**Working Engineers’ Satisfaction with Helping People and Society Through Their Jobs**

Angela R. Bielefeldt1\* and Nathan E. Canney2

1Univ. of Colorado Boulder, 428 UCB, Boulder, CO, USA 80309.

\*E-mail: [angela.bielefeldt@colorado.edu](mailto:angela.bielefeldt@colorado.edu);

2Instructor, Seattle Univ., ENGR 513, 901 12th Ave., Seattle, WA 98122-1090. E-mail: [nathan.canney@gmail.com](mailto:nathan.canney@gmail.com)

**Word count:** 7326 (without figures and tables)

**Abstract**

This research explored the extent that working engineers were satisfied with their ability to help or serve people and/or society through their jobs. Over 450 engineering graduates responded to an online survey, including alumni recently transitioning to the workforce from 16 U.S. institutions and professional volunteers with Engineers Without Borders-USA. Only 18% of the respondents currently working in engineering jobs had some level of dissatisfaction with helping others through their job; this differed by job sector and discipline but not gender or between recent alumni and service-active engineers. Forty percent cited dissatisfaction with service aspects of their work as a contributing factor for leaving an engineering job. A few seemed to have left engineering careers due to dissatisfaction with their ability to help others. The results point to the importance of aligning personal goals for helping people/society with engineering careers; employers facilitating these connections may reap benefits in employee retention.

**Keywords**: engineering professionals; helping society; job satisfaction; job transitions

**Introduction**

Engineers “make a world of difference” and are “essential to health, happiness, and safety” (National Academy of Engineering 2008). A growing number of engineering students appear to have a strong interest in helping society, based on the growth of learning through service and service-learning (SL) programs such as Engineering Projects in Community Service (EPICS) and Engineers Without Borders (EWB)-USA (Amadei, Sandekian, and Thomas 2009; EPICS 2017; IJSLE 2014; Zoltowski and Oakes 2014). In a recent study of US engineering students, 26% of female students and 16% of male students cited a desire to have an impact on society as a factor which influenced their choice of their engineering major (Canney and Bielefeldt 2015a); these societal impact motivations were described by 28-30% of civil and environmental engineering students but only 10% of mechanical engineering students (Canney and Bielefeldt 2015b). A 2008 study with engineering students in the UK found a desire to make a difference to the world was selected as the primary motivation to study engineering (among 7 options) by 13.5% of the students; in addition, 21.9% of male students and 33.5% of the female students indicated that making a difference to the world was what they would most like to have achieved in life (among 5 options) (Alpay et al. 2008).

Some have voiced concern that students who were drawn to engineering for its helping attributes may be dissatisfied with the perceived helping benefits of their engineering work after graduation (Rulifson, Canney, and Bielefeldt 2015). While one’s engineering skills may in fact be helping communities and people through infrastructure and products, their day-to-day work may be conducted in isolation from communities and customers or driven by cost constraints rather than maximizing social benefits. The transition from college to the workforce is particularly important, when the professional socialization process which communicates the values of the engineering workforce is occurring (Cech 2014; Young et al. 2016). During the socialization process, an individual may form judgements about the fit or alignment of their interests and values to the work environment (Grosemans, Coertjens, and Kyndt 2017), which they may perceive either narrowly as a particular job or more generally as indicative of the engineering profession as a whole. If an individual perceives a poor fit between their helping/service values and their engineering job, this could lead to low job satisfaction. Low satisfaction may motivate the individual to change jobs, seeking a better fit to their values via a transition within the engineering profession, or perhaps ultimately leaving the engineering workforce and transitioning into a different career. This is particularly concerning for women, as they have been found to choose engineering majors and stay in engineering careers largely due to a desire to help others (Buse, Bilimoria, and Perelli 2013; Bystydzienski and Brown 2012; Hewlett et al. 2008; Meyers and Mertz 2011). In addition, women are underrepresented in the engineering profession and leave engineering at higher rates than other professions (Fouad and Singh 2011; Frueh 2014; Glass et al. 2013).

A number of models describe factors that impact one’s decision to stay or leave a job, so-called voluntary turnover. This is an important transition from the perspective of both the individual and the employer. One factor is meaningfulness, which relates to the perceived fit between an individual’s values and their work-role (Scroggins 2008). In the context of this study, if an individual values the ability to help people and society, they will find their engineering work meaningful if they feel that their work has these impacts. Links between perceptions of organizational corporate social responsibility and meaningfulness of work, person-organization fit, turnover intentions, job satisfaction, and organizational commitment have been found among workers broadly in North America, China, South Korea, Europe, and Asia (Glavas and Kelley 2014; Hudson, Bryson, and Michelotti 2017; Im, Chung, and Yang 2017; Wang et al. 2017); no similar studies with engineers were found. Low perceived meaningfulness of one’s work has been linked to intentions to leave the job for teachers, nurses, and veterinary technicians (Cortese, Gatti, and Ghislieri 2014; Huerkamp 2006; Janik and Rothmann 2015); studies of this type for engineers were not found. Job satisfaction has been related to both meaningful work (Fairlie 2011; Miller and Wheeler 1992) and retention (Lo 2015). Satisfaction can relate to one’s particular job or more broadly to their entire career. A number of negative experiences with multiple jobs within the same career may lead to low career satisfaction over time. Other relevant literature includes studies on public service motivation and/or prosocial motivation, where these factors have been shown to relate to job satisfaction (Andersen and Kjeldsen 2013; Liu et al. 2015; Liu, Tang, and Yang 2015). Thus, if helping others is becoming a value of students graduating with engineering degrees, this value may have important implications for job satisfaction and ultimately retention. A large array of factors are known to impact overall job satisfaction, including pay, promotional opportunities, co-worker relations, co-worker attitudes, task variety, task identity, task significance, autonomy, feedback, and organizational characteristics; the relative importance of these factors varies for each individual (Redmond 2015). However, this was a job facet satisfaction study, intended to explore engineers’ satisfaction specifically with the helping and service aspects of their jobs. This information is not currently available in the literature.

**Research Questions**

The goal of this research was to explore engineers’ satisfaction with the ways that they help and serve both people and society through their jobs. The specific research questions (RQ) and research hypotheses (H) that the study explored were:

RQ1. Are recent engineering graduates and/or professionals currently or historically active in volunteer engineering service generally satisfied with their ability to help and/or serve people and/or society through their engineering careers?

H1a. Helping satisfaction will be lower among those who were active in engineering service in college and/or currently are EWB-USA volunteers as compared to typical engineering graduates. This hypothesis is based on the idea that service active individuals hold higher expectations for helping others through their jobs, making it more difficult to fulfill these aspirations through many traditional engineering jobs.

H1b. Helping satisfaction will vary between different job sectors, with the most satisfaction among individuals working at non-governmental organizations (NGOs) and the least among engineers working in industry/consulting. This hypothesis is based on the idea that NGOs are generally focused on service and helping, while industry is more focused on business and profits. In addition, anecdotal information exists that students very active in humanitarian engineering tried to find jobs at NGOs to continue this type of work and were oftentimes unsuccessful or discouraged from doing so by engineering mentors (Canney 2016); jobs in industry/consulting are more readily available and therefore were taken in lieu of the desired position with an NGO.

H1c. Women will be less satisfied with the helping aspects of their engineering work than men. This hypothesis is based on findings that women have greater service and helping aspirations through their work than men (Canney and Bielefeldt 2015a); as such, they have a greater chance for disappointment in their engineering jobs.

H1d. Satisfaction with the helping aspects of engineering work will vary between disciplines. Mechanical engineers will be the most satisfied since they generally had the lowest aspirations in this regard (Canney and Bielefeldt 2015b) and a wide variety of job options are available to mechanical engineers perhaps allowing them greater ability to align their personal values with their job.

H1e. Individuals with graduate degrees will be more satisfied with the helping aspects of their work. Motivations to pursue graduate studies vary, but generally involve positioning oneself for desired jobs. This may include more specialized areas of engineering, changing areas within engineering, or coming to engineering graduate studies from non-engineering Bachelor’s degrees. Going through this additional transition and gaining stronger credentials should position one more strongly to align their personal values with their career.

RQ2. Does dissatisfaction with service aspects of their work motivate individuals to transition to a new job and/or career outside engineering?

H2a. Some engineers will cite dissatisfaction with service aspects of their job as a reason that they left their engineering job.

H2b. More women than men will cite dissatisfaction with service aspects of their job as a reason that they left an engineering job.

H2c. Some individuals with engineering degrees will be working in non-engineering jobs due to dissatisfaction with the helping and service aspects of engineering jobs.

**Methods**

The career experiences of alumni from engineering programs were examined using an exploratory mixed-methods approach, embedded in a larger research project on social responsibility. The initial qualitative component of this mixed-methods study focused on individuals who were active in engineering service programs in college including EWB-USA and others, and had since graduated; 19 individuals were interviewed. From these open-ended interviews, research questions were developed. Two different versions of a career survey were developed and piloted, with 40 and 10 responses from working engineers, respectively. Based on participant and researcher feedback to improve usability, the survey was revised to the form used in this research. This online survey was distributed using the web-platform, Qualtrics, to a broader audience of engineering graduates and EWB-USA professional volunteers (i.e. non-student members).

The career survey began with an informed consent statement, approved by the University of Colorado Boulder institutional review board for human subjects research. The survey questions relevant to this research are shown in Table 1. The survey first asked individuals to consider the job where they were most satisfied with their ability to engage in service or to help people/society; this “most satisfying” job may also have been their current job and/or their only job after college. Respondents then characterized the job type (across nine sectors) and their satisfaction level with the ability to help/serve others through the job (initial and current; 7-point scale). Note that individuals would define for themselves what they perceived as service or helping through their job; an open-ended question asked them to “describe the ways in which you engaged in service or helping people/society through this job.” Detailed analyses of these responses are outside the scope of this study; however, a summary of these responses is presented in Supplemental Materials Table S1. The majority of the responses demonstrated how the individual perceived that their primary engineering work had a direct or indirect benefit to people, communities, and society.

Table 1. Survey questions to evaluate attitudes toward job satisfaction with helping others

|  |  |
| --- | --- |
| Q# | Question [response options] |
|  | Think about the job where you were the MOST satisfied with your ability to engage in service or to help people/society… (this could be your current job or your only job after college) |
| 1 | Type of job (select one of the following 9 options): [engineer in consulting/industry, engineering in the public sector, engineering research, NGO/non-profit related to engineering, military, academic/education related to engineering, work as a self-employed engineer, non-engineering related, other] |
| 1b  1c | If Q1 non-engineering or other: briefly describe this job  If Q1 non-engineering: Briefly describe why you chose a job not closely related to engineering |
| 2 | How satisfied were you initially with your ability to help people/society and/or engage in service through this job? [7 point scale: very dissatisfied, dissatisfied, somewhat dissatisfied, neutral, somewhat satisfied, satisfied, very satisfied] |
| 3 | Describe the ways in which you engaged in service or helping people/society through this job |
| 4 | How long did you stay at this job [< 3 mo, 3-12 mo, 1-3 yrs, 3-5 yrs, >5 yrs, this is my current job] |
| 5 | If not current job: Was any of your motivation to leave this job due to dissatisfaction with the service aspects of the work? [4 options]:  no, I changed jobs for other reasons;  dissatisfaction with time to participate in service outside of work was one among many factors;  dissatisfaction with service aspects of my work was one among many factors;  dissatisfaction with service aspects of my work was the primary motivation for change |
| 6 | If current job, current satisfaction with service [7 point scale; very dissatisfied to very satisfied] |
| 7 | I have only had one job after college, which I described above [yes/no; skip questions 8-13 if ‘yes’] |
|  | Think about the job where you were the LEAST satisfied with your ability to engage in service or to help people / society… (this could be your current job) |
| 8-13 | Repeat of questions 1-6 above |
| D1 | In what year did you earn your undergraduate degree? [5-yr increments then decades] |
| D2 | Undergraduate major [check all that apply; types of engineering, and non-engineering] |
| D3 | Earned graduate degree? Graduate major [check all that apply; types of engineering, and non-engineering] |
| D4 | Gender [male, female, prefer not to say] |

If the job where they were most satisfied with their ability to engage in service was not their current job, they were asked if dissatisfaction with the service aspects of their work contributed to their motivation to change jobs. Survey takers were then asked to consider the job after college where they were the least satisfied with their ability to engage in service or to help people/society (which could also be their current job). The same series of questions were asked about this job. The survey concluded with demographic questions such as the year they earned their undergraduate degree, their undergraduate and graduate majors, and gender.

An email invitation to participate in the survey was distributed to a number of groups in March and April, 2015; these groups and the number of responses are summarized in Table 2.

Table 2. Career survey participant groups

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Group | N emails delivered | N consent and completed Q1 | N completed >90% of survey | % response rate |
| 1. Seniors or graduate students in Aug. 2012 majoring in ME, CE, EnvE majors at four institutions; expected to be working in spring 2015 | 663 | 173 | 135 | 20 |
| 2. Seniors in engineering at 16 institutions in April 2014, expected to be working in spring 2015 | 570 | 134 | 91 | 16 |
| 3. Students who graduated in EnvE in 2000-2012 from a large public doctoral institution with SL options in engineering courses | 57 | 30 | 23 | 40 |
| 4. Students who graduated in CE and EnvE in 2008-2014 from a program at medium public doctoral institution with required engineering SL courses | 125 | 29 | 26 | 21 |
| 5. Alumni from a large public doctoral institution who were active in EWB and/or a graduate level humanitarian engineering program | 235 | 68 | 53 | 23 |
| 6. Graduates from a technical public doctoral institution who were active in EWB-type programs | Open invite | 14 | 11 | N/A |
| 7. EWB-USA professionals listserv | Unknown of 1728 | 174 | 126 | 7\* |
| ALL | 3425 | 622 | 465 | 14\* |

\* estimated; N/A = not applicable

Groups 1 and 2 had graduated with an engineering degree from a diverse range of U.S. institutions and had participated in a survey on engineering social responsibility as seniors and/or graduate students in August 2012 (Group 1) and April 2014 (Group 2). Thus, these individuals had recently transitioned from college to the workforce. All were recent graduates from 16 institutions, which included: a large public doctoral (39%); a technically-focused public doctoral (21%); a medium public doctoral (4%); three public Master’s institutions (11%); three private doctoral institutions (11%); five private Christian-affiliated institutions (8%); and two additional public doctoral institutions (6%) (Bielefeldt and Canney 2016). In Group 1, respondents had degrees in mechanical engineering (ME), civil engineering (CE), or environmental engineering (EnvE). Among the graduate students invited to participate in the survey from Group 1 (n=343), 33% indicated that they had full-time engineering work experience prior to graduate school. In Group 2, all engineering majors at the institution could be represented. Respondents in Groups 1 and 2 may or may not have been active in engineering service activities during college. Respondents in Groups 3 to 6 also graduated from the institutions represented among Group 1. Group 3 was a convenience sample of environmental engineering alumni, to boost response numbers. Individuals in Groups 1, 2, and 3 were considered “typical” alumni with engineering degrees from U.S. institutions in that they were not known to specifically have had engineering-related service experiences as students.

Individuals who were involved in engineering-related service were also invited to participate in the survey; these individuals may be more interested in using engineering to help others than typical engineering graduates. Group 4 represented civil and environmental engineering alumni who engaged in service-learning as part of required engineering courses in their curriculum. Groups 5 and 6 were alumni from voluntary engineering service activities during college. The Group 7 survey participants were professional volunteers with EWB-USA; the institutions from which they received their engineering degrees are not known.

For the first three groups, the survey invitation email stated that the goal of the research was “to better understand the career pathways of engineers”; for Groups 4 to 7 the email additionally stated “you have been included in the study because you did or are involved in some form of engineering service”. The response rates were calculated as a percentage of those who completed at least 90% of the survey out of the total number of delivered emails. Response rates were highly variable, ranging from about 7% to 40%.

The demographics of the survey respondents are provided in Table 3. Because the demographics were voluntary questions at the end of the survey, this information was missing for some of the respondents. The majority of the respondents (55%) had earned their bachelor’s degree within the five years prior to the survey, and therefore likely represent junior engineers. The sample was over-represented in women, where 11 to 20% women was expected (Fouad and Singh 2011). Higher survey response rates for women are common (Smith 2008) and service-active engineering groups have approximate gender parity (e.g. 40% women among the members of EWB-USA; Litchfield and Javernick-Will, 2014). Based on the Qualtrics location information (latitude and longitude), 27 of the respondents were outside the U.S.

Table 3. Demographics of Respondents

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Group | Year earned undergrad degree, % | | | %  female | % degree(s) in | | | % with graduate degree(s) |
|  | 2000-2004 | 2005-2009 | 2010-2014 | ME+ | CE+ | EnvE |
| 1 | 5 | 18 | 76 | 39 | 43 | 36 | 23 | 64 |
| 2 | 0 | 2 | 97 | 43 | 39 | 23 | 5 | 16 |
| 3 | 40 | 23 | 37 | 37 | 0 | 23 | 100 | 30 |
| 4 | 0 | 35 | 65 | 38 | 0 | 96 | 23 | 15 |
| 5 | 6 | 49 | 31 | 51 | 18 | 56 | 38 | 85 |
| 6 | 10 | 10 | 70 | 36 | 10 | 40 | 60 | 55 |
| 7 | 8 | 20 | 18 | 32 | 14 | 53 | 17 | 54 |
| **All** | **8** | **21** | **55** | **40** | **28** | **40** | **24** | **50** |

Given the large number of different engineering degree disciplines that were reported by survey respondents, clusters of similar degrees were created to aid analysis: ME+ included aerospace and mechanical engineering; CE+ included civil, construction, and architectural. Both undergraduate and graduate degrees were reported on the survey, and respondents could indicate multiple degrees (such as a dual major); therefore, the sum of all engineering disciplines in Table 3 can exceed 100%. For example, many respondents reported degrees in both civil and environmental engineering; during analysis to compare disciplines these individuals were counted as environmental (which is more specialized). Less common disciplines among the survey respondents were: electrical and/or computer engineering (6%), math or natural science Bachelor’s degree (physics, chemistry, biology; individuals earned graduate degrees in engineering) (6%), and chemical engineering (4%). Half of the survey respondents possessed one or more graduate degrees, which is a higher percentage than is typical in the engineering workforce; for example, it is estimated that one in four civil engineers has a master’s degree (BLS 2015).

Statistical analyses of the data were conducted using IBM SPSS. Significant differences were inferred when *p* values or significance (sig.) levels were below 0.05. Given the categorical data, chi-square tests were most commonly conducted to explore differences between response groups. In a few instances, non-parametric statistics were used (since the data were ordinal and non-normal). The related-samples Wilcoxon signed rank test is the non-parametric equivalent of a paired t-test, the Mann-Whitney U test is the equivalent of an unpaired t-test, and the independent samples Kruskal-Wallis (KW) test is the non-parametric equivalent of an unpaired ANOVA. Two-tailed tests were conducted. When KW tests found significant differences among the multiple categories (such as job type or discipline), post-hoc tests were conducted to identify which pairs of conditions were different. Significant differences were inferred when the Bonferroni adjusted 2-sided asymptotic significance (adj. sig.) was below 0.05.

**Results and Discussion**

***Satisfaction with engineering jobs helping others***

This section explores the first research question (RQ1): Are engineers generally satisfied with their ability to help/serve people and/or society through their engineering careers? The responses describing non-engineering jobs were removed from the data set (n=39 from current/most satisfying job; n=25 least satisfying job). The initial satisfaction with respect to an ability to help others ranged from very dissatisfied (1) to very satisfied (7) (Figure 1A). There were significant differences in the distribution of helping satisfaction levels between the three job categories (most satisfying, only job, and least satisfying; p < 0.001). For the job that was the most satisfying for helping (n=208), most individuals were initially satisfied with their ability to help others; only 10% selected one of the dissatisfied categories. For those with only a single engineering job (n=255), the majority were initially somewhat satisfied with their ability to help others through their job or neutral; only 15% indicated one of the dissatisfied categories. For the least satisfying job for helping (n=194), most initially felt neutral in regards to their satisfaction with their ability to help others; 37% selected one of the dissatisfied categories.



Figure 1. Distribution of level of satisfaction with ability to help people / society through engineering jobs; (A) initial satisfaction levels; (B) current satisfaction levels

Current satisfaction levels with an ability to help others through their engineering job are shown in Figure 1B. Paired statistical tests were conducted comparing initial and current helping satisfaction. For those with only a single engineering job (n= 194) there were not statistically significant differences between the initial and current levels of satisfaction (p=0.388). For those describing the engineering job that they found the most satisfying with respect to helping/serving others (n=99), initial and current levels of satisfaction with helping others through their job were significantly different (p=0.009). On an individual basis, 49% had not changed, 35% increased their satisfaction, and 15% had decreased satisfaction. Thus a person’s satisfaction levels with respect to an ability to help/serve can change over time at the same engineering job. Perhaps as one gains more seniority, they can better align their personal values for helping with their position. Low and/or decreasing satisfaction levels might be a factor that leads one to consider changing jobs or careers. In regards to the engineering job where individuals were least satisfied with their ability to help others (n=53), the initial and current levels of helping satisfaction were not significantly different (p=0.315).

Some of those who reported dissatisfaction with the helping aspects of their work described ways they engaged in helping people / society through their work, but also acknowledged perceived short comings. For example, “This job doesn't allow me to work directly with communities. However, my work focuses on ways to improve and advance engineering practice in a way that makes buildings safer in disasters.” This seems to reflect a personal desire to work more closely with people needing help. One could imagine that other engineers might be fully satisfied with the helping aspects of the same job. Another example write-in comment was: “I tangentially helped with projects on environmental remediation but my work felt very paltry.” Thus, it must be reinforced that satisfaction is a personal perception relative to one’s expectations, and not an objective measure of the amount of helpfulness or benefits to society that are derived from particular engineering jobs.

Most individuals were able to find an engineering job that was personally satisfying in the extent to which it helps others. Among the 215 individuals who described an initial and/or current level of satisfaction for two jobs (most and least satisfying for helping), only ten people (5%) had all dissatisfaction ratings (3 or less). This included 30% women, 70% with graduate degrees, 50% civil engineers, 30% environmental engineers, and 10% mechanical engineers; 60% graduated with their Bachelor’s degree in 2005-2009, 20% in 2010-2014. Four reported jobs in consulting/industry for both the most and least satisfying; one job was an NGO for both most and least satisfying; the others had jobs in different sectors. Having experienced multiple engineering jobs where they were dissatisfied with their ability to help/serve others through their work, this small number of individuals might be particularly at risk for leaving engineering entirely.

The extent to which satisfaction with helping others through engineering jobs varied based on service activity, job type, gender, discipline, and possessing engineering graduate degrees are presented next to address the specific hypotheses associated with the general research question.

*Service Activity*

The data were explored to determine if the individuals who were invited to participate in the survey on the basis of engineering service activity in college and/or via EWB-USA (Groups 4 to 7) had different levels of satisfaction with their ability to help/serve others as compared to individuals expected to be more typical of engineering graduates (Groups 1 to 3); results are shown in Table 4. Both initial and current satisfaction with the helping aspects of their engineering jobs were not significantly different between the two clusters of survey respondents. Thus, the hypothesis that service-active individuals would be less satisfied with the helping aspects of their engineering jobs than typical engineering graduates was disproved. Engineers likely have some capability to align their helping and service goals with appropriate job types through their job selection process, ultimately resulting in similar satisfaction levels with this aspect of their work. Others may derive satisfaction from the fact that their job allows them sufficient time and/or resources to volunteer outside of work in personally meaningful ways.

Table 4. Average satisfaction with helping and/or service aspects of engineering jobs for survey respondents representing typical engineering graduates (Groups 1-3) compared to those with engineering service activity (Groups 4-7)

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Job type | Survey respondents | Initial  n | Avg initial satisfaction with helping others | Asymptotic sig. (2-sided test) | Current  n | Avg current satisfaction  with helping others | Asymptotic sig. (2-sided test) |
| Job most satisfied with ability to help/serve | Groups 1-3  Groups 4-7 | 81  141 | 5.0  5.2 | 0.196 | 32  67 | 5.5  5.6 | 0.425 |
|  |  |  |  |  |  |  |
| Only engineering job after college | Groups 1-3  Groups 4-7 | 176  79 | 4.7  4.8 | 0.325 | 130  67 | 4.8  4.9 | 0.715 |
| Job least satisfied with ability to help/serve | Groups 1-3  Groups 4-7 | 71  123 | 3.8  3.9 | 0.555 | 23  30 | 3.3  3.8 | 0.361 |

*Engineering job types*

The distribution of engineering job types differed among the only post-college job and those described as the most and least satisfying with respect to an ability to help others (p= <0.001; Table 5). Consulting/industry was the most common job type overall, and had a much higher representation among the least satisfying helping jobs. Consulting/industry jobs also had the lowest average initial helping satisfaction level for both the most satisfying helping job and the only post-college engineering job. As hypothesized (H1b), NGOs comprised a higher percentage of the jobs most satisfying for helping (16%) and only 2% of the jobs least satisfying for helping; they also had the highest average initial helping satisfaction rating among the least satisfying job types. Academic/engineering education jobs were also over-represented among the most satisfying helping jobs in comparison to the least satisfying helping jobs.

Table 5. Percentage of engineering job types and average initial satisfaction level with ability to help others through the job

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| Engineering job type categories | N | % most satisfying | % only eng. job | % least satisfying | Average initial satisfaction level (1-7 scale) | | |
| Most satisfying job | Only eng. job | Least satisfying job |
| Consulting / industry | 380 | 40 | 52 | 62 | 5.0 | 4.6 | 3.8 |
| Public sector | 122 | 14 | 14 | 15 | 5.4 | 4.8 | 4.1 |
| NGO | 71 | 16 | 6 | 2 | 5.2 | 5.0 | 5.2 |
| Academia / eng. education | 66 | 13 | 10 | 1 | 5.4 | 5.4 | 4.5 |
| Research | 67 | 7 | 10 | 7 | 5.2 | 4.8 | 4.1 |
| Military, self-employed, other | 76 | 10 | 7 | 12 | 5.4 | 4.8 | 3.1 |

For the job where individuals were the most satisfied with their ability to help others, the helping satisfaction levels did not differ among the six engineering job types (p=0.49 initial satisfaction, p=0.75 current satisfaction). Differences in initial satisfaction with an ability to help through their engineering jobs were found among job types for those who had only one engineering job after college (p=0.015); those working in consulting/industry jobs had a lower initial helping satisfaction versus academic/engineering education jobs (adj. p=0.028). For the engineering jobs where individuals were the least satisfied with their ability to help others through their work, initial helping satisfaction levels differed among job types (p=0.018); helping satisfaction at NGOs was higher than ‘other’ engineering job types (military, self-employed, other) (adj. p=0.048). There were not differences in the current helping satisfaction levels between different engineering job types (data not shown). Small numbers of respondents in some job type categories may have limited the ability to detect statistically significant differences; additional research should be conducted to gather a larger data set.

*Gender*

There were not statistically significant differences in the extent to which women and men were satisfied with helping others through their engineering jobs (Figure 2). These results disproved the hypothesis that women’s satisfaction with the helping aspects of their engineering jobs would be lower than men’s, due to the greater expectations and desires of the women in regards to the helping attributes of their job that might be harder to fulfill. This indicates that both women and men find engineering jobs similarly satisfying and dissatisfying in the extent to which they are able to help others through their work.



Figure 2. Average initial and current satisfaction levels with the helping/service aspects of engineering jobs from female and male survey respondents

*Engineering disciplines*

Due to the low number of respondents from many of the engineering disciplines, only three groups were statistically compared for helping satisfaction levels: mechanical (ME+), civil (CE+), and environmental (EnvE) (Figure 3). For the engineering job that was the most satisfying for its ability to help others, differences were found in initial satisfaction with helping between disciplines (p=0.025); paired tests found a significant difference between mechanical and environmental (adj. p=0.026). As hypothesized, the discipline that was the least concerned with helping others through engineering based on data from engineering students (mechanical per Canney and Bielefeldt 2015b) was found to have the highest satisfaction level; the discipline the most concerned with helping others based on student data (environmental) ended up the least satisfied with this aspect of their engineering jobs initially. There were not statistically significant differences between these three majors in current satisfaction levels for the most satisfying job.



Figure 3. Average initial and current satisfaction levels with the helping/service aspects of engineering jobs in different disciplines

There were not significant differences between the disciplines in the satisfaction levels with helping in their jobs for individuals who had only worked at a single engineering job after college or for individuals’ least satisfying engineering jobs. This likely means that individuals in different disciplines may face similar struggles and be equally successful in the degree to which they are able to align the helping goals for their jobs with the actual extent to which they perceive these helping attributes (both success and lack of success in achieving this alignment). The average initial satisfaction with helping others at one’s only job for a range of disciplines was: biomedical/biological 5.0 (n=10), electrical and/or computer 5.0 (n=19), CE+ 4.9 (n=78), ME+ 4.7 (n=78), Env 4.5 (n=52), chemical 4.4 (n=13). Additional research is needed to explore this wider range of disciplines.

*Graduate degrees*

There were not significant differences between individuals with only a Bachelor’s degree and those with graduate degrees in their satisfaction levels with the helping aspects of their engineering jobs, with the exception of higher initial helping satisfaction at the only engineering job after college among those with a graduate degree (Table 6). Possessing a graduate degree may allow individuals to initially achieve greater alignment of a job with their helping interests. For the other job categories, individuals may have worked in those jobs prior to earning their graduate degree, which confounds the results.

Table 6. Average satisfaction with helping and/or service aspects of engineering jobs for survey respondents with and without graduate degrees

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Job type | Survey respondents | Initial /  Current  n | Avg initial satisfaction with helping others | Avg current satisfaction  with helping others | Asymptotic sig. (2-sided test)  Initial/Current |
| Job most satisfied with ability to help/serve | Bachelor’s  Graduate | 71 / 37  121 / 59 | 5.1  5.3 | 5.5  5.7 | 0.521 / 0.724 |
|  |  |  |  |  |
| Only engineering job after college | Bachelor’s  Graduate | 139 / 109  97 / 76 | 4.5  5.1 | 4.7  5.0 | 0.000 / 0.092 |
| Job least satisfied with ability to help/serve | Bachelor’s  Graduate | 75 / 24  116 / 28 | 3.8  3.9 | 3.6  3.5 | 0.745 / 0.918 |

***Leaving engineering jobs and/or careers***

This section explores the second research question (RQ2): Does dissatisfaction with service aspects of their work motivate individuals to transition by changing engineering jobs and/or leaving engineering careers? Individuals were asked if dissatisfaction with service aspects of their engineering jobs was a contributing factor to changing jobs; results are summarized in Table 7. In the engineering job where individuals were the least satisfied with their ability to help others, 40% cited dissatisfaction with service aspects of the work as a factor motivating them to change jobs. As expected, far fewer individuals cited this dissatisfaction as a reason to leave from the job where they were the most satisfied with their ability to help others (only 13%).

Table 7. Extent to which dissatisfaction with service aspects was a reason for leaving engineering job

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| Job type | Response  n | Changed job for other reasons (not due to dissatisfaction with service aspects of the work) | Dissatisfaction with time to participate in service outside of work was one among many factors | Dissatisfaction with service aspects of my work was one among many factors | Dissatisfaction with service aspects of my work was the primary motivation for change |
| Job most satisfied with helping others | All = 158  Male = 91  Female = 56 | 85%  90%  79% | 1%  1%  0% | 9%  4%  16% | 4%  4%  5% |
| Job least satisfied with helping others | All = 138  Male = 85  Female = 52 | 56%  62%  46% | 4%  5%  2% | 26%  21%  35% | 14%  12%  17% |

When the category ‘dissatisfaction with time to participate in service outside of work’ was removed due to low response frequency, and the two categories of changed jobs partially/primarily due to dissatisfaction with service were combined, it was found that women were more likely to have changed jobs due to dissatisfaction with service aspects (p= 0.032 for most satisfied job; p=0.037 for least satisfied job). However, the satisfaction levels with the helping aspects of engineering jobs did not differ between women and men. Thus, it appears that women consider leaving jobs due to unfulfilled helping/service goals even at similar reported satisfaction levels with helping. For example, among those who reported changing jobs partially or primarily to dissatisfaction with service, the average initial helping satisfaction level at the least satisfying job was 3.7 (near neutral) for women compared to 3.0 (somewhat dissatisfied) for men. It appears that women may place greater value on feeling satisfied with the helping/service aspects of their work in order to stay, while men need to feel dissatisfied in order to leave. This may account in part to the higher attrition of women out of the engineering workforce than men; further qualitative and/or quantitative studies would be needed to verify this assertion.

Beyond leaving a particular engineering job, it was of interest to see if there was evidence that dissatisfaction with helping/serving others through engineering jobs caused individuals to leave engineering careers. There were 39 individuals who described the job where they were most satisfied with their ability to help others as non-engineering related. Among these non-engineering jobs the write-in descriptions indicated that seven were teaching and four were health related (family therapist, epidemiologist, healthcare consulting, doctor); other common clusters were not found. The reasons given for working at these non-engineering jobs by the 23 who wrote-in a response included helping and service related elements for six individuals; low interest in engineering/more interest in something else for six individuals; ethics-related issues for two individuals; poor ability to find engineering work for three individuals. Example quotes related to service and helping include: “Lack of service related engineering jobs available for entry level engineers in the developing world. The profession of engineering tends not to emphasis social engagement.” “I use mechanical engineering in orthopedic surgery to directly help people's quality of life.” “My job as a teacher in Tanzania as a Peace Corps volunteer gave me more opportunity and time for service.”

Among the individuals who described non-engineering jobs as their most satisfying for helping others, 31% were female (less than 40% female among all respondents); thus, higher attrition of women than men to non-engineering jobs was not evident. It was unclear whether or not the individuals who described non-engineering jobs as their most satisfying job had left engineering entirely, or may at some point return to an engineering-related job.

Among the 39 individuals whose most satisfying job for helping others was non-engineering related, 24 also described a job they found the least satisfying for helping. These least satisfying job types were: consulting/industry (n=16; 67%), public sector (n=2; 8%), military (n=1), engineering research (n=1), self-employed engineer (n=1), and non-engineering (n=3; 13%). Thus, the majority (87%) had worked in engineering jobs that they reported as least satisfying in regards to helping others. Among the 21 individuals whose most satisfying helping job was non-engineering and least satisfying helping job was in engineering, 62% had left their engineering job due to service/helping dissatisfaction but only 10% had left their non-engineering job due to service/helping dissatisfaction.

**Summary, Limitations, and Conclusions**

The research results both confirmed and refuted various hypotheses that were initially proposed. Recent engineering graduates and professionals active in volunteer service had varying levels of satisfaction with their ability to help/serve people and/or society through their engineering careers. Only a small percentage (~13%) had some level of dissatisfaction with the helping aspects of their work, seeming to indicate that the majority of engineers recognized the benefits of their work to people and society. There were not significant differences found between individuals invited to participate in the survey due to engineering service activity (as either a student or currently as a professional) as compared to typical engineering graduates. Helping/service satisfaction was higher in some job sectors (such as NGOs) and lower in others (such as industry/consulting). Helping/service satisfaction did not differ significantly between females and males, which was unexpected based on previous literature. There were differences between disciplines (mechanical vs. environmental engineering) in initial satisfaction with an ability to help others at the jobs where individuals were most satisfied with their ability to help, but not differences among disciplines in current levels of helping satisfaction. A significant percentage of engineers cited dissatisfaction with service aspects of their job as contributing to their decision to leave the engineering job they characterized as the least satisfying with respect to helping others. More women than men cited dissatisfaction with service aspects of their job as a reason that they had changed jobs. More research is needed to determine the extent to which dissatisfaction with the helping/service aspects of engineering jobs leads some individuals to take non-engineering jobs and/or leave the engineering profession.

One limitation is that the study explored only a single facet of job satisfaction – one’s satisfaction with the extent to which they perceived that their job helped/served people and/or society. Different individuals characterized different elements as helpful/service (Table S1). Thus, two engineers could derive different levels of satisfaction from similar amounts of actual service/help provided by their job. The perceived helpfulness of one’s job is clearly only one among many factors that could impact one’s overall satisfaction with their job. The importance of this factor would vary between individuals, ranging from not at all important to critically important. The relative importance of helping/service in the overall job satisfaction of engineers compared to other job factors should be explored. Similarly, a large number of factors influence a decision to change jobs and/or careers (Denissen et al. 2014; Donohue 2006; Fouad et al. 2016); this study explored helpfulness/service perceptions in relation to persistence in engineering jobs. Further work should compare the importance of helping/service relative to other job factors in voluntary transitions to other jobs.

Another limitation of the study is the somewhat small number of responses, biased to a predominance of individuals who had recently transitioned from earning engineering degrees at U.S. institutions (either Bachelor’s or graduate degrees) to the work force. There was a predominance of mechanical, civil, and environmental engineers among the data set, so the results should not be considered generalizable to other disciplines such as biomedical, chemical, and electrical/computer engineering. Further, one might be concerned that Groups 5, 6, and 7 (representing 41% of the survey respondents) were more motivated to service and helping than typical engineers, and as such likely hold a higher standard for being satisfied with the helping aspects of their engineering jobs; however, statistical comparisons did not find differences between the helping satisfaction levels among the groups. In addition, these results do not address the extent to which jobs were selected in an attempt to align helping and service aspirations with job attributes, and the extent to which these aspirations may have changed or evolved over time (to either increasing or decreasing levels). The importance of service goals in motivating job selection are explored in another manuscript. A complete and extensive exploration of the pathways of engineers in regards to the evolution of their helping and service motivations over time has not yet been completed.

What appears to be the case is that some individuals work toward finding a fit for their helping and service goals in engineering. Many engineers (40%) had worked in jobs where they were not particularly satisfied with their ability to help others. Creating a profession that allows for better alignment between career work and an ability to help is important and this change must be facilitated by both employees and employers alike. Employers should work to ensure that engineers recognize the societal benefits of their engineering work. Employers can also provide employees with opportunities to engage in helpful activities such as pro bono work, paid time off to participate in service with groups such as EWB-USA, or time to participate in community service of their choosing such as outreach to K-12 schools (Rulifson et al. 2015). Providing these opportunities may help engineers to feel more satisfied about their jobs, thereby increasing retention at the job itself and within the engineering profession as a whole.

**References**

Alpay, B., A.L. Ahearn, R.H. Graham, and A.M.J. Bull. 2008. “Student enthusiasm for engineering: charting changes in student aspirations and motivation.” *European Journal of Engineering Education* 33 (5-6): 573-585.

Amadei, B., R. Sandekian, and E. Thomas, E. 2009. “A model for sustainable humanitarian engineering projects.” *Sustainability* 1: 1087-1105. doi:10.3390/su1041087.

Andersen, L.B., and A.M. Kjeldsen. 2013. “Public service motivation, user orientation, and job satisfaction: a question of employment sector.” *Int. Public Management Journal* 16 (2): 252-274. doi: 10.1080/10967494.2013.817253.

Bielefeldt, A.R., and N.E. Canney. 2016. “Humanitarian aspirations of engineering students: differences between disciplines and institutions.” *J. Humanitarian Engineering* 4 (1): 8-17.

BLS – Bureau of Labor Statistics. 2015. Occupational Outlook Handbook. Civil Engineers. How to Become a Civil Engineer. Published Dec. 17, 2015. Accessed Oct. 11, 2016. <http://www.bls.gov/ooh/architecture-and-engineering/civil-engineers.htm#tab-4>

Buse, K., D. Bilimoria, D., and S. Perelli. 2013. “Why they stay: women persisting in US engineering careers.” *Career Development International* 18(2): 139-154.

Bystydzienski, J.M., and A. Brown. 2012. “‘I just want to help people’: Young women’s gendered engagement with engineering.” *Feminist Formations* 24(3): 1-21.

Canney, N. 2016. “Shaping future engineers through service learning in engineering education.” In *Engineering Professionalism – Engineering Practices in Work and Education*, edited by S. Brodersen, S. and U. Jørgensen, 125-144. Rotterdam: Sense Publishers.

Canney, N., and A.R. Bielefeldt. 2015a. “Gender differences in the social responsibility attitudes of engineering students and how these beliefs change over time.” *Journal of Women & Minorities in Science and Engineering* 21 (3): 215-237.

Canney, N., and A.R. Bielefeldt. 2015b. “Differences in engineering students’ views of social responsibility between disciplines.” *Journal of Professional Issues in Engineering Education and Practice* 141(4). doi: 10.1061/(ASCE)EI.1943-5541.0000248, 04015004.

Canney, N., and A. Bielefeldt. 2016. “Validity and reliability evidence for the Engineering Professional Responsibility Assessment tool to measure social responsibility in students.” *Journal of Engineering Education* 105 (3): 452-477.

Cech, E.A. 2014. “Culture of disengagement in engineering education?” *Science, Technology, & Human Values* 39(1): 42-72.

Cortese, C.G., P. Gatti, and C. Ghislieri. 2014. “Job demands, meaningful work, and turnover intentions among nurses.” *La Medicina del Lavoro* 105 (1): 37-47.

Dalecki, M.G., J.C Whitehead, and G.C. Blomquist. 1993. “Sample non-response bias and aggregate benefits in contingent valuation: An examination of early, late, and non-respondents.” *Journal of Environmental Management* 38: 133-143.

Denissen, J.J.A., H. Ulferts, O. Ludtke, P.M. Muck, D. Gerstorf. 2014. “Longitudinal transactions between personality and occupational roles: A large and heterogeneous study of job beginners, stayers, and changers. *Developmental Psychology* 50 (7): 1931-1942. doi: 10.1037/a0036994.

Donohue, R. 2006. “Person-environment congruence in relation to career change and career persistence.” *Journal of Vocational Behavior* 68 (3): 504-515. doi: 10.1016/j.jvb.2005.11.002.

EPICS. 2017. EPICS University Consortium – Intuitions. Accessed Nov. 24, 2017. <https://engineering.purdue.edu/EPICS/university/institutions>

Fairlie, P. 2011. “Meaningful work, employee engagement, and other key employee outcomes: Implications for human resource development.” *Advances in Developing Human Resources* 13 (4): 508-525.

Fouad, N.A., and R. Singh. 2011. *Stemming the Tide: Why Women Leave Engineering*. NSF and University of Wisconsin Milwaukee, 64 pp.

Fouad, N.A., R. Singh, K. Cappaert, W-H. Chang, and M. Wan. 2016. “Comparison of women engineers who persist in or depart from engineering.” *Journal of Vocational Behavior* 92: 79-93. doi: 10.1016/j.jvb.2015.11.002.

Frueh, S. 2014. *Career choices of female engineers: a summary of a workshop*. Committee on Career Outcomes of Female Engineering Bachelor’s degree Recipients, National Academy of Engineering, National Academies Press, Washington DC. 103 pp.

Glass, J.L., S. Sassler, Y. Levitte, and K.M. Michelmore. 2013. “What’s so special about STEM? A comparison of women’s retention in STEM and professional occupations.” *Social Forces* 92 (2): 723-756. doi: 10.1093/sf/sot092.

Glavas, A., and K. Kelley. 2014. “The effects of perceived corporate social responsibility on employee attitudes.” *Business Ethics Quarterly* 24 (2): 165-202.

Grosemans,I., L. Coertjens, and E. Kyndt. 2017. “Exploring learning and fit in the transition from higher education to the labour market: A systematic review.” *Educational Research Review* 21: 67-84.

Hewlett, S.A., C.B. Luce, L.J. Servon, L. Sherbin, P. Shiller, E. Sosnovich, and K. Sumberg. 2008. *The Athena Factor: Reversing the Brain Drain in Science, Engineering, and Technology.* Cambridge, MA: Harvard Business School Publishing Corporation. 109 pp.

Hudson, S., D. Bryson, and M. Michelotti. 2017. “Individuals’ assessment of corporate social performance, person-organization values and goals fit, job satisfaction and turnover intentions.” *Industrial Relations*, 72 (2): 322-344.

Huerkamp, M.J. 2006. “Job dynamics of veterinary professionals in an academic research institution: I. Retention and turnover of veterinary technicians.” *Journal of the American Association for Laboratory Animal Science* 45 (5): 16-25.

Im, S., Y.W. Chung, and J.Y. Yang. 2017. “Employees’ participation in corporate social responsibility and organizational outcomes: the moderating role of person-CSR fit.” *Sustainability* 9 (28), 14 pp. doi: 10.3390/su9010028.

IJSLE – International Journal for Service Learning in Engineering. 2014. *Special Issue: University Engineering Programs that Impact Communities: Critical Analyses and Reflection*. Special edition Fall, 562 pp.

Janik, M., and S. Rothmann. 2015. “Meaningful work and secondary school teachers’ intention to leave.” *South African Journal of Education* 35 (2): Art. #1008, 13 pp. doi: 10.15700/saje.v35n2a1008.

Litchfield, K., and A. Javernick-Will. 2014. “Investigating gains from EWB-USA involvement.” *Journal of Professional Issues in Engineering Education and Practice* 140 (1). doi: 10.1061/(ASCE)EI.1943-5541.0000181, 04013008.

Liu, B., X. Zhang, L. Du, and Q. Hu. 2015. “Validating the construct of public service motivation in for-profit organizations: a preliminary study.” *Public Management Review* 17 (2): 262-287, doi: 10.1080/14719037.2013.798023.

Liu, B., T. L-P. Tang, and K. Yang. 2015. “When does public service motivation fuel the job satisfaction fire? The joint moderation of person-organization fit and needs-supplies fit.” *Public Management Review* 17 (6): 876-900. doi: 10.1080/14719037.2013.867068.

Lo, J. 2015. “The information technology workforce: A review and assessment of voluntary turnover research.” *Inf. Syst. Front*. 17: 387-411.

Meyers, K., and B. Mertz. 2011. “A large scale analysis of first-year engineering student essays on engineering interests.” *American Society for Engineering Education 2011 Annual Conference & Exposition Proceedings*, San Antonio, TX: ASEE. 16 pp.

Miller, J.G., and K.G. Wheeler. 1992. “Unraveling the mysteries of gender differences in intentions to leave the organization.” *Journal of Organizational Behavior* 13 (5): 465-478.

Redmond, B.F. 2015. Chapter 11 – Job Satisfaction. In: PSYCH 484: Work Attitudes and Job Motivation. Pennsylvania State University. Last modified on Nov. 9, 2015. Accessed March 10, 2016. <https://wikispaces.psu.edu/display/PSYCH484/11.+Job+Satisfaction#id-11.JobSatisfaction-VariablesofJobSatisfaction/Dissatisfaction>

Rulifson, G., N. Canney, and A. Bielefeldt. 2015. “Service-motivated students’ transitions to industry.” *American Society for Engineering Education 122nd Annual Conference & Exposition Proceedings*. Paper ID #13612. 10pp. Seattle, WA: ASEE.

Sax, L.J., S.K. Gilmartin, and A.N. Bryant. 2003. “Assessing response rates and nonresponse bias in web and paper surveys.” *Research in Higher Education* 44 (4): 409-432.

Scroggins, W.A. 2008. “The relationship between employee fit perceptions, job performance, and retention: Implications of perceived fit.” *Employee Responsibilities and Rights Journal* 20 (1): 57-71.

Smith, W.G. 2008. “Does gender influence online survey participation? A record-linkage analysis of university faculty online survey response behavior.” ERIC. 21 pp. Accessed Dec. 7, 2017. <https://files.eric.ed.gov/fulltext/ED501717.pdf>

Wang, W., Y. Fy, H. Qiu, J.H. Moore, and Z. Wang. 2017. “Corporate social responsibility and employee outcomes: a moderated mediation model of organization identification and moral identity.” *Frontiers in Psychology* 8: article 1906, 14 pp. doi: 10.3389/fpsyg.2017.01906.

Young, G.D., D.B. Knight, L.M. Warburton, and C.D. Ciechon. 2016. “Developing student-centered partnerships: Professional socialization and the transition to industry.” *American Society for Engineering Education 123rd Annual Conference & Exposition Proceedings*. Paper ID #15418. 14 pp. New Orleans, LA: ASEE.

Zoltowski, C.B., and W.C. Oakes. 2014. “Learning by doing: reflections of the EPICS program.” *International Journal for Service Learning in Engineering*, special edition fall, 1-32.