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Perspectives of Engineers on Ethical Dilemmas in the Workplace

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Abstract
The research questions explored in this study were: To what extent do engineers feel that they are confronted with ethical dilemmas at work? Did ethical dilemmas contribute to changing jobs or careers? Did these issues vary between types of engineering jobs, engineering disciplines, or gender? Survey responses were received from 504 individuals and represented 719 different jobs. For 31% of the jobs, individuals indicated that they never felt that they had been confronted with an ethical or moral dilemma regarding how their work impacted people, society, and/or the environment. This may truly reflect a lack of these circumstances, or may indicate that some individuals are not adept at recognizing such issues. For 34% of the jobs, ethical/moral dilemmas were encountered infrequently and were not of significant personal concern, compared to ethical/moral dilemmas encountered infrequently but of significant personal concern in 16% of the cases. Smaller percentages of the jobs were reported to have frequent ethical dilemmas that were and were not of significant personal concern; 9% and 8%, respectively. Finally, 2% indicated that the moral/ethical dilemma was the primary reason that they had left their job. These cases might reflect that the individual was in *moral distress*, feeling powerless to pursue what they believed to be an ethical course of action. The frequency and degree of concern of ethical dilemmas encountered varied between job sectors and engineering disciplines, but not by gender. Informing students about the likelihood of encountering ethical dilemmas might better prepare them for these challenges.

Background
Engineering ethics in the workplace are of critical importance. Recently the news has been rife with examples of engineering problems and failures – faulty airbags[1,2], the Volkswagen emissions "defeat device" to evade environmental regulations[3], construction of a new Veterans Affairs Hospital in Colorado wildly mismanaged[4], issues with the new San Francisco-Oakland Bay Bridge[5], the Deepwater Horizon oil spill[6], the Hurricane Katrina disaster in New Orleans[7]. These cases all include elements related to engineering ethical issues. It is unclear that the engineers in these cases had sufficient education to prepare them to act for the best interest of society and the environment. One engineering educator has noted:

> A traditional education does little to prepare you for morally courageous action… our obligation as individuals to speak out and correct wrong-doing and injustices… We've created an entire class of people to whom we outsource the need to speak out… [but] if you are part of that team, however small and unsuspecting your role, and you have a conscience, you bear partial responsibility for that outcome. With increasing specialization and complexity, the only truly effective police are those that have the expertise and those that are working on the inside…. You can't legislate morality. (Marc Edwards[8])

Professionally licensed engineers in the U.S. are bound by a Code of Ethics, and can lose their license to practice engineering for ethical violations. However, a significant percentage of engineers do not become professionally licensed. Regardless, students graduating from ABET-accredited engineering, engineering technology and computing programs must have an understanding of professional and ethical issues.[9-11] But the depth and breadth of this knowledge is poorly defined, proper assessment is difficult, and most assessments focus predominately on

microethical issues. Macroethical issues such as social responsibility, the impact of engineering on society, and aspirational ethics to promote human well-being are also important.[12-15] Furthermore, there can be a disconnect between 'understanding' and 'action', highlighted by the American Society of Civil Engineers: "programs could have students achieve an "understanding" of [ethics]… through seminars or lectures. Seminars or lectures may be ineffective in addressing ethical decision-making and, more importantly, influencing ethical and professional behavior. In fact, professional engineers themselves have reported their ethics education as undergraduates did little to prepare them for the ethical realities they face in their profession."[16, p. 25-26]

There is limited information on the extent to which engineers feel that they encounter ethical dilemmas in the workplace. In a 1997 survey of 100 practicing engineers, 70% of the individuals indicated that yes, they had been faced with an ethical issue in the course of their engineering practice.[17] In addition, 19.2% indicated that an employer had done something to try to deter them from acting in alignment with their perceived ethical and social responsibility (or to penalize them after they acted). In contrast, 34% indicated they had been encouraged to act as obligated on ethical or social responsibility grounds. It is unclear if the practicing engineers who participated in this study considered both microethical and macroethical issues when responding.

In a study by Harding et al.[18] of engineering students with work experience, the unethical context most frequently noted as temptations in the workplace were improper use of company resources, followed by falsifying records, ignoring product quality problems, and lying about work quality. Less than 20% of the students noted being tempted to ignore safety problems, accept improper gifts from vendors, or take credit for others' work. These issues all seem to be primarily microethical concerns. The cited reasons for being tempted toward unethical workplace behavior were most often associated with the notion that "everyone does it", followed by "I wanted to seem better than I was" and "someone told me to do it".[p. 10]

Annual surveys were conducted at a large public university in 2012 to 2014 of alumni who had graduated with their engineering bachelor's degree 3 to 5 years prior. As one among many questions on a long survey, individuals were asked how often they were faced with ethical or moral decisions in their line of work. The responses from the 222 alumni were: 45% rarely, 23% monthly, 17% weekly, and 15% daily (unpublished data). It is unclear if alumni interpreted this question to include both microethical issues and societal impact concerns. There appeared to be weak differences between majors, with the highest frequency of ethical or moral issues among civil and chemical engineering majors (average 2.3-2.4, between monthly and weekly); moderate among environmental, aerospace, architectural, and mechanical engineering alumni (average 2.0-2.1, approximately monthly); and lowest among electrical and computer engineers (average 1.7, between rarely and monthly). In addition, 21% of the alumni indicated that their undergraduate experience did not at all/not very well prepare them to recognize and deal with unethical behavior.

One might expect that different engineering disciplines and sectors are more likely to encounter various ethical dilemmas. For example, bioethics relates primarily to biomedical engineering. Tow and Loosemore[19] noted that the construction industry has been branded "more corrupt than any other sector of the international economy."[p. 122] The issues identified included extrinsic reward of unethical behavior, competition, unrealistic profit goals, ignoring conflicts of interest,

and an absence of reward systems for those who act ethically. In a similar study of ethics in the construction industry[20], it was noted that "all respondents had witnessed or experienced some degree of unethical conduct, in the form of unfair conduct, negligence, conflict of interest, collusive tendering, fraud, confidentiality and propriety breach, bribery and violation of environmental ethics."[p. 117] Disciplines such as civil and architectural engineering are more likely to interact with the construction industry than other branches of engineering, potentially increasing their temptations for unethical behavior.

A focus on workplace ethics is not unique to engineering. Kaas[21] discusses the importance of using the affective domain of Bloom's taxonomy for designing ethics instruction for accounting students, in contrast to the approach currently used which tends to focus on microethical issues. In medicine some have bemoaned the "lack of adequate schooling in the values, ethics, and culture of caring."[22, p. 321] Studies in nursing have determined that *moral distress* can cause nurses to leave their jobs and/or the profession.[23-24] Moral distress was characterized as a condition where one felt that they were powerless to pursue what they perceived to be an ethically correct action. Moral distress has also been identified in all types of healthcare professions[23] and veterinary students.[25] Gender differences in moral distress among critical care nurses were found.[26]

No previous studies on moral distress among engineers were identified, but this idea could be relevant. As more students are attracted to engineering with goals of helping others, as embodied in messages from *Changing the Conversation*[27] and service activities such as Engineers Without Borders (EWB), it is important to determine if these individuals find a place for their values within the engineering profession. A specific impetus for this research grew out of a series of interviews with 19 alumni of engineering service programs; these interviews were conducted in spring 2013 (unpublished). Two interviewees noted ethical dilemmas that confronted them as environmental/civil engineers working in consulting. In one case, the ethical dilemmas caused him to leave engineering entirely for a career in family therapy. This quote from his interview illustrates the issue:

> …there's a fundamental incompatibility that's being for profit and being for the public good… and so there were a few situations where I was asked to do things that I thought were unethical, and I kind of asked around to other people in the field who had been in similar situations where, like, the major client would say like, 'Oh, we don't think that these laws are accurate. Can you go back and, like, make these changes or...' …or one of my project managers actually he told me to kind of bury some of the findings that we came up with in text rather than (making it a clear) summary with a diagram and a... a table because, as he put it, the people at the EPA are lazy, and they won't read through the text but if they see these numbers so clearly in the...in the diagram and in the...in the summary like this then they're gonna get worried and that's gonna be a problem for our client and those kind of things that seem like clearly, clearly that's unethical. Yeah, and I had a hard time with that, so I did end up leaving [engineering] after a couple of years…

This appears to be an example of moral distress that led to career change. The frequency that moral distress leading to job or career change occurs among practicing engineers is unclear.

Another engineer who was working as an environmental/civil consultant noted tensions between the business-side of engineering and ethically doing his best work:

> ...I guess you always know that corporations make decisions based on the bottom line, right? I mean, that's number one. They may say things differently, but, you know, in the end that's...they all have to reply that they're...to act according to their stock broker's wishes… and you have to take that into consideration when you're spending your client's money and...because it does influence their bottom line and it does...you know, if all things were great and ethics were the only thing you thought about...yeah man, punch that place full of holes and do it in an environmentally sensitive way that you get the information you need …but ethics plays into that, you know? And it's very closely tied to the economic….

Despite recognizing ethical issues, this engineer did not appear to find them particularly worrisome.

In summary, the previous research on ethics in engineering work settings has been limited and leaves a number of unanswered questions.

Research Questions

The goal of this research was to explore engineers' perceptions of the extent to which they felt they had been confronted with ethical dilemmas in their work, including situations that encompass macroethical issues. The specific research questions explored were:

RQ1. To what extent do working engineers feel that they are confronted with ethical dilemmas at work?

- 1a. Does this vary between types of engineering jobs?
- 1b. Does this vary between different disciplines?
- 1c. Does this vary by gender?

RQ2: Do engineers report that ethical dilemmas were a reason that they had changed their jobs?

RQ3. Are there any relationships between the perceptions of ethical dilemmas at work and one's attitudes toward professional social responsibility?

Methods

Through an exploratory mixed methods design, an online survey focused on social responsibility was developed from the results of 19 interviews with individuals who had been active in engineering service programs during college. The survey was developed in Qualtrics. The survey began with an informed consent statement that was approved by the University of Colorado Boulder institutional review board for human subjects research (protocol #11-0414). For those who consented to participate, the survey then asked a series of questions about the job where they were most satisfied with their ability to engage in service or to help people/society (or their only job after college), as well as the job where they were they were the least satisfied with their ability to engage in service or to help people / society. Individuals were asked "While working at this job, did you ever feel that you were confronted with an ethical or moral dilemma regarding how your work impacted people, society, and/or the environment?" This language was intentionally selected with the goal to activate thoughts of both microethical and macroethical issues. A question also asked to what degree ethical issues factored into their decision to leave their job. There were also 12 items to assess attitudes toward professional social responsibility, selected from among the fifty Likert-items on the Engineering Professional Responsibility

Assessment (EPRA) survey.[28] The selected items focused in the professional connectedness (6 items), costs/benefits (3 items), and analyze dimensions (3 items) of the Professional Social Responsibility Development Model (PSRDM).[29] The survey ended with demographic items including discipline(s) of their undergraduate and graduate degrees, and gender. The precise survey questions relevant to the current study are provided in the Appendix.

An email invitation to participate in the survey was distributed to seven groups in March and April of 2015 (Table 1). For Groups 1, 2 and 3 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 survey invitation email additionally stated "you have been included in the study because you did or are involved in some form of engineering service". Two reminder emails were sent to each group; the survey remained open for each group for one month. Groups 1 and 2 had previously participated in a large social responsibility study when they were seniors or graduate students majoring in mechanical engineering (ME), civil engineering (CE), environmental engineering (EnvE), or other engineering majors. Groups 3 to 6 were additional respondents from among the alumni at the institutions from Group 1. Finally, Engineers Without Borders-USA (EWB-USA) sent out an email invitation to their professional members; this could encompass individuals at all career stages from any number of backgrounds.

Table 1. Survey Response Rates from Engineers

Survey Distribution Group Number and Description	N emails delivered	N completed ethics question	N completed >90% of survey	% response rate	Early-Late Chi-test sig.
1. Alumni who were seniors or graduate students majoring in ME, CE, or EnvE at four institutions in Aug. 2012	663	148	135	22	0.79
2. Alumni who were seniors majoring in engineering at 16 institutions in April 2014	570	103*	91	18	0.70
3. Alumni who were EnvE majors at a large public institution and graduated between 2000-2011	57	24	23	42	0.71
4. Alumni from a large public institution who were active in EWB-type programs between 2001 and 2010	235	52	53	22	0.97
5. Alumni who graduated in CE and EnvE in 2008-2014 from a program at a medium public institution with required engineering SL courses	125	27	26	22	0.24
6. Alumni from technical public institution who were active in EWB-type programs	Open invite	11	11	N/A	N/A[+]
7. EWB-USA professionals	Unknown of 1728	139	126	8*	0.15
TOTAL	3425	504	465	15*	

* estimated; [+] n too small to conduct chi-square test

The response rates in Table 1 were calculated as a percentage of those who completed the first ethics question on the survey out of the number of delivered emails. However, individuals may have chosen not to complete various individual questions, and in particular may not have supplied the demographic information at the end of the survey. Response rates were highly variable between the groups, with a maximum of 42% from Group 3, the majority of the groups near 20%, and the EWB-USA professional members (Group 7) at only 8%. As a method to determine whether nonresponse bias might be a significant concern, the categories of the first ethics response from the "early" respondents within a group (those who responded within 4 days of the first email invitation) were compared to the "late" respondents from the same group (those who responded after the first reminder email until the survey was closed).[30,31] The results from the chi-square tests to compare the early and late groups are shown in Table 1. The results for all groups did not find significant differences between the early and late responders, so it is unlikely that nonresponse bias was significant.

As shown in Table 1, the majority of the responses (~50%) were fairly recent alumni of engineering programs at 16 institutions (Groups 1 and 2). Individuals in Groups 1 and 2 had completed previous social responsibility surveys as seniors or graduate students; email matching was used to populate any demographic information that was missing from the career survey. Across Groups 1 to 6, the representation of different institution types among the respondents are summarized in Table 2. Nearly half of all respondents were alumni from a single large public institution. A large number of responses were also acquired from alumni of medium public institutions. Among the respondents as a whole, all sizes (student enrollment small <5000, medium 5000-15,000, large >15,000) and many types of institutions were represented, including seven of the eight U.S. Carnegie geographic regions.

Table 2. Institutional Information representing the alumni respondents

Survey Groups	# institutions	Size	Control	Carnegie Classification[32]	Geographic region(s)	% responses
1, 2, 3, 4	1	Large	Public	RU/VH	Rocky Mountains	49
1, 2, 6	1	Medium	Public	RU/H	Great Lakes	17
1, 2, 5	1	Medium	Public	RU/H	New England	10
1, 2	3	Medium and Large	Private	RU/VH	New England, Southwest, Far West	8
2	3	Large	Public	Master's	Rocky Mountains, Far West, Southeast	7
2 (religiously affiliated)	5	Small and Medium	Private	Bac, MS, DRU	Southeast, Plains, Far West	5
2	2	Large	Public	RU/VH, H	Plains, Far West	4

The demographics of the respondents in the different groups are presented in Table 3. The majority of the individuals (55%) had earned their bachelor's degree within the five years prior to the survey, and likely represent junior engineers and engineers-in-training. The sample was over-represented in women (40%), compared to the estimated 11% women among practicing engineers.[33] Higher survey response rates for women than men are commonly found. In addition, survey Groups 5, 6 and 7 were/are service-active and these groups are known to have

approximate gender parity. For example, women comprise 40% of the professional members of EWB-USA.[34]

Table 3. Demographics of Survey Respondents

Group	Undergraduate degree earned by year, %				% female	% degree in			% with graduate degree(s)
	Before 1999	2000-04	2005-09	2010-14		ME+	CE+	EnvE	
1	1	5	18	76	39	43	36	23	64
2	0	0	2	97	43	39	23	5	16
3	0	40	23	37	37	0	23	100	30
4	0	0	35	65	38	0	96	23	15
5	14	6	49	31	51	18	56	38	85
6	10	10	10	70	36	10	40	60	55
7	54	8	20	18	32	14	53	17	54
All	**16**	**8**	**21**	**55**	**40**	**28**	**40**	**24**	**50**

Given the large number of different engineering degree disciplines that were reported by survey respondents, two clusters of similar degrees were created to aid analysis: ME+ included aerospace and mechanical engineering; CE+ included civil, construction, and architectural. A number of individuals had degrees in multiple areas, which is not surprising given that half of all of the individuals possessed both undergraduate and graduate degrees. Particularly common was an overlap between environmental and civil engineering; 51 people reported having both of these degrees.

The survey results were exported into a spreadsheet. Basic statistical tests such as a chi-squared tests were conducted in Excel. More sophisticated statistical analysis, such as the non-parametric Kruskal-Wallis test and correlation analyses were conducted in IBM SPSS Statistics version 23. Significant differences were inferred when p values were below 0.05 (sig. <0.05), values of 0.05-0.10 were indicative of potential differences.

Results and Discussion

Perception of ethical dilemmas at work

First, the extent that working engineers felt that they were confronted with ethical dilemmas at work was explored. Individuals had the opportunity to respond to the following question, and select as many answers as were appropriate: "While working at this job, did you ever feel that you were confronted with an ethical or moral dilemma regarding how your work impacted people, society, and/or the environment?" There were 269 individuals who provided a response to this question based on their only job after college, 235 responded for their most satisfying job with respect to helping others, and 215 individuals also responded for their least satisfying job with respect to helping others.

Results are shown in Figure 1. Ninety-seven percent of the individuals selected a single option among the ethical dilemmas choices. There was a significant difference in the percentage distributions for the type and frequency of encountering moral or ethical dilemmas between the only jobs, most satisfying jobs, and least satisfying jobs (chi-squared p <0.001). Most individuals indicated that they infrequently encountered an ethical or moral dilemma at work and it was not of significant personal concern (34%); a similar percentage reported having never encountered a

moral or ethical dilemmas at work on these jobs (31%). A smaller percentage (18%) indicated that they frequently encountered ethical or moral dilemmas at work; for about half of these the dilemmas were of significant personal concern. For their least satisfying job, 7% (15 people) indicated that the moral/ethical dilemma was the primary reason they had left the job; this response was not given by anyone in relation to their most satisfying job with respect to helping people and/or society or for their only job.

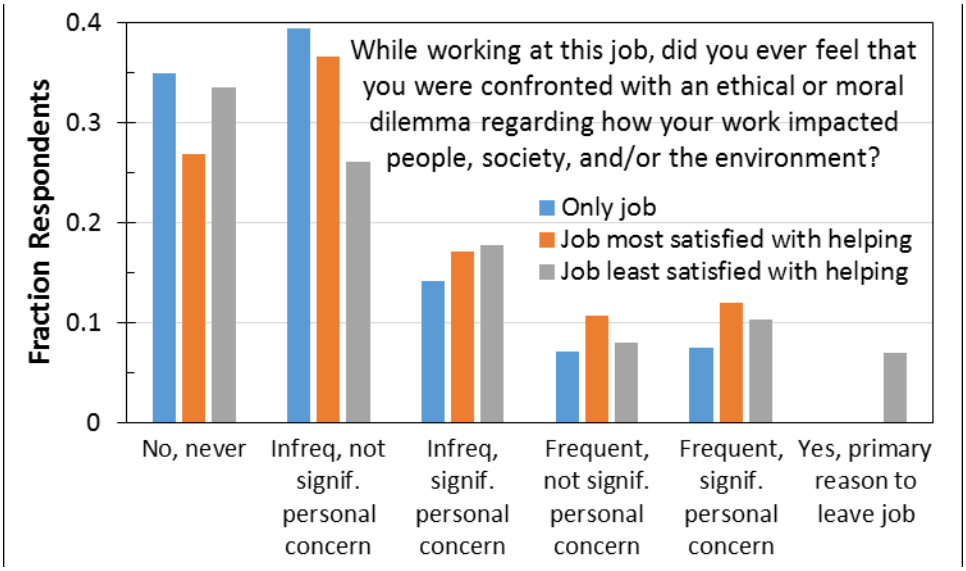

Figure 1. Responses related to being confronted with ethical or moral dilemmas

Exploring the individuals who described both a most and a least satisfying job, 59% had different ethical ratings for the two jobs. These ratings were, however, correlated (Pearson correlation coefficient 0.211; 2-tailed sig. 0.003). This result seems to imply that both the job characteristics and individual characteristics determined if a person perceived ethical dilemmas at their job. Among the 41% of the people who rated both jobs with the same ethical dilemma category, 36% indicated that in both jobs they were never confronted with a moral or ethical dilemma. This may be due to a lack of perceiving some situations as posing ethical dilemmas, while others might have characterized the same situations differently. This idea is reflected in the Pittsburgh-Mines Engineering Ethics Assessment Rubric, where the attribute "recognition of dilemma" has a level 1 where an individual does not perceive an ethical problem and a level 4 where an individual has an ability to recognize less obvious ethical dilemmas.[35]

The perception of encountering ethical dilemmas at work varied among engineering job types (Figure 2; sig. 0.000). No ethical dilemmas were reported most frequently in association with engineering research and non-engineering jobs. The explanations for working in these non-engineering jobs varied widely, including "Forced to find second career after being laid off from the petroleum industry in 1980's" to "I have never worked professionally as an engineer, though my technical background has been valuable in many other positions." The highest frequency of encountering ethical dilemmas were cited by those working for non-governmental organizations (NGOs) or non-profits. This is particularly interesting given that individuals who are motivated for public good are more likely to select an NGO for a job (as indicated by individuals working for NGOs having the highest average overall social responsibility scores as compared to the

other job sectors in this survey). Therefore, these individuals might also be particularly attuned to moral or ethical dilemmas, particularly those of a macroethical nature such as social justice. Further, many of these situations might include work in international settings (such as EWB-USA). Differences in cultural norms may lead to ethical and moral dilemmas. This may include aspects such as "facilitation payments" (aka. bribes) that are common in some settings.[36] Note that the job types were not equally represented; the majority of the jobs were in consulting/industry (47%), followed by the public sector (13%), non-engineering (8%), engineering research (8%), academia (8%), and NGOs/non-profits (8%).

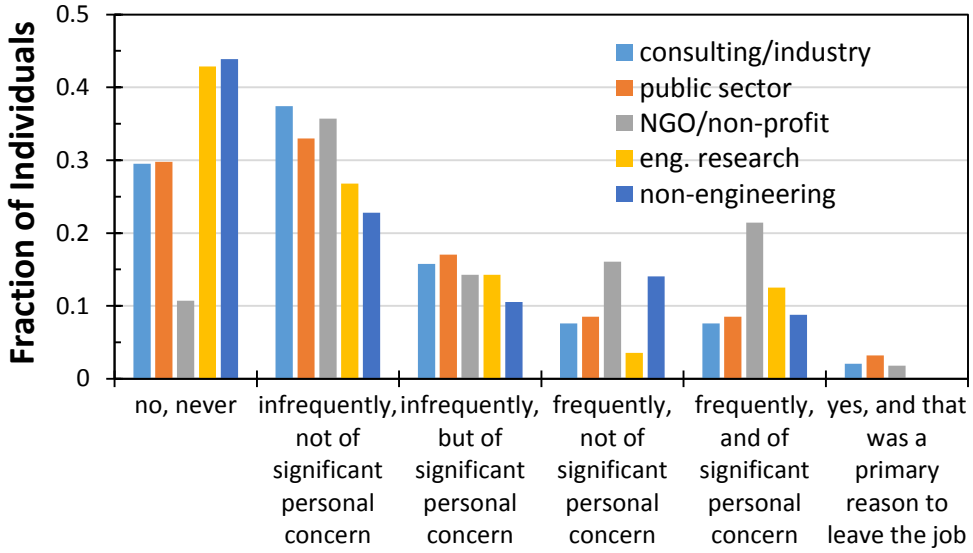

Figure 2. Job sectors and the perceived frequency/concern about encountering moral/ethical dilemmas on the job

The perception of confronting ethical dilemmas and personal concern resulting from it varied among different college engineering majors (sig. 0.04). As shown in Figure 3, graduates with electrical and computer engineering (ECE) degrees had the highest percentage of individuals who did not perceive that they had been confronted with an ethical or moral dilemma on the job; environmental engineering graduates had the lowest percentage of individuals with this belief.

There were not significant differences between engineering majors in the frequency that individuals perceived encountering ethical dilemmas (sig. 0.14). Between 41-45% of those with degrees in chemical engineering, ECE, environmental, and ME+ reported infrequently encountering ethical dilemmas at work, compared to 53% of those with CE+ degrees. A frequent perception of encountering ethical dilemmas at work was reported by 25% of those with environmental engineering degrees, compared to 17-19% of ME+ and CE+ degree holders, and 9% of those with ECE and chemical engineering degrees. While these percentages appear very different, the low numbers of individuals representing some degree types likely prevented the differences from being statistically significant.

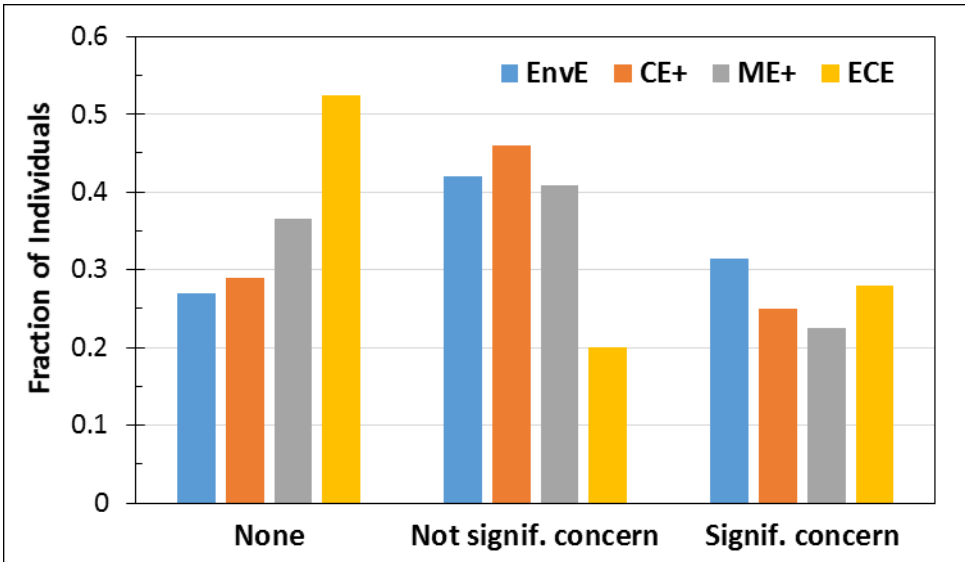

Figure 3. Different levels of perception and concern for encountering moral/ethical dilemmas at work among those with degrees in different engineering disciplines

The perception of encountering ethical dilemmas at work was not significantly different between genders (chi-squared test sig. 0.07; Kruskal-Wallis test sig. 0.296). For example, 34% of the males and 27% of the females indicated that they had never encountered a moral or ethical dilemma in the course of their work.

Changing jobs due to ethical dilemmas

The very small number of individuals (n=15) who reported changing jobs due to ethical concerns were explored in more detail. All of these job changes were associated with the job the individual had characterized as the least satisfying with respect to service and/or helping people/society. The characteristics of these individuals who changed jobs due to ethical issues as compared to all of the individuals who reported a least satisfying job are summarized in Table 4. The low numbers prevented appropriate application of statistical chi-squared tests, and therefore statistical differences should not be inferred. The job types most commonly associated with a change due to ethical dilemmas were consulting/industry (53%) and public sector (27%); there were similar proportions of these job types among all 215 individuals who reported a least satisfying job. The median amount of time that individuals remained at the job that they left due to ethical dilemmas was 1 to 3 years; by comparison, 26% of the engineers were still working at the job that they characterized as least satisfying. Most of the individuals who left a job due to ethical issues held degrees in civil and/or environmental engineering. A higher percentage of aerospace and environmental engineers and fewer mechanical engineers left the job due to ethical dilemmas, compared to the overall data set. There was not a difference in tendency to leave based on gender. All 15 individuals also reported encountering ethical dilemmas at their 'most satisfying' job; these individuals may have been more discerning in viewing situations through an ethical lens. There were no obvious categorical differences evident in the types of individuals or jobs that were left due to ethical dilemmas.

Table 4. Characteristics of Individuals Who Left Jobs due to ethical issues compared to all individuals who described a least satisfying job

Item	Attribute	15 who left job due to ethics, % (n)	All least satisfying jobs, %
Job type left	Consulting engineer or working for private industry	53 (8)	56
	Engineering in the public sector	27 (4)	13
	NGO / non-profit related to engineering	7 (1)	2
	Other	7 (1)	6
	Self-employed engineer	7 (1)	4
Length of time at job	Less than 3 months	7 (1)	5
	3 – 12 months	20 (3)	22
	1-3 years	47 (7)	28
	3-5 years	7 (1)	8
	>5 years	20 (3)	11
Degrees	Aerospace	13 (2)	3
	Chemical	7 (1)	2
	Civil	47 (7)	49
	Environmental	33 (5)	23
	Mechanical	7 (1)	19
	Electrical and/or Computer	0 (0)	3
Graduate degrees?	yes	60 (9)	61
Gender	Male	67 (10)	61
	Female	33 (5)	36
Other "more satisfying" job ethical dilemma category	No, never	7 (1)	25
	Infrequently, not of significant personal concern	40 (6)	35
	Infrequently, of significant personal concern	13 (2)	17
	Frequently, not of significant personal concern	13 (2)	10
	Frequently, of significant personal concern	27 (4)	13
Other "more satisfying" job sector	Consulting engineer or working for private industry	33 (5)	34
	Engineering in the public sector	27 (4)	12
	NGO / non-profit related to engineering	7 (1)	15
	Other	7 (1)	4
	Self-employed engineer	7 (1)	3
	Academia / education related to engineering	7 (1)	12
	Non-engineering (lawyer, family therapist)	13 (2)	11

Ethical dilemma perceptions and social responsibility attitudes

Potential relationships between individuals' social responsibility attitudes and their perception of ethical dilemmas were explored. For each individual, the "worst" situation for ethical dilemmas at work was identified. For example, if an individual characterized one job as never encountering an ethical dilemma but their other job as infrequently encountering an ethical dilemma of significant personal concern, the second categorization was associated with the individual. Then the average social responsibility scores were calculated for individuals in each category of "worst" ethical situation. Results are shown in Table 5. SR12 reflects the average across the 12

7-point Likert-items used to measure social responsibility (SR). The individuals who reported never encountering ethical dilemmas at work or encountering them infrequently and not finding them of significant personal concern had the lowest SR12 scores. The SR12 scores increased for individuals who perceived ethical dilemmas more frequently and/or perceived them as more serious. There were weak positive correlations between attitudes toward professional social responsibility (SR12) and the perception of being confronted with unethical situations. These correlations were the strongest with the six items that measured the professional connectedness dimension (PC6) of the PSRDM. Professional connectedness represents an individual's sense of moral obligation to help others due to the professional skills that they possess. There was nearly a full Likert-point difference in the average PC6 scores of individuals who indicated that they had left their job due to ethical issues as compared to those who never encountered ethical dilemmas at work or encountered ethical issues infrequently that were not of significant personal concern.

Table 5. Average Scores on 7-point Likert scale for different perceptions of encountering various ethical dilemmas on the job.

Worst Ethical response	SR12	Analyze3	CB3	PC6
No, never	5.34	5.94	5.49	4.96
Infrequent, not significant personal concern (IF/NS)	5.35	5.86	5.62	4.97
Frequent, not significant personal concern (F/NS)	5.59	6.17	5.59	5.31
Infrequent, significant personal concern (IF/S)	5.70	6.05	5.81	5.46
Frequent, significant personal concern (F/S)	5.81	6.30	5.95	5.49
Left job due to ethical issues	5.94	6.42	5.67	5.82
*Pearson Correlation Coefficient**	*0.241*$^{.000}$	*0.169*$^{.000}$	*0.142*$^{.002}$	*0.247*$^{.000}$

* *2-tailed significance*

Interestingly, the frequency of perceiving ethical dilemmas was more related to higher analyze dimension scores (Analyze3) than the personal significance, as indicated by the inversion of the trend between the F/NS and IF/S categories. The analyze dimension represents the opinions that one should examine social issues from a professional perspective and include stakeholders in engineering decisions. An example of one of the items that was used to measure the analyze dimension was "It is important for engineers to consider the potential broader impacts of technical solutions to problems." It is logical that someone who believes this more strongly would be more likely to perceive an ethical dilemma related to how their work impacted people, society, and/or the environment as compared to an individual who felt that this was not important.

The weakest differences and correlations were in the cost/benefit dimension (CB3). These items reflect one's appreciation for trade-offs between engaging in behaviors that help others through work. Those with the highest CB scores were those who described significant personal concern upon encountering ethical dilemmas at work. One item from the survey that represents this dimension was "I would be willing to have a career that earns less money if I were serving society."

At the end of the survey, individuals were invited to share any comments about ethical or social responsibility ideas. Only 33 comments were written-in, and among those only 4 addressed issues directly related to ethics. These comments were:

> I worked soil and groundwater contamination and remediation projects - these were somewhat satisfying but my employer was unethical and I left the job after 6 months.
>
> I found the Engineering Consulting work that I did out of school to be highly unethical. This may have been my company culture, but several of my peers from different firms had similar experiences.
>
> More opportunity to influence business ethics, ethical sourcing, small business promotion etc.
>
> In consulting, I had the privilege of working at companies that took on clients and projects that we were comfortable with and therefore did not have to worry about ethical concerns.

The comments show that individuals had different experiences and opinions about their work in the consulting sector.

Summary and Conclusions

There were few engineers that appeared to have experienced moral distress. Less than 7% of the individuals in the survey indicated that they had left their least satisfying job due to ethical dilemmas. Among those, 13 located to other engineering jobs while two (13%) left engineering for other professions. Given this small number, there was no evidence of differential moral distress within a particular type of engineering job, engineering discipline, or gender. It is possible that this number is higher than might be typical for engineering, given that 63% of the respondents for a least satisfying job represented individuals in survey Groups 4, 5, 6 and 7 – all of whom had participated in engineering service programs in college or were currently active members of EWB-USA. These individuals might have greater aspirations to helping others through engineering, and as-such be less tolerant of perceived ethical dilemmas regarding how their work impacts people, society, and/or the environment. These groups also were most likely to represent respondents who had more work experience since they were not based on alumni who had recently completed a previous survey as students.

The study found differential self-reported frequency and personal concern over perceived ethical dilemmas on the job based on job sector. It is certainly possible that individuals on the survey may have interpreted the terms “frequently” and “infrequently” differently. Based on other studies, it appears that frequently is perhaps daily or weekly, while infrequently is closer monthly or a few times per year. Differences in personal concern but not frequency were found between different disciplines. No differences were found between genders.

The results point to an array of additional research questions. What types of moral and ethical dilemmas do individuals perceive? Do the types of ethical dilemmas vary between job sectors or in different disciplines of engineering work? This information could be helpful in order to discuss these issues during undergraduate and graduate education, so as to better prepare

engineers for the types of situations that they will encounter. It is also important to understand the sources of these pressures – do they originate from more senior engineers or from those outside the engineering profession? This information might open more dialogue across the engineering profession to encourage ethical behavior and reduce the ethical pressures that are being encountered. This approach has been taken in regards to global ethics.[37-38] A greater understanding of the ethical pressures faced by engineers is a good first step in determining how to improve the education of engineers to face these challenges.

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Appendix: Survey Questions Relevant to this Research

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)

Q2 The job where I was the most satisfied with my ability to engage in service or helping others would be best characterized as:

- ☐ Consulting engineer or working for private 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

If Non-engineering related or other selected, Q2a Briefly describe this job
If Non-engineering related selected, Q2b Briefly describe why you chose a job not closely related to engineering

Q7 While working at this job, did you ever feel that you were confronted with an ethical or moral dilemma regarding how your work impacted people, society, and/or the environment?

- ☐ No, never
- ☐ Infrequently, and not of significant personal concern
- ☐ Infrequently, but of significant personal concern
- ☐ Frequently, but not of significant personal concern
- ☐ Frequently, and of significant personal concern
- ☐ Yes, and that was a primary reason to leave the job

Q8 How long did you stay at this job?

☐ less than 3 months; ☐ 3-12 months; ☐ 1-3 years; ☐ 3-5 years; ☐ more than 5 yrs; ☐ this is my current job

If 'this is my current job' was not selected:

Q8a Was any of your motivation to leave this job due to dissatisfaction with the service aspects of the work?

- ☐ 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

Q9 I have only had one job after college, which I described above: ☐ Yes; ☐ No

If Q9 = NO: Think about the job after college where you were the LEAST satisfied with your ability to engage in service or to help people / society... (this could be your current job)

REPEAT Q2, Q7, Q8 above

Q17 Please indicate your level of agreement with the following statements. Scale:
Strongly disagree, 1; Disagree, 2; Slightly disagree, 3; Neutral, 4; Slightly agree, 5; Agree, 6; Strongly agree, 7

1. It is important to me personally to have a career that involves helping people
2. It is important for engineers to consider the potential broader impacts of technical solutions to problems
3. Service should not be an expected part of the engineering profession
4. I would be willing to have a career that earns less money if I were serving society
5. I view engineering and community service work as unconnected
6. It is important to incorporate societal constraints into engineering decisions
7. I felt called by the needs of society to pursue a career in engineering
8. Engineering firms should take on some pro bono work
9. I would not change my engineering design because it conflicted with community feedback
10. I think it is important to use my engineering to serve others

11. I believe my life will be positively affected by the volunteering that I do
12. I believe that extra time spent on community service is worthwhile
13. Since earning my bachelor's degree, I have become more motivated to help people and society through my work
14. Since earning my bachelor's degree, I have become less confident of my ability to make positive impacts on people and society through engineering

Demographics

Q24 In what year did you earn your undergraduate degree?
□ 2010-2015; □ 2005-2009; □ 2000-2004; □ 1990-99; □ 1980-89; □ 1970-79; □ 1960-69; □ 1950-59

Q25 What was your undergraduate major? Check all that apply or closest option.
Options: Aerospace engineering; Biological engineering, biomedical engineering; Chemical engineering; Civil engineering; Computer science or engineering; Electrical engineering; Environmental engineering; Industrial engineering; Mechanical engineering; Mining, petroleum, nuclear engineering; Math or natural science (physics, chemistry, biology); Humanities or social science related; Arts related; Others

Q26 Did you earn graduate degrees? □ Yes □ No
If Yes: Q27 In what majors did you earn graduate degrees? Check all that apply or closest option. (same options as provided for Q25)

Q28 Gender: □ Male; □ Female; □ Prefer not to say