001 | Yes (at 99%) |
| ***Leadership Position*** | | | | | | | |
| Chief executives (all fields) | 1649000 | 0.256 | 0.26 | 0.05 | 2.52 | 0.012 | Yes (at 95%) |

| |
|---|
| p = pooled sample proportion= $(p_1 * n_1 + p_2 * n_2) / (n_1 + n_2)$ |
| SE = standard error = $\text{sqrt}\{ p * ( 1 - p ) * [ (1/n_1) + (1/n_2) ] \}$ |
| z = test statistic = $(p_1 - p_2) / SE$ |
| P value = using z table: (1-table value)*2 |
| Significance = (1-P value )*100 |

Further analysis of the industry data shows that the percentage of women sustainability leaders was highest among the top-fifteen design firms and construction companies. Women held the sustainability leader position for eleven of the fifteen (73%) respondents from these thirty organizations. One possible explanation for this finding is that these larger organizations are able to hire specifically for the sustainability leader position, while smaller organizations are more apt to shift an employee from another

position to fill the sustainability leader role. With a new hire or dedicated position, an organization has greater opportunity to align the skills and interests of the employee with the position, which may help explain the higher percentages in these larger organizations.

*Results of academic leaders survey*

Similar to the findings from industry, the percentage of women attending the CSE workshops was much higher than the percentage of women engineering faculty in general. Thirty-two percent of the over 180 participants in CSE workshops to date have been women, with increasing percentages each year. In comparison, the most recent data shows that just 12% of all engineering faculty are women (Gibbons 2009). Even the percentage of women faculty in the discipline with the highest percentage of women, environmental engineering (22%), is significantly below the percentage of women attending CSE workshops (See Figure 4.2).

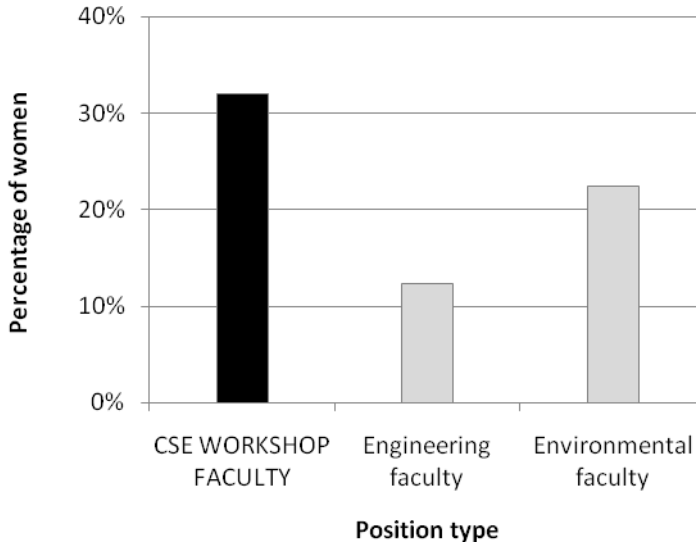


**Figure 4.2: Percentage of women in selected engineering faculty roles**

A two-proportion z-test was also used to test the statistical significance of the proportion of women in sustainability leadership positions in education versus the proportion of women in academia positions. A p-value less than 0.01 reveals that the proportion of women in sustainability leadership positions in education is greater than proportion of women in engineering faculty positions (at a 99% confidence level) (Table 4.2). Environmental faculty had a higher proportion of women than all engineering faculty and is still statistically significant at a 95% confidence level with a p-value less than 0.05.

**Table 4.2: Summary of Academic Statistical Analysis**

| | Sample size | Proportion women | Ps | SE | Z | P value | Significance |
|---|---|---|---|---|---|---|---|
| ***CSE workshop faculty*** | *180* | *0.320* | | | | | |
| Engineering faculty | 24207 | 0.123 | 0.12 | 0.02 | 7.98 | < .0001 | Yes (at 99%) |
| Environmental faculty | 196 | 0.223 | 0.27 | 0.05 | 2.09 | 0.04 | Yes (at 95%) |

| |
|---|
| Ps = pooled sample proportion= $p = (p_1 * n_1 + p_2 * n_2) / (n_1 + n_2)$ |
| SE = standard error = $sqrt\{ p * ( 1 - p ) * [ (1/n_1) + (1/n_2) ] \}$ |
| z = test statistic = $(p_1 - p_2) / SE$ |
| p-value = using z table: (1-table value)*2 |
| Significance = (1-P value )*100 |

# CHAPTER FIVE

# QUALITATIVE SURVEY TO GUIDE FUTURE RESEARCH

Both data sets analyzed in this research show a positive, statistically significant, relationship between the subject of sustainability and the percentage of women in engineering leadership positions. Still, the question remains: "Is sustainability a *causal* factor for the higher percentage of women in sustainable engineering leadership positions?" To help guide future research into this question, a qualitative follow-up survey was conducted among the women identified in the initial data sets.

## *Online Survey*

By gathering the names of a number of women in sustainability leadership roles from both industry and academia, the opportunity presented itself to further investigate causality between the percentage of women and the subject of sustainability. In total, 25 women holding sustainability director positions in industry were e-mailed a request (Appendix C) to fill out a short survey (questions listed in Figure 5.1). A mix between open-ended questions and multiple choice questions was used. A total of 14 of the 25 women completed the survey.

1. Please list the year and major for your degrees.
2. Please briefly describe your career path from earning your bachelor's degree to your current sustainability leadership position.
3. Which best characterizes your interest in sustainability?
   A. I joined the workforce with sustainability as an interest.
   B. My interest in sustainability developed primarily after I joined the workforce, prior to taking my current position.
   C. My interest in sustainability is a result of my being placed in my current position.
4. Please briefly describe your duties in your current sustainability leadership position.
5. Which best describes how your current position was filled?
   A. I was hired specifically for this sustainability leadership position.
   B. I was shifted from another position within our company to this sustainability leadership position.
   C. Sustainability leadership duties were added to my existing responsibilities with the company.
6. What is the percentage of women in leadership positions at your company (Please give your best estimate if you are not sure exactly)?
7. Do you think the topic of sustainability could be an explanatory factor for the higher percentage of women sustainability director positions?
   A. No
   B. Yes, it is one of many
   C. Yes, it is the primary factor
8. What other factors, other than interest or skill in sustainability, may be contributing to the higher percentage of women in these sustainability director positions?

**Figure 5.1: Women As Sustainability Leaders Survey**

The contact information for the women who attended the CSE workshops was available on-line through university websites. A total of 36 women that participated in the CSE workshops were asked to participate in the survey (Appendix D). A total of 13 of 36 women completed the Women as Sustainability Leaders in Education survey found in Figure 5.2.

1. Please list the year and major for your degrees.
2. In which department do you teach your sustainability related classes?
3. Please briefly describe an approximate chronological list of classes taught.
4. Which best describes why you are teaching sustainability related topics?
   A. I was hired specifically to teach sustainability education by my department.
   B. I initiated the idea to teach sustainability within my department.
   C. I primarily teach another topic and was asked by my department to teach sustainability.
5. What is the percentage of women teaching in your department? (Please give your best estimate if you are not sure exactly)
6. Do you think the topic of sustainability is an explanatory factor for the higher percentage of women teaching sustainability related topics?
   A. No
   B. Yes, it is one of many
   C. Yes, it is the primary factor
7. What other factors may be contributing to the higher percentage of women teaching sustainability

**Figure 5.2: Women As Sustainability Leaders in Education Survey**

The data collected from the surveys was an important step into determining whether the connection between sustainability and women in engineering should be further investigated. Questions in the survey were designed to gather hard data (year and major of degrees, career paths, classes taught), while other questions were used to gather important opinions and information held by the women related to factors that might be contributing to the higher percentage of women in sustainability director positions or teaching sustainability. To strengthen the connection, possible confounding factors must first by discussed.

*Potential alternative explanations for the correlation*

Alternative explanations would discredit a causal link between the subject of sustainability and the percentage of women in leadership positions. Some of these alternative explanations are provided here along with discussions, supported by responses to the qualitative survey, indicating that each of the alternative explanations may not be an explanatory variable. Still, additional research into these alternative explanations is needed to increase understanding of the connection between the subject of sustainability and women in engineering leadership positions.

One alternative explanation for the correlation between sustainability and women in engineering leadership positions is that organizations employing a sustainability leader are typically forward-thinking, and are therefore more likely to have a higher percentage of women in leadership positions. However, the results from the qualitative survey do not support this explanation. Respondents estimated the percentage of women in leadership positions in their companies (15%) and departments (21%) as close to the industry average and significantly below the percentage of sustainability leaders.

A second alternative explanation for the correlation is that women represent a higher percentage of younger engineers and are therefore more likely to possess formal education in relatively new subjects like sustainability. However, the available data also fails to support this explanation. First, the percentage of women among newly graduated engineers is still well below the percentages in sustainability leadership positions (Gibbons 2009). Second, more than half of the qualitative survey respondents received their latest degree prior to 2000. Finally, the qualitative survey respondents who attended

the CSE workshops received their doctorate degree an average of 13 years ago, with the most recent Ph.D. received in 2002.

A third alternative explanation for the correlation is that sustainability leadership positions do not require a "technical" background, so more women are eligible for these positions. However, qualitative survey results showed that all but 3 of the women hold degrees in science, technology, engineering or math, with the remaining 3 respondents holding degrees in architecture. Many of the women had a combination of degrees to broaden their abilities, such as a B.S. in Civil Engineering and an M.B.A. Survey respondents in industry positions most recent degrees earned included engineering (5), architecture (3), environmental studies (3), construction management (2), and administration (2).

Finally, it could be said that there was a higher percentage of women faculty at the CSE workshops because women may be more likely to go to workshops to improve their teaching skills. The distribution of participants was 46% of the attendees were tenured faculty while the other 54% were untenured faculty (Davidson 2010). The goal of the workshops was to improve sustainable engineering classes already developed. In this sense, the mix between tenured and untenured faculty may just mean that many teachers were attracted to the workshops to bounce ideas off individuals that have been teaching for a while or try to gather fresh ideas from the younger faculty.

*Expert opinions on causality*

To help guide future research, the sustainability leader respondents to the qualitative survey were asked explicitly if they thought the subject of sustainability was an explanatory factor for the higher percentage of women in leadership positions. Four respondents thought that sustainability was *the* key factor; 19 thought that the subject of sustainability was one of many factors; and 3 thought the subject of sustainability was not a factor.

Respondents were prompted to expand upon these answers with one or more explanations. The full-length answers were classified using nominal categorization, where the respondents freely responded and similar responses were grouped together. As shown in Table 5.1, these expanded answers fell roughly into 3 general categories. While limited in scope, these responses are included here to help guide future research questions.

**Table 5.1: Expanded responses to factors contributing to the higher percentage of women**

| | Number of Instances | | |
|---|---|---|---|
| **Category** | **Industry** | **Academia** | **Total** |
| Sustainability requires strengths inherent in women | 6 | 7 | 13 |
| Sustainability happens to align with characteristics of women | 6 | 5 | 11 |
| Sustainability provides an opportunity to painlessly satisfy diversity goals | 3 | - | 3 |

Thirteen of the 27 responses suggest that **sustainability requires strengths inherent in women.** These responses support the notion of sustainability as a subject that appeals to the interests and talents of women. For example, women are more likely to

practice interactive leadership (Rosener 1990), which is especially useful in new and evolving fields like sustainability. Selected responses from this category include:

- "Women tend to be caretakers, and sustainability is the largest application of this sensibility that there is" (3 similar instances).
- "Holistic and strategic thinking and risk management skills (are) attributes of women" (2 similar instances).
- "Sustainability shows how the field of engineering can have a positive impact on the lives of many people" (2 similar instances).
- "Many women want a career where they are working for more than just a paycheck. Sustainability often feels more like a calling 'than just a job'" (2 similar instances).
- "The young field of sustainability requires a balance between technical know-how and relationship building as well, and I think that striking such a balance is often a female strength."
- "At the heart of sustainability is nurturing the earth, which may be more inherent in women."
- "The multidisciplinary nature of this subject suits many women affinity for systems-thinking."

Eleven of the 27 expanded responses suggest that **sustainability happens to align with characteristics of women.** These responses support a relationship between

the subject of sustainability and greater percentages of women in leadership positions. However, these responses imply that the relationship is for reasons other than interest and talent in the subject of sustainability. For example:

- "A higher percentage of women are already in environmental sciences and engineering; sustainability is a natural extension of that" (2 similar instances).
- "Women are less likely to accept the corporate status quo as it has not worked for them. There is no risk in going out on a limb for a subject that you are passionate about."
- There is an "alignment of sustainability with other positions traditionally held by women (Human Resources, Community Service and Marketing)."
- Sustainability is a "new, growing field – women are excited about new opportunities"
- "It is also easier … to find female mentors/leaders in environmental engineering and sustainability than I encountered in civil engineering and in the military."
- "Women are not as 'scared' as men to look like 'tree huggers' or 'bleeding hearts' ... our ego is not vulnerable within the industry/peer-group to such silly fears."
- "It is my impression that women appreciate a career field where they feel they are positively contributing to the health of their community and planet."

- "This is a growth area that was at least initially not seen as competitive or desirable. In a field with relatively limited leadership opportunities for women, perhaps women foresaw a growth opportunity in this particular niche. Had the role been seen as being as critical to success as it now is, I suspect the competition for the role would have been more intense across the board and we would have seen a similar percentage of women in these roles as elsewhere in the profession. As it was, you had to be willing to take a big risk to associate yourself entirely with a subject that as recently as 10 years ago was seen as on the fringe."
- "Perhaps the research fields related to sustainability attract proportionally more women than other fields, and therefore more women teach in these areas"
- "More women are entering academia. If newer generation includes more women, a new subject like sustainability would be reflected in this population."

Finally, 3 of the 27 expanded responses suggest that **sustainability provides an opportunity for companies to painlessly satisfy diversity goals.** The thought behind this philosophy is that sustainability leadership positions are less important than others and therefore an easy place to get credit for having women in leadership positions.

- Sustainability "probably is considered by company leaders as the softer (side) of the industry" (2 similar instances).

- “Most companies are interested in promoting women for diversification. This is an area in which younger women can be promoted without conflict with others who have been with the company much longer.”

# CHAPTER SIX

## FUTURE RESEARCH

Both the quantitative data and the qualitative follow up surveys highlight a potential opportunity for increasing the amount of women in the engineering profession. To test this relationship, sustainability must be taught and practiced in engineering to measure whether the correlation proves true. The key times where to incorporate sustainability need to be identified. This could start during a career as an adult, once a woman is working and can make the decision to practice sustainability in her profession. This could happen in higher education, where influential classes and teachers can help to make the connection. Girls in primary school through high school are exposed to programs that are intended to increase participation in engineering. What if these girls were exposed to sustainability in engineering? Therefore, future research needs to be addressed from three different perspectives, at the career, college, and pre-college levels.

The topics increase in importance, with pre-college analysis being the most important tool to measure the correlation. It is critical to introduce sustainability in engineering before college because children have a wide variety of interests they accumulate as they progress through primary and secondary school, but eventually decide on a specific interest to pursue in college. With the introduction to sustainability early on, there is the opportunity to track whether students follow this interest through college into their career.

*Career Path Tracking*

An important element to determining if sustainability could influence women to choose engineering is to look at career paths. The 17 responses to the industry survey offered a wide variety of ways that brought the women to their current position. A few examples were:

- "3 years of doing Architectural Electrical Design work; developed the idea of starting a Sustainable Design group; for 2 years split my time with both responsibilities; full time Sustainability since then."
- "I began working briefly for a small architecture firm specializing in new urbanism. I then started working for a general contractor and have been here for 5 years. I started in their estimating department and soon moved into the field. I had always been interested in sustainability and made it a focus at my current job. After completing a large construction project in 2008, I moved full time into the company's sustainability director."
- "Was an asst. project manager then project manager for a commercial general contractor. When LEED was introduced to the public in 2000, I was the individual with the most knowledge. 10 years later I am a director for a general contractor and have built the position to what it is today."

A clearer mapping of different ways women could achieve this leadership position is needed. There is a clear and defined path for how one becomes a doctor and although it takes many years of schooling, people still do it because they have a timeline

as to when they will reach their career objective. Obviously, to become a sustainability leader there will be more than one career path because a wide variety of engineering or architectural related degrees could provide an individual with the skills needed to achieve their career goal. By broadening the career tracking through more surveys, similar paths may reveal themselves. These more defined career paths will be exceedingly helpful to younger women looking to follow the same path.

*Higher Education Opportunities*

In regards to higher education, important information to collect is the amount of women graduating with degrees related to sustainable engineering. This will be difficult as individuals can graduate with a degree in mechanical engineering, for instance, and be educated in energy efficiency, which is related to sustainability. There is, however, a limited amount of degree programs in sustainable engineering where actual graduation ratios could be measured. There are universities in the United States conferring the particular type degree that would be targeted for this research in both undergraduate and graduate degree programs. Table 6.1 lists some of the current undergraduate programs that could be targeted for research.

**Table 6.1: U.S. Sustainable Engineering Undergraduate Programs**

| University | Sustainable Engineering Degree |
|---|---|
| Drexel University | Appropriate Technology (BS) |
| Indiana Institute of Technology | Energy Engineering (BS) |
| James Madison University | Sustainable Engineering (BS) |
| Rochester Institute of Technology | Environmental Sustainability (BS) |
| Stevens Institute of Technology | Green Engineering Minor |
| Virginia Polytechnic Institute | Green Engineering Minor |

(AASHE 2010)

Targeted research could also be conducted at graduate programs at universities across the United States (Table 6.2).

**Table 6.2: U.S. Sustainable Engineering Graduate Programs**

| University | Sustainable Engineering Degree |
|---|---|
| Appalachian State University | Renewable Energy Engineering (MST) and Building Energy Engineering (MTS) |
| Arizona State University | Civil, Environmental, and Sustainable Engineering (PhD and MS) |
| City College of New York | Sustainability in the Urban Environment (MS) |
| Rochester Institute of Technology | Sustainable Engineering (MS) |
| University of Pittsburgh | Construction Management and Sustainability (MS) and Sustainability and Green Design (MS) |
| Villanova | Sustainable Engineering (MS) |

(AASHE 2010)

There other options besides the sampling of degree programs listed. Internationally, there are degree programs that focus on sustainable engineering. In the

United States, there are additional sustainable engineering concentrations and different types of degree certificates that could also be measured to increase data.

The National Science Foundation funds the Research Experiences for Undergraduates (REU) program held at universities across the country. A summer REU gives undergraduate students the opportunity early in their college career to participate in research. These REU programs provide an excellent opportunity to introduce sustainability as it could be integrated into the wide variety of projects that the REU students participate in.

From 2001 to 2006, Rowan University in New Jersey held a REU program every summer with an emphasis on Pollution Prevention and Sustainability. In the years this REU was held, at least half of the participants were women (Rowan University 2006). The majority of the participants in this program were engineering majors with the remaining science or mathematics majors.

Similar type REUs could be very influential in introducing sustainability to an undergraduate engineering student and at the same time providing data to the university holding the program. The university receiving funding for the program is required to keep track of participants by the NSF to see if the REU was influential in participants going to graduate school or pursuing careers in research. The opportunity would be present to survey whether sustainability was one reason to pursue engineering through college. Clemson University already has received NSF funding for a number of years to hold REUs in different departments including mathematics, genetics and biochemistry, bioengineering, and chemical engineering. In the future, other departments at Clemson

could potentially take the opportunity to apply for funding to hold a multi-disciplinary sustainability REU.

*Introducing Sustainability Pre-College*

There is a widely recognized need to recruit more women in engineering. In the attempt to rectify this, universities across the country have developed outreach programs that try to encourage young women to consider going to college to study science, technology, engineering, or mathematics. Still, as previously discussed, the percentage of women studying engineering has not increased, but surprisingly, has slowly decreased in the past ten years (Gibbons 2009). Based on the research already conducted, it appears that the integration of sustainability concepts into these programs could have a positive impact.

A comprehensive survey of programs aimed to increase the number of women in science and engineering by the National Science Foundation has already compiled important insights about how to create future programs. The Operation Smart program, which has served thousands of fourth and fifth grade girls across their country, found that through monitoring the participants, "girls of all ages like their math and science to be useful and relevant to their everyday lives." Sustainability is as relevant of a topic as ever.

The current generation going through elementary, middle, and high school is well aware of the environmental impacts humans are imparting on the world: Recycling, for instance, is not a new concept. The challenge in creating effective programs is teaching

sustainability concepts from the engineering perspective. An example of teaching from the engineering perspective is “design for disassembly”, where students could take apart old computers or electronics. The resulting learning experience would be brainstorming ideas how to not only design the item to be taken apart easier, but what parts could be reused now that it is easier to take apart. This type of program would be targeted as primarily an all girl experience to allow girls to work in small group settings where they can discover topics on their own without the possibility of a male taking over. These types of experiences build self-confidence, which in turn builds leadership skills.

Besides outreach programs, sustainability can be integrated at the high school level in physical science classes. These classes could provide meaningful and immediate impacts in helping women choose a major. Also, the effect of a women role model teaching the physical science classes could be an excellent motivator. At the high school level, the direct impacts of role models and of sustainability in engineering can be realized and connected - potentially prompting a choice to study engineering. If the connection is made that engineering is an important part of creating a better world that will become an integral part in making a career choice.

# CHAPTER SEVEN

# CONCLUSIONS

Several limitations warrant consideration when interpreting the conclusions based on this research. First, the data sets for this research are not a perfect cross-section of all engineers in sustainability leadership positions. The industry data is from the design and construction industry where some leaders have non-engineering backgrounds. The academic data represents a broad spectrum of engineering disciplines, but excludes any faculty members teaching sustainable engineering who have not attended CSE workshops. Despite these limitations, this research does provide empirical evidence that the participation of women in selected sustainable engineering leadership positions is significantly higher than their participation in similar leadership positions. This finding supports the connection between the subject of sustainability and greater participation of women in engineering.

This research suggests that women are more likely to pursue engineering and related fields when the subject of sustainability is emphasized. Therefore, *incorporation of sustainability in engineering, a key need by itself* (NSF 2008; NAE 2001)*, is likely to have ancillary benefits by addressing the need to attract more women to the field.*

For leadership populations, like the ones studied here, these implications are especially pronounced. Women in leadership positions serve as role models to attract other women to the field (Shalala 2007; McIlwee and Robinson 1992). Accordingly, the increased percentage of women in sustainability leadership positions should help attract more women to the field, which will lead to a greater percentage of women in leadership

positions, and so on. Figure 7.1 shows this "positive feedback loop", where an increase in one area causes an increase in another area, which in turn causes an increase in the first area (Meadows 2008). A survey respondent explained her firsthand experience with this feedback loop, noting that: "it is also easier (I've found) to find female mentors/leaders in … sustainability than … in civil engineering and in the military."

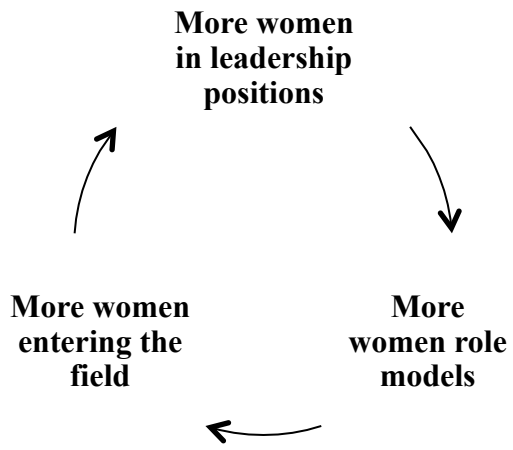


**Figure 7.1: The "women as sustainability leaders" positive feedback loop**

Combined with the existing body of knowledge, the findings from this study produce recommendations for applying the subject of sustainability to increase the percentage of women in engineering and for future research to better understand the connections between these two variables.

1. *Integrate sustainability in engineering education and practice*: Despite recommendations from leading organizations (NSF 2008; NAE 2001) and increasing numbers of individual courses which emphasize sustainability, the vast majority of engineering programs have yet to infuse sustainability across the curriculum (Allenby et al. 2009). Engineering programs like James

Madison University's, which make sustainability the central subject, are the exception rather than the rule (James Madison University 2009). In industry, over one third (44 of 123) of the organizations responding to the survey did not have anyone responsible for organization-wide sustainability. Improved integration of sustainability in engineering education and practice will lead to better engineering solutions and is likely to help attract a higher percentage of women to the field.

2. *Publicize sustainability leadership opportunities for engineers*: Leadership from engineers is critical in the pursuit of sustainability. Publicizing this requirement, beginning with young girls, could help the field attract and retain more women.

3. *Investigate the career paths of women in sustainable engineering leadership positions*: Detailed study of how women reach sustainability leader positions could yield valuable insight to help encourage more women to enter the field through similar channels. This type of study would also help clarify the role of sustainability in attracting these women to the field.

4. *Create opportunities to learn about sustainability in universities:* A National Science Foundation sponsored REU program would bring students from across the country to Clemson and give them the opportunity to learn about sustainability while conducting research.

5. *Link sustainability and engineering to pre-college students.* Outreach programs that make a clear connection with hands-on activities to young girls have the potential to make a difference in bridging the gender gap.

6. *Expand this research*: This research can be expanded to study additional data sets and to examine trends over time. For instance, the percentage of women has increased at each of the first 3 CSE workshops.

Incorporating the subject of sustainability in engineering, a crucial need by itself, seems to also address the crucial need to increase the percentage of women in the field. This research identified a positive correlation between the subject of sustainability and the percentages of women in engineering leadership positions in industry and academia. Women in these leadership positions in industry and academia serve as role models to other women, helping them aspire to similar leadership positions.

# APPENDICES

APPENDIX A

Top 100 Design Firms Results

| Top 100 Design Firms | | | |
|---|---|---|---|
| Rank | Company | Name | Gender |
| 1 | URS Corp | Sally Vivian | F |
| 2 | Jacobs | None | x |
| 3 | AECOM Technology Corp. | | |
| 4 | Flour Corp. | Nancy Kralik | F |
| 5 | CH2M Hill | Andrea Ramage | F |
| 6 | The Shaw Group, Inc. | | |
| 7 | Bechtel | Susan Kubanis | F |
| 8 | Tetra Tech | None | x |
| 9 | Parsons | None | x |
| 10 | KBR | None | x |
| 11 | Foster Wheeler Ltd. | None | x |
| 12 | AMEC | Linzie Forrester | F |
| 13 | Parsons Brinckerhoff Inc. | Marcia Kaiser | F |
| 14 | MWH Global | | |
| 15 | Black & Vaetch | Peter Binney | M |
| 16 | HDR | Michaella Wittmann | F |
| 17 | Earth Tech Inc. | | |
| 18 | Louis Berger Group | Jeffrey Raven | M |
| 19 | CB&I | None | x |
| 20 | Worley Parsons Corp. | Peter Meurs/Paul Hardisty | M |
| 21 | Mustang Engineering | | |
| 22 | HNTB Cos. | Brad Schulz | M |
| 23 | Arcadis US | David Worth | M |
| 24 | CDI Engineering Solutions | None | x |
| 25 | HOK | Mary Ann Lazarus | F |
| 26 | Gensler | Kirsten Ritchie | F |
| 27 | CDM | Tom A. Pedersen | M |
| 28 | ERM Holdings Ltd. | | |
| 29 | PBS&J | | |
| 30 | S&B Holdings Ltd. | | |
| 31 | Kimley Horn & Associates | None | x |
| 32 | Burns & McDonnell | J. David Langford | M |
| 33 | MACTECH | Bill Weber | M |
| 34 | Fugro Inc. | | |
| 35 | Sargent & Lundy LLC. | | |

| | | | |
|---|---|---|---|
| 36 | HKS Inc. | | |
| 37 | Stantec Inc. | | |
| 38 | ENGlobal Corp. | None | x |
| 39 | Malcolm Pirnie Inc. | James M. Callahan | M |
| 40 | Michael Baker Corp. | | |
| 41 | Terracon Consultants Inc. | Tom Warn | M |
| 42 | Perkins & Will | Peter Busby | M |
| 43 | Skidmore Owings & Merrill LLP. | Roger Frechette | M |
| 44 | Dewberry | Tim Kraft | M |
| 45 | The Kleinfelder Group Inc. | Mark Hooyer | M |
| 46 | TRC Cos. Inc. | | |
| 47 | BE&K Inc. | None | x |
| 48 | McDermott International Inc. | | |
| 49 | Brown & Caldwell | | |
| 50 | STV Group Inc. | | |
| 51 | RTKL Associates Inc. | Karl Stumpf | M |
| 52 | Conestoga-Rovers & Associates | Janet Stavinga | F |
| 53 | Professional Service Indus. (PSI) | None | x |
| 54 | Burns & Roe Group Inc. | Gregory Zoll | M |
| 55 | Gannett Fleming | | |
| 56 | Bureau Veritas | | |
| 57 | Stanley Consultants Inc. | Russell Price | M |
| 58 | ENVIRON | | |
| 59 | Hatch Mott MacDonald | Roland Ericsson | M |
| 60 | Universal Ensco Inc. | | |
| 61 | TranSystem Corp. | | |
| 62 | Weston Solutions Inc. | Matt Goldman | M |
| 63 | ATC Associates Inc. | | |
| 64 | WSP Group | | |
| 65 | RMJM Hillier | Philip C Dordai | M |
| 66 | NBBJ | None | x |
| 67 | David Evans & Associates Inc. | Paul Horton | M |
| 68 | Carollo Engineers PC | Mary Hansel | F |
| 69 | Leo A Daly | Brad A. Schaap | M |
| 70 | RBF Consulting | Mike Burke | M |
| 71 | Wilbur Smith Associates | None | x |
| 72 | Zachry Group | | |
| 73 | Arup | Peter Head | M |
| 74 | Heery International Inc. | None | x |
| 75 | Golder Associates Inc. | John Wates | M |
| 76 | Callison | Teresa Burrelsman | F |
| 77 | SmithGroup Inc. | None | x |

| | | | |
|---|---|---|---|
| 78 | Reynolds Smith and Hills, Inc. | | |
| 79 | POWER Engineers Inc. | None | x |
| 80 | KCI Technologies Inc. | None | x |
| 81 | CMX | | |
| 82 | T.Y. Lin International | None | x |
| 83 | Gresham Smith and Partners | Jane Ahrens | F |
| 84 | Vanasse Hangen Brustlin Inc. | Leo Pierre Roy | M |
| 85 | Langan Eng'g and Envirn Services | | |
| 86 | Greenman-Pederson Inc. | | |
| 87 | Enercon Services Inc. | None | x |
| 88 | Woolpert Inc. | Nadja Turek | F |
| 89 | Perkins Eastman | None | x |
| 90 | Hazen Sawyer PC | Sandeep Mehrotra | M |
| 91 | LFR Inc. | Doug Wolf | M |
| 92 | Gulf Interstate Engineering Inc. | | |
| 93 | Ghafari Associates LLC | | |
| 94 | Zimmer Gunsul Frasca Architects LLC | Johanna Brickman | F |
| 95 | Day & Zimmerman | None | x |
| 96 | Cannon Design | Punit Jain | M |
| 97 | Ingenium International Inc. | Laura Long | F |
| 98 | TransCore | None | x |
| 99 | ECS | None | x |
| 100 | Clough Harbour & Associates LLP | Nick Schwartz | M |

APPENDIX B

Top 100 Contracting Firms Results

| Top 100 Contractors | | | |
|---|---|---|---|
| Rank | Company | Name | Gender |
| 1 | Bechtel | Susan Kubanis | F |
| 2 | Flour Corp. | Nancy Kralik | F |
| 3 | The Turner Corp. | Michael Deane | M |
| 4 | KBR | None | x |
| 5 | Kiewit Corp. | | |
| 6 | Skanska USA Inc. | Noel Morrin | M |
| 7 | Bovis Lend Lease | Maria Atkinson | F |
| 8 | PCL Contractor Enterprises Inc. | Sarah Siegel | F |
| 9 | Perini Corp. | | |
| 10 | Jacobs | None | x |
| 11 | McDermott International Inc. | | |
| 12 | CB&I | None | x |
| 13 | Clark Group | Anna Campos | F |
| 14 | The Whiting-Turner Contracting Co. | Richard Warhall | M |
| 15 | The Walsh Group Ltd. | | |
| 16 | Foster Wheeler Ltd. | None | x |
| 17 | Structure Tone | None | x |
| 18 | URS Corp | Sally Vivian | F |
| 19 | Gilbane Building Co. | Carol Moore | F |
| 20 | McCarthy Holdings Inc. | None | x |
| 21 | Granite Construction Inc. | | |
| 22 | JE Dunn Construction Group | | |
| 23 | The Shaw Group, Inc. | | |
| 24 | Hensel Phelps Construction Co. | Greg Gidez | M |
| 25 | Balfour Beatty Construction | Tracy A. Browne | F |
| 26 | Zachry Group | | |
| 27 | M.A. Mortenson Co. | None | x |
| 28 | TIC Holdings Inc. | | |
| 29 | Black & Vaetch | Peter Binney | M |
| 30 | Fagen Inc. | | |
| 31 | Webcor Builders | Megan White | F |
| 32 | Brasfield & Gorrie LLC | | |
| 33 | Hunt Construction Group Inc. | Ray Libonati | M |
| 34 | Swinerton Inc. | Grant French | M |
| 35 | The Yates Cos. Inc. | | |

| | | | |
|---|---|---|---|
| 36 | Opus Group | Dan Young-Dixon | M |
| 37 | Tutor-Saliba Corp. | | |
| 38 | Austin Industries | | |
| 39 | BE&K Inc. | None | x |
| 40 | The Weitz Co. LLC. | None | x |
| 41 | Turner Industries Group LLC. | None | x |
| 42 | DPR Construction Inc. | None | x |
| 43 | Barton Malow Co. | Jennifer Macks | F |
| 44 | CH2M Hill | Andrea Ramage | F |
| 45 | Pepper Construction Group | Ted Krasnesky | M |
| 46 | Parsons | None | x |
| 47 | Holder Construction Co. | Beth Studley | F |
| 48 | Manhattan Construction Co. | None | x |
| 49 | Suffolk Construction Co. Inc. | | |
| 50 | Hoffman Corp. | | |
| 51 | Alberici Corp. | Thomas Taylor | M |
| 52 | Duke Construction | | |
| 53 | The Flintco Cos. Inc. | | |
| 54 | Ryan Cos. US Inc. | | |
| 55 | The Lane Construction Corp. | | |
| 56 | Walbridge Aldinger | | |
| 57 | AMEC | Linzie Forrester | F |
| 58 | Day & Zimmerman | None | x |
| 59 | EMJ Corp. | None | x |
| 60 | ValleyCrest Cos. | | |
| 61 | Robins & Morton | Nick Dill | M |
| 62 | Sundt Construction Inc. | Ian W. McDowell | M |
| 63 | HITT Contracting Inc. | Kim Pexton | F |
| 64 | Michels Corp. | None | x |
| 65 | The Howard S. Wright Cos. | | |
| 66 | Clayco Inc. | Paul Todd Merrill | M |
| 67 | Shawmut Design and Construction | Tom Perry | M |
| 68 | Hardin Construction Co. LLC | | |
| 69 | Hathaway Dinwiddle Construction | | |
| 70 | Kraus-Anderson Construction Co. | | |
| 71 | Willbros Group Inc. | | |
| 72 | James G. Davis Construction Corp. | None | x |
| 73 | Layne Christensen Co. | | |
| 74 | Adolfson & Peterson Construction | Drew Russ | M |
| 75 | L.F. Driscoll Co. | None | x |
| 76 | Devcon Construction Inc. | None | x |

| | | | |
|---|---|---|---|
| 77 | The Beck Group | | |
| 78 | The Kokosing Group | | |
| 79 | Flatiron Construction Corp. | Walter Maxson | M |
| 80 | The Layton Cos. | | |
| 81 | Choate Construction Co. | | |
| 82 | David E. Harvey Builders Inc. | | |
| 83 | The Haskell Co. | Darryl Wernimont | M |
| 84 | VCC | | |
| 85 | The Boldt Co. | | |
| 86 | Okland Construction Co. Inc. | | |
| 87 | Hunt Building Co. Ltd. | | |
| 88 | James McHugh Construction Co. | | |
| 89 | Dick Construction Co. | | |
| 90 | Walton Construction Co. LLC | Michael Burt | M |
| 91 | Graycor | | |
| 92 | Messer Construction | Kurt P. Bouley | M |
| 93 | Panattoni Construction Inc. | | |
| 94 | Balfour Beatty Infrastructure Inc. | | |
| 95 | Moss & Associates LLC | | |
| 96 | Hawaiian Dredging Construction Co. | | |
| 97 | Matrix Service Co. | None | x |
| 98 | Ames Construction Inc. | None | x |
| 99 | Kitchell Corp. | None | x |
| 100 | William A. Berry & Sons Inc. | | |

# APPENDIX C

## Sustainability Leaders Survey

Re: Women as Sustainability Leaders
Dear **,

We are studying women as sustainability leaders in the design and construction industry. Our preliminary results show a very high percentage of women in these sustainability leadership positions when compared to the percentages of women in general engineering leadership positions. Based on these compelling preliminary results, we are seeking more information.

We would greatly appreciate if you can take a few minutes to complete the linked survey and provide your valuable insights. The results will help other women reach similar leadership positions like yours, and could also increase the percentage of women in the industry in general.

Sincerely,

Link to survey goes here

**Information Concerning Participation in a Research Study**
**Clemson University**
(Women as Sustainability Leaders)

**Description of the research and your participation**

You are invited to participate in a research study, the purpose of which is to gather information about women in sustainability leadership positions.

Your participation will involve completion of an eight question survey that should take 5-10 minutes.

**Risks and discomforts**

There are no known risks associated with this research.

**Potential benefits**

Those who complete the survey will provide information to help other women interested in sustainability leadership positions.

**Protection of confidentiality**

Your responses are anonymous. Your identity will not be revealed in any publication that might result from this study.

**Voluntary participation**

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

**Contact information**

If you have any questions or concerns about this study or if any problems arise, please send an e-mail to leidyk@clemson.edu. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Office of Research Compliance at 864.656.6460.

## APPENDIX D

### Sustainability Leaders in Education Survey

Re: Women as Sustainability Leaders
Dear ***

We are studying women as sustainability leaders in higher education. Our preliminary results show a very high percentage of women teaching sustainability related topics when compared to the percentages of women teaching technical subjects like science, math and engineering. Based on these compelling preliminary results, we are seeking more information.

We would greatly appreciate it if you can take a few minutes to complete the linked survey and provide your valuable insights. The results will help other women reach similar leadership positions like yours, and could also increase the percentage of women in science, math, and engineering in general.

Sincerely,

Link to survey goes here

**Information Concerning Participation in a Research Study**
**Clemson University**
(Women as Sustainability Leaders in Education)

**Description of the research and your participation**

You are invited to participate in a research study, the purpose of which is to gather information about women in sustainability leadership positions.

Your participation will involve completion of a seven question survey that should take 5-10 minutes.

**Risks and discomforts**

There are no known risks associated with this research.

**Potential benefits**

Those who complete the survey will provide information to help other women interested in sustainability leadership positions.

**Protection of confidentiality**

Your responses are anonymous. Your identity will not be revealed in any publication that might result from this study.

**Voluntary participation**

Your participation in this research study is voluntary. You may choose not to participate and you may withdraw your consent to participate at any time. You will not be penalized in any way should you decide not to participate or to withdraw from this study.

**Contact information**

If you have any questions or concerns about this study or if any problems arise, please send an e-mail to leidyk@clemson.edu. If you have any questions or concerns about your rights as a research participant, please contact the Clemson University Office of Research Compliance at 864.656.6460.

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