Military-Bound and Veteran Student Views on Socially Responsible Engineering

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Abstract

This research explored the perspectives of engineering students on the relationship between service in the military and views of social responsibility as engineers, in particular *professional connectedness* or the obligation that an engineer has to help solve social problems or help others using their professional skills. Three research questions (RQs) were examined: (1) How does the professional connectedness of engineering students attending a military academy compare to students at other institutions? (2) How do engineering students with military aspirations view social responsibilities related to the engineering profession and perceive negative feelings from their peers related to the ethics of military service? (3) How do engineering students with a history of military service view social responsibilities related to the engineering profession and perceive negative feelings from others related to the ethics of military service? The first RQ was examined using the results from two large surveys of engineering students attending 17 institutions with about 3300 respondents, including 222 students attending one of the U.S. military academies. The *professional connectedness* element of social responsibility was measured using 19 Likert-type items with a 7-point response scale. It was found that the average professional connectedness of male engineering students attending a military academy was higher than male engineering students attending other types of institutions. With respect to RQ2, interviews were conducted with two students participating in ROTC and one who conducted research on drones. These students described their social responsibilities related to military issues as including using engineering to protect troops and the public, the role of the military in taking down oppressive governments, and the military role in responding to disasters. To explore RQ3, open ended questions on the survey allowed students to describe events or courses that influenced their views of social responsibility and/or to define their ideas of social responsibility, and one alumnus who was a veteran also shared his story during an interview. These veterans saw military service as a strong reflection of social responsibility and a sacrifice to the greater good. Some veterans pushed back on the notion of social responsibility as an obligation in general. One student veteran shared a story of being disparaged for his military association. The results help engineering faculty understand the perspectives of students with military backgrounds and/or aspirations. Faculty should consider these perspectives in their teaching, particularly when facilitating discussions and debates around ethics and societal impacts in their courses.

Introduction

A key attribute of professionalism is a "normative orientation toward the service of others" [1]. Professional social responsibility concerns the extent that individuals have a responsibility to serve and help others by virtue of possessing specialized knowledge. 'Others' can be conceptualized at a personal, societal, and/or environmental level. Engineering has been characterized as a weak profession [2, 3]. There is general consensus that engineers should consider the societal and environmental impacts of their work, embodied through codes of ethics, e.g. [5, 6]. There is also consensus that this attribute should be explicitly taught [7, 8]. Engineering ethics education could include both microethics (relating to individual actions) and macroethics (the collective responsibility of the profession) [9], as well as targeting both cognitive and affective attributes [10]. It has been demonstrated that engineering students and

practitioners possess a range of nuanced understandings about the professional social responsibilities of engineers [11-13]. The military is also a profession [4]. This research explores areas of intersection among engineers' professional social responsibility and the military, shown conceptually in Figure 1.
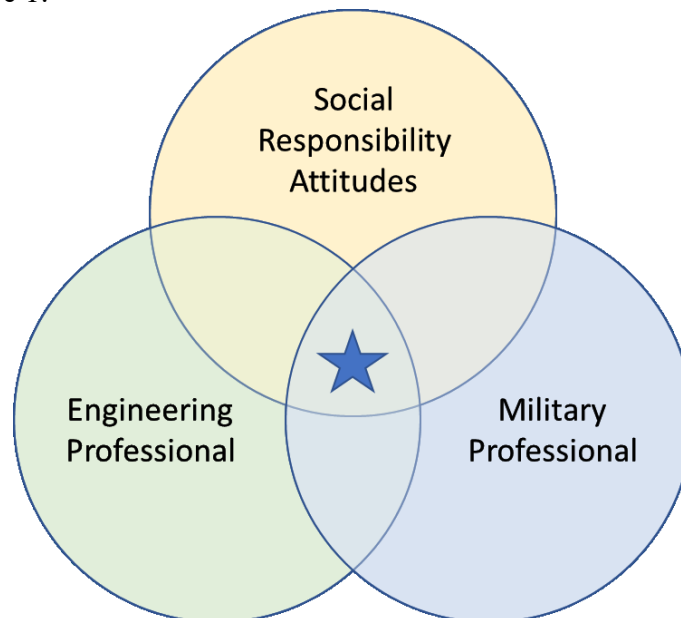

Figure 1. Areas of intersection between social responsibility, engineering, and military explored in this research

Service elements are prominent in the military profession. Long standing core principles of the military profession include duty, honor, country, integrity, loyalty, trust, commitment, dignity, and service [4, p. 29-30]. Serving their country is commonly cited as a reason to enlist in the military [14-16]; some individuals are drawn to military service as a 'calling' while others view it as an occupation [4, p. 31]. Ngaruya et al. [17] found that public service motivation was higher for Reserve Officer Training Corps (ROTC) cadets than 'regular' undergraduate students at a mid-size public university. In Denmark, combat troops were found to have a higher normative motivation for public service (based on values and duty) than civilians; civilians had higher affective public service motivation (based on compassion and empathy) [18]. The military today has roles that extend beyond waging and winning wars, including the current nonconventional war on terrorism. The U.S. military has been involved in domestic issues such as search and rescue operations post Hurricanes Katrina and Rita, developing key domestic infrastructure like dams and levees, border security in 2018-2019, interventions in humanitarian crises (Bosnia, Kosovo, Somalia), peacekeeping, peace enforcement, and nation building [4]. Some have ascribed a 'duty of care' to the military and debated the roles of individual versus collective responsibility [19], similar to ideas of microethics versus macroethics in engineering. Military ethics research also asserts that the military is concerned with character development [20, 21]. Bertha [22] examined the intersections among military operations, the practice of engineering, and applied/professional ethics, and provides case examples of 'military engineering ethics.'

Engineering education interfaces with the military in three key ways: (1) students being educated to become commissioned military officers at U.S. service academies and other institutions via ROTC programs, who are majoring in engineering; (2) military veterans as 'non-traditional

students' earning engineering degrees; and (3) engineering students who will work on defense and/or military-related technology. Key facets of these three groups are discussed below.

The U.S. government's service academies all award engineering degrees. As well, ROTC programs are present at "over 1700 college and universities" [23]. Thus, a number of engineering students are simultaneously receiving formal education for two professions. "Doctors, lawyers and engineers… serve as military professionals and also as professionals in their particular discipline or training. (They are considered for promotion completely separately from other officers.)" [4, p. 33]. These *multi-professionals* are not combat forces, and as such may have an ethos distinct from those serving in combat roles. Differences among the military branches with respect to attitudes toward international human rights and using the military for non-war operations have been described [4], but the current research will not distinguish among difference branches of the U.S. military. The U.S. Air Force ROTC states "the most highly desired majors for AFROTC cadets are electrical engineering, computer engineering, meteorology, nuclear physics, and nuclear engineering" [24]. The Navy ROTC classifies academic majors into desirability, with the most desirable Tier 1 majors including aerospace, chemical, electrical, mechanical, naval, nuclear, ocean, and systems engineering; Tier 2 majors include civil, computer, and biomedical engineering [25]. There are also specific military posts available to civil engineers via the Navy Seabees, Navy Civil Engineering Corps, and Army Corps of Engineers. At one large, public institution among about 5000 undergraduate students enrolled in the College of Engineering, about 2% were participating in ROTC [unpublished data]. While these students will generally begin their careers in the military, many eventually complete their service and enter engineering jobs in the civilian sector.

Nationally, there has been a push to assist military veterans in obtaining college education, with funding provided by the GI bill [26]. The number of these veterans who matriculate in engineering programs and eventually graduate is not well enumerated. At one large, public institution among about 5000 undergraduate students enrolled in the College of Engineering, 1% were military veterans [unpublished data]. Veterans likely bring unique "funds of knowledge" and perspectives to the classroom [27, 28]. Multiple identity theories are also relevant; veterans likely have an identity associated with their military service which will align to varying degrees with their emerging engineering identity. Their multiple identities may be reinforcing or conflicting. As well, the idea of a profession might align more with the officer side of the military versus enlisted. This indicates that there will be unique considerations among the intersections of socially responsible engineering in the education of commissioned officers (via military academies, ROTC, etc.) and veterans who served in the enlisted ranks. It has been stated that "civilians and the military… differ in systematic ways in their attitudes concerning whether and how to use force and in their willingness to bear the human costs of war" [4, p. 27]; thus, one might expect different attitudes toward professional social responsibility among engineering students who are and are not involved with the military in some capacity.

Finally, many 'traditional' engineering students will enter careers where their work intersects with military interests. Lucena describes how engineering education has consistently been influenced by the defense needs of the United States since World War II [29]. Students may actively seek military-related jobs, or more likely, will find themselves in them. A recent National Academy of Engineering (NAE) report analyzed STEM workforce concerns of the U.S.

Department of Defense (DOD), in terms of the 'defense industrial base' and DOD civilian and military employees [30]. Many new technologies are developed with military funding or potential military applications in mind, as acknowledged in a recent NAE report [31].

Military issues in relation to engineering have often been portrayed in a negative light; e.g [32]. For example, in discussing the "rise of the military-industrial-academic complex", Blue et al. states "we do not assume careers within the military are **necessarily** without integrity" [33, p. 90; emphasis added by authors of this paper]. Boriskin [34] accused some fellow "engineers employed by the military" of being "dishonest and even border[ing] on evil". Students in college classrooms with a history of military service or military aspirations likely have different perspectives to offer.

The professional social responsibility development model (PSRDM) has been proposed to describe the evaluation of social responsibility ideas among engineering students [35]. It draws on Schwartz's altruistic helping behavior model [36] to explain one's personal social responsibility attitudes (the so-called personal social awareness realm) and allows that professional attitudes related to engineering can develop separately (the professional development realm). Then engineering students bring these two distinct areas together to some extent in the professional connectedness realm. Previous research operationalized the PSRDM theory into the Engineering Professional Responsibility Assessment (EPRA) [37]. Engineering students were found to differ in their social responsibility attitudes, on average, based on factors such as gender, discipline, institution, and religious / spiritual beliefs [38]. This research explores the engineering social responsibility attitudes of students with military aspirations and veterans.

Research Questions
This exploratory research emerged from a larger study on social responsibility among engineering students and alumni. The research questions that were probed are:
   RQ1. How does the professional connectedness of engineering students attending a military academy compare to students at other institutions?
   RQ2. How do engineering students with *military aspirations* (a) view social responsibilities related to the engineering profession and (b) perceive negative feelings from their peers related to the ethics of military service?
   RQ3. How do engineering students with a *history of military service* (a) view social responsibilities related to the engineering profession and (b) perceive negative feelings from professors related to the ethics of military service?

Methods
A large social responsibility study gathered information using two primary methods: surveys and interviews. The surveys were primarily focused on measuring students' social responsibility attitudes using a series of 50 Likert-type items that mapped to the seven constructs within the Professional Social Responsibility Development Model (PSRDM) [35, 37]. Supporting items included students reporting involvement in volunteer and service activities during college and events and/or people that influenced their views of social responsibility and community service. The survey ended with demographic items (e.g. institution, gender, rank, major). During the first phase of the research, the survey was distributed in fall 2012 at five institutions, including one military academy and four doctoral institutions. At the military institution the survey invitation

was distributed to first year students in engineering and sophomore and senior students majoring in civil, environmental, and mechanical engineering. In the second phase of the research, the survey was modified to include additional open-ended response items, such as defining social responsibility and courses that impacted their views of SR. The survey invitation was distributed in spring 2014 at 17 institutions to engineering students in all undergraduate ranks and majors.

For RQ1, the data analysis focused on the quantitative survey responses to 19 Likert-type items that mapped to the professional connectedness (PC) dimension of SR. Responses to negatively-worded items were reversed, and then responses to all 19 items on the 1 to 7 scale were averaged to represent an overall PC score. The responses from students attending the military academy were combined into a single file. For the comparator groups, similar institutions were grouped: two Jesuit Master's Large institutions; two public Master's large institutions; 4 private doctoral institutions, and 6 public doctoral institutions (due to very low response numbers, two other religiously affiliated institutions were left out of the dataset). Comparisons among institution types used non-parametric statistics which do not require that responses are normally distributed (paired Mann Whitney U tests, SPSS v. 25). Gender, discipline, and rank were found in previous research to influence SR scores, so these aspects were also explored.

The primary source of information that contributed to addressing RQ2 was a series of longitudinal interviews with engineering students. A sub-set of the individuals who participated in the EPRA survey as incoming first-year students in fall 2012 volunteered to potentially participate in interviews. Criterion-based methods were used to select students for interviews from among these volunteers; these details have been previously described [39]. Thirty-four interviews were conducted in spring 2013; within this group, two students were participating in ROTC. Twenty students who continued studying engineering participated in the interviews in subsequent years, one of whom was in ROTC. The other ROTC student could not be contacted after the first interview. Among the follow-up interviews, military themes emerged significantly in one other interview, through descriptions of Unmanned Aerial Vehicle (UAV) research, and reactions from her peers. The verbatim transcripts of the interviews were read, and relevant themes related to the research questions identified such as duty, defense engineering, and contributing to war as a socially responsible practice. This research question is answered mostly by one student's interviews, and her extended descriptions of experiences and well-formed opinions. She may or may not be representative of a significant population of students with military aspirations; the other two students provide additional diverse perspectives.

For RQ3, students who were military veterans (or participating in ROTC per RQ2) were identified among the survey respondents. First, keyword searches were conducted among the open-ended responses using terms including military, ROTC, Army, Air Force, Navy, Marines, and guard. The write-in responses were then explored in more detail to determine if the context of the reference was previous military service (e.g. "I have served in multiple tours overseas with the U.S. Army"). It is noted that additional military veterans and/or students participating in ROTC may have responded to the surveys but were not identified, as they did not disclose that information in their open-ended survey responses. In addition, Karl (pseudonym) was interviewed as an engineering alumnus (as part of the larger study); he had been an enlisted marine before coming to college where he participated in ROTC; insights from his interview are also included.

Results and Discussion

RQ1: Quantitative Comparison of Professional Connectedness
Looking at the quantitative data (Table 1 and Figure 1), the PC scores of the students attending the military academy and Jesuit schools were similar and higher than the public master's and public doctoral institutions. Differences by institution have been previously reported [38]. There were a small number of individuals who indicated via their open-ended responses that they had previously served in the military or were participating in ROTC. The ROTC members had lower PC than those attending the military academy. The individuals who had served in the military also had lower PC, on average. These individuals likely had more life experience and were perhaps less idealistic in regards to their engineering career goals. Another alternative explanation is generational differences between younger engineering students and these older veterans. Support for this idea can be found in among the Phase 1 results; the average PC score among individuals 24 and older who were undergraduate students was 4.96 (n=31) compared to 5.06 among undergraduates 18-23 years old (n=670) (data not shown).

Table 1. Summary of average professional connectedness scores among survey respondents

	Military Academy		Jesuit Master's L		Private Doctoral		Public Master's L		Public Doctoral		ROTC		Served military	
	n	PC	*n*	PC	*n*	PC	*n*	PC	*n*	PC	*n*	PC	*n*	PC
All⁺	*222*	5.20	*160*	5.25	*441*	5.17	*328*	5.07*	*1971*	5.06*	12	4.83	16	4.47
Male	*154*	5.25	*102*	5.13	*208*	5.02*	*218*	4.93*	*1264*	4.91*	7	4.70	15	4.48
Female	*19*	5.56	*55*	5.56	*224*	5.31	*107*	5.31	*659*	5.37				

⁺ Included individuals who did not complete all demographics, so gender, rank, and/or major unknown
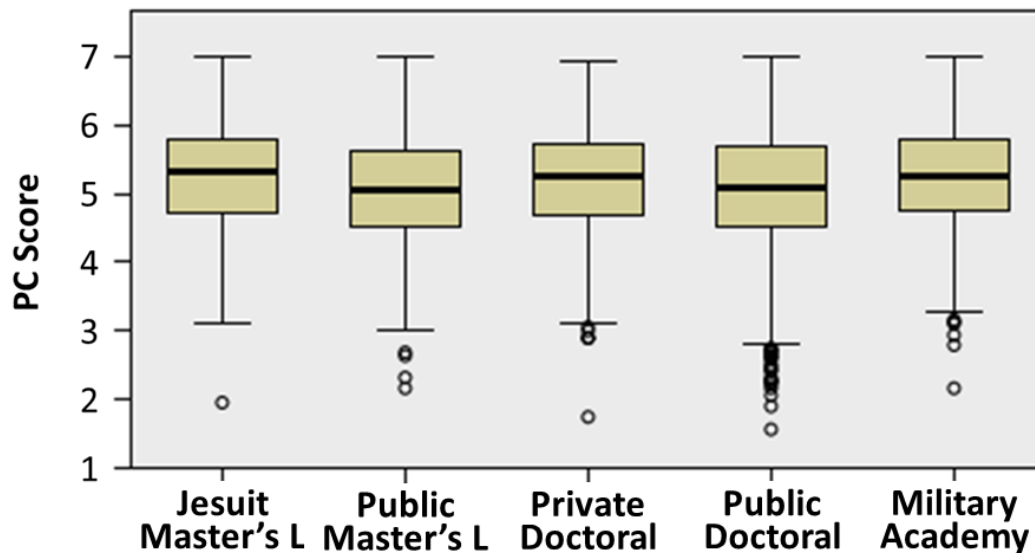* p<0.05 compared to military academy

Figure 2. PC scores of students attending different types of institutions; box-and-whisker plot shows median (middle line in box), first and third quartile (top and bottom of box), minimum and maximum (whiskers), and statistical outliers (circles).

Previous research determined that female engineering students possessed higher SR scores than males [40]. The percentage of female respondents among the military academy students was significantly lower than the other institutions. Disaggregating the data by gender, the PC scores

of the male students attending the military academy were higher than those attending other types of institutions (significance in paired tests shown; Figure 3). Among female students, PC scores among those attending the military academy were not statistically different than any other institutions. In addition, there was not a statistically significant difference between PC scores of male and female students attending the military academy (Mann-Whitney U test; sig. 0.169).
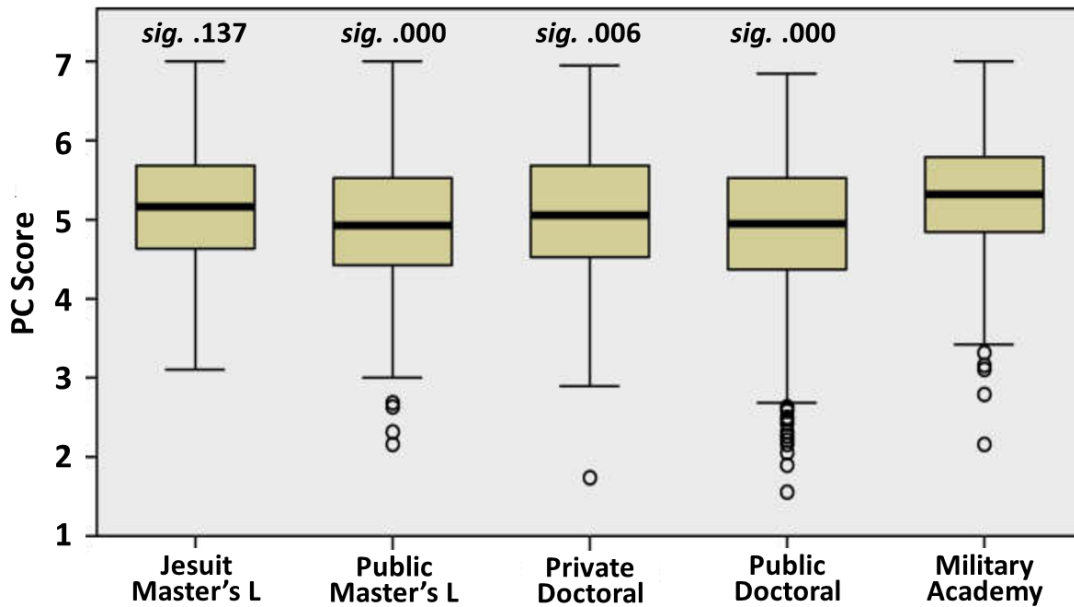

Figure 3. Box-and-whisker plot of PC scores of male students attending different types of institutions; statistical significant in paired tests versus military academy shown.

The cross-sectional data were examined for potential trends with rank (i.e. time in college); results are summarized in Table 2. Given the low number of female student respondents at the military academy, trends with rank were only explored for male students. It appears that the students entering the Jesuit institutions may have the highest SR (if one assumes that changes during the first-year (FY) were not significant at the comparator institutions). It appears that there were higher PC scores among sophomores to seniors versus FY students at the military academy and public master's institutions compared to decreasing trends at the Jesuit institutions; however, these are not longitudinal data and there are small numbers of students, so further research would be needed to verify these trends.

Table 2. Average PC scores of male students with rank and two common majors

Rank or Major	Military Academy		Jesuit Master's L		Private Doctoral		Public Master's L		Public Doctoral	
	n	PC	n	PC	n	PC	n	PC	n	PC
First year^	10	4.99	16	5.31	44	5.12	15	4.62	234	4.89
Sophomore	74	5.25	21	5.26	26	4.96	51	5.05	176	4.94
Junior	18	5.30	30	4.86	35	4.86	67	4.83	174	4.85
Senior	51	5.25	35	5.20	49	8.13	67	5.05	359	4.84
Mechanical	60	5.14	35	5.19	65	4.94	58	4.97	604	4.81
Civil	49	5.44	28	5.11	29	5.18	18	5.21	245	5.15

^ FY students at Military Academy completed the survey in early fall (first) semester, at Jesuit institutions and Master's L FY students completed the survey in mid spring (second) semester; other institutions FY students in both fall 2012 and spring 2014.

Major is also expected to play a role [38, 41]. An example of the male mechanical and civil engineering results are shown in Table 2; other majors are not shown due to low numbers of respondents. The data for mechanical engineering male students follows previous trends where students attending the military academy and Jesuit Master's institutions had more positive professional connectedness attitudes than students attending public Master's institution or private doctoral institutions, who were in turn higher than students attending public doctoral institutions. For civil engineering male students, average professional connectedness scores were higher than mechanical engineering males among all institution types, with the exception of the Jesuit Master's institutions (which also had low numbers of students in these majors). Across institution types, the male civil engineering students attending the military academy had the highest average professional connectedness scores.

Among the 19 PC survey items, the wording of particular terms may have resonated more with some groups. The frequency that terms were used among the PC items included: *community* in 5 items; *society / social* in 5 items; *others / people* in 5 items; *serve / service* 6 items; *help* within 4 items. Veterans of military service may interpret some of the language in the survey items differently than civilians. Individuals with military associations may interpret *service* as serving America and/or the ideals for which it stands, versus serving particular people or communities. The four PC items with the largest differences in the average scores of military academy students, ROTC students, and veteran students are shown in Table 3. Military academy and ROTC students had similar average scores on volunteerism importance and a career helping people, while average veteran scores were a full Likert point lower. Both ROTC and veteran students had lower scores than military academy students in reference to being involved with social justice issues. Overall on average, veterans were low outliers.

Table 3. Average student responses on specific PC survey items

Survey Item	Military Academy	ROTC	Veterans	Jesuit	Private Doctoral	Public Masters	Public Doctoral
Importance for a professional engineer: volunteerism	5.2	4.9	3.7	4.7	4.8	4.8	4.9
Engineers should use their skills to solve social problems	5.7	4.5	4.9	5.6	5.6	5.4	5.4
I believe that I will be involved in social justice issues for the rest of my life	4.8	3.9	3.6	4.7	4.5	4.4	4.4
It is important to me personally to have a career that involves helping people	6.0	5.7	4.8	5.7	5.8	5.6	5.5

RQ2a. Engineering Students with Military Aspirations: Views of SRE
Students with military aspirations, particularly ROTC in this study, generally expressed a deep understanding of their personal social responsibility and related it directly to their professional aspirations. While only five interviews were performed with ROTC students (one with Tim and four with Jamie), their experiences and beliefs are important stories to share. Additionally, Rachael connected social responsibility with her UAV research funded by the federal government. Details from these interviews are described below.

Tim

Tim was an ROTC participant and mechanical engineering major in his second semester attending a large public university. As an incoming first-year student his PC score was 6.2, among the top quartile of students. He expressed views on connections between the military and social responsibility that are rational, contradictory, complex, and accepting of certain paradigms. When asked why he was interested in weapons engineering, beyond the "cool" factor, he said: *"I'm not saying I'm some kind of a war junkie…but we have to make these instruments and… the better you make them, the more you can reduce civilian casualties and you can make things safer while also making them more deadly…."*

Much later in the interview, he described the most significant social issue to him, professionally and personally:

> *It's gotta be war. I really don't want that to sound like a warmongering thing because I'm not out there to just go kill bad guys, but I just think that: one, I'm out there to try to save as many American lives as possible and two, the whole purpose of war is just a furthering of political issues. … I hate politics, but political issues are just social issues and social issues are things that people like me are really passionate and emotional about. …there aren't even women's rights in the Middle East. …Yes, you can liberate that….*

He clearly sees the direct role that the military has in "liberation," and that these are effective means to the ends of political progress. Further expanding on the global social responsibility that the U.S. military has, Tim described the ways soldiers are engaged with service outside of combat:

> *…there are thousands of soldiers out there right now not fighting. They are literally in Africa teaching kids how to play softball, they call it making friends with the younger generation or something …. It almost looks bad kind of saying, "hey, we're not bad people," but it is good that you actually go over there and help out a lot. I hope I get to do that kind of thing. …with the Air Force, my Colonel, he got the call when Haiti, you know the earthquake… they were there less than 24 hours after the earthquake… that's not really in the news ever. It says we're sending supplies there, but it doesn't say who is sending them.*

Tim had quite a well-rounded understanding of the various roles the military plays, and had a good diversity of influences, too. While he unfortunately only participated in the research for one year, his thoughtful, and sometimes passionate responses created a heightened interest in how ROTC education engages topics such as social responsibility beyond the typical engineering curriculum.

Jamie

Through four interviews, Jamie openly and continuously described the strong connections she made between her social responsibilities and her "call to serve." In the first year, a combination of "cool" technology and an ability to contribute to progress seemed to drive Jamie's choice of major and ROTC involvement:

> *I really like the idea that I can create things, things that are useful mostly because I joined the Air Force this year. I am a ROTC cadet and my main goal for my career right now is to be building technology that will help keep the soldiers on the front lines safe. You know, put a wall of metal between the bad guys and our guys. A wall of living, thinking metal that will help protect them.*

>*If I had my choice in careers…I would work on new technologies for the Air Force. They are doing some really cool stuff… I would love to be on the cutting edge of military technology. … I did quite a bit of research when I started hearing about laser cannons and rail guns. … the big idea is that if I could build something new and something different that someone hasn't thought of before. That would be cool.*
>
>*…For me, the point of an engineer is to build things, or revise things to make them better. And I think that's one of the things that really drives society forward. That engineers are sort of behind almost anything that's progressing in a sort of real and measurable way. And I think that sort of productivity is really important in society in general, but also to just making people's lives better in a day-to-day fashion.*

When asked about the most important social issue, she said, "conflict, in particular armed conflict…." This led to one of the most interesting reflections on social responsibility that the research team encountered throughout the entire study:

>*I personally put a huge value in human life and to get a little bit existential with this…. I know that what I do with my life is probably going to kill people, and I'm okay with that. And I hope that the God I meet one day, will be able to see that I did the best that I could with the skills that I had to protect as many people as I could and yes, there was a net loss, but unfortunately you can't reason with some people, except with a gun. So, that being said, I feel that human life is very sacred and I'm okay with the idea that it's possible, one day, that a more harsher and judgmental God will say 'hey, you killed' and I will say, 'yes I did'. And I would take the punishment as it came. So, for me armed conflict is always sort of an interesting thing because I don't know which God I'll meet and you know, killing people is meaningful at least to me, and I worry that sometimes people don't see it the same way.*

In just her first year of college, Jamie, like Tim, connected her educational and professional choices with social issues, and has considered how they could interact in her future (even beyond her time on Earth).

Picking up her story at the start the second year interview, before discussing social responsibility at all, she indicated her strong sense of duty:

>*Interviewer: …connecting to your reasons for getting into the Air Force and ROTC and mechanical [engineering] … describe to me now how you think about it.*
>
>*Jamie: It's a call to serve. …one of the things that I see as an incredible blessing in my world is the fact that I am free. … as a girl… in a lot of other countries I would not have these opportunities, and the fact that America is the land of the free and the basic human rights are laid out for everybody means that I can pursue these things, and part of being able to pursue that for me means being able to protect it. … U.S. citizens that have taken that urge to protect across the seas and are doing their best to defend our values and defend our future, and some of them have given their lives. And one of the things that I see as being a possibility is that if I'm a good engineer and I can build better equipment… through my service and my talents protect some of those people… I believe a lot in the military and I believe a lot in its use and purpose. I think it's limited…, but I see it as an incredibly powerful way to reach people. … I see it as an incredible way to serve not just America, but our, sort of, global community.*

When asked more specifically about how she understands social responsibility, Jamie responded with details that are intimately tied to her identity as a future military service member:

> ...I am on scholarship for ROTC now, which means that the taxpayers of America are paying for me to go to college, so that I can become an effective Air Force officer. ...Society has put a pretty big investment in my education and they will put an even bigger investment in my training to protect them and the interest of America in a global political world. ...It is this perpetual 'as best you can' that the Air Force harps on a lot and really factors into my idea of social responsibility that you have a responsibility to society, no matter where you are, no matter what you've done, to do the best you can.

Jamie maintained this strong sense of contributing to society as both an engineer and member of the armed forces throughout college. She took on leadership roles with the ROTC, becoming wing commander. In this role she organized a range of service projects that included working with Veterans of Foreign Wars, as well as building a stronger mentorship program for younger cadets. Her senior design project was "working for the Air Force". When asked in the fourth-year interview what factors would make a job personally rewarding, Jamie's response included "What I am really looking for in a job is to wake up and want to go do what I'm doing... doing something that is valuable to somebody… that real tangibility of making something better gets me really excited… I guess it's that internal belief that what I do matters that I'm really looking for." When prompted to discuss social responsibility Jamie responded:

> I think social responsibility is almost as important for military officers as it is for an engineer… I see that there is a lot… we have a responsibility to do it right and to do it with grace and efficiency and effectiveness… Also with social responsibility there is definitely a giving back component… we're in a community and some of us have a lot more resources than others and you can't require people to give because that doesn't go very well. … There is a responsibility to give as much as you can when you can… we can so we should so we do.

Both students participating in ROTC had deeply considered the service aspects of their future selves in the military, which was not often the case with students who finished engineering degrees more broadly. With some formal education and a confrontation with the reality that they are contributing to warfare directly, these students analyzed their role as an engineer in society. These insights into their views on SR would not be evident without interviews; Jamie's incoming PC score was 5.2, a full point lower than Tim's. These insights provide context when comparing the quantitative survey measurement.

Rachael
Rachael was not an ROTC student, but presents an interesting perspective that could represent a larger proportion of students: those who perform research funded by military-related organizations. During her third year attending a private doctoral institution, Rachael worked on the "software side" of a project to design and outfit a UAV for use in areas of high radiation, to perform search and rescue following the Fukushima disaster in Japan. Additionally, she worked for a summer at a national lab that was focused on security and space exploration, which was her dream job. The research into drones provided opportunities to consider her social responsibility as an engineer, largely caused by other students' perspectives on the harm done by the technology (described below).

RQ2b. Students with Military Aspirations: Perceived Negativity Towards Military
All three students connected with the military provided detailed accounts or more general perceptions of others expressing negativity towards them for their choice of how to use their engineering education. Some were direct, others more abstract and diffuse, and the students described how they responded in different ways.

The ROTC student, Jamie, described how she developed her ideas by recounting the following conversation with her first-year roommate: "…*she asked me 'hey, do you ever consider the fact that you kill people?' 'Well I don't yet but yeah, I will.' 'Oh, how does that fit with your Christianity?'…I hope that if I'm good to people that I'm going to be okay.*" Jamie went on to discuss what specifically she expected her role to be as a military engineer in the future, stating, "*I will kill people and my job is to design things to kill people in the most efficient way possible. …the reason why I want to do my job is that it means more of the good guys won't get killed.*" Later in the interview, Jamie loosely defined social responsibility as being "a decent human being," and reflected, "*I'm not sure that most people would describe a soldier as a decent human being …because [for me] the engineering is so tied up with being a soldier, I'm not sure that I'm necessarily a…decent human being with mechanical engineering… I'm trying to be a decent human being while I'm not being a soldier.*" While Jamie seemed very confident in her perceived role, and that she was making the right educational and professional decisions, she clearly had some inner conflicts associated with what other people think of soldiers.

Tim described some more intense encounters, perhaps due to attending a more left-leaning / liberal institution than Jamie or maybe he felt more passionately defensive of the military. In his interview in the second semester of college, ROTC student Tim shared:

> …*it really bothers me when people don't support war. I get that maybe you're like, 'I hate that we have to go to war,' ok, that's fine, but at least support it. At least support the soldiers. …I live in a pretty liberal town, I am the odd guy out with the buzz cut. …There are people who go and protest at soldiers' funerals and stuff, like these crazy left-wing, like 'you're going to hell.' I think that's messed up, that stuff just kills me.*

While Tim certainly identifies with the positive social responsibilities of the military, and his role as an engineer, he encounters politically-charged preconceptions and generalizations about all military.

Rachael described her encounters with students on her private liberal campus, who implicitly tied UAV research to military applications that are more commonly negatively portrayed:

> …*when I tell people that I'm working on a drone or something like that, their initial response is that I'm a terrible, terrible person. So because [my university] is very politically active …before they actually know what the drones are for or anything, their initial thought is, 'oh you're a horrible person,' like, 'you're going to use the drone for like blowing people up and stuff.' And I'm like, 'no, this one's not for that.'*

Later in the interview, when asked to reflect more broadly on some major influences throughout her time in college, Rachael explained how being "called out" made her more aware of her future responsibilities: "*I guess one of the big things that has changed… a lot of people have called me out for working on drones…. It sort of changed the way that I have seen like, oh, what am I going to be doing as an engineer with the government? And like, what that will impact in the world.*"

While interactions such as those described above can be challenging, students who have the tools, poise, and confidence to engage can actually benefit greatly from the opportunities for reflection these discussions can provide. But if taken too far or lacking a supportive community like ROTC, it is possible that students may feel isolated or misfit at some institutions.

RQ3a. Military Veterans Descriptions of SRE

Within some survey responses, individuals linked their military experiences, engineering aspirations, and/or social responsibilities. One military veteran wrote, "Social Responsibility to me entails putting to use my acquired knowledge and skills so that the general public and immediate community may benefit. Any difference I can make by contributing to Society is a major contributor to my decision to pursue Engineering as a major and Career." This same individual in their description of events that had influenced their ideas of SR wrote, "I served in the U.S. Marines for 4 years during which time I did several volunteer events in the local community in which I was stationed. To see a difference being made by just taking a few hours of your time to help build a playground or pick up garbage is a very self-rewarding experience for me personally and I know that I am making a difference in people's lives."

On the survey, some individuals referred to the military in their definitions of SR but it was unclear whether these individuals had personal affiliations with the military: "Social responsibility is the duty of each member of society to better their communities in whatever way they are able. Each member of society should be expected to contribute as far as they are able. That could be through professional, strong families, military service, etc." Another example is: "We did not become a society out of nowhere. It was built through time by many people, from many different cultures who contributed free time to make society a better place. This includes but not limited to political leaders, military and philanthropist. Therefore, as a society today, we should feel obligated to help out, to give back and to do a service that helps us all. That is what social responsibility means to me."

An in-depth interview with a military veteran, Karl, who then went to college and earned a degree in engineering illustrates various ties among social responsibility, the military, and engineering. Karl had been a corporal in the Marines, and then enrolled in college and an ROTC program. He had a strong sense of SR and came to believe that his positive contributions to the world as an environmental engineer would exceed those in military service. Karl started by sharing his story of how he chose to major in engineering during college:

> *[Entering college] I had at that time about sixty or seventy credits of like, humanities types stuff 'cause of my night classes in the Marine Corps... And so I could've gone and done history or political science or something like that and gotten my commission earlier... my whole path at that time was become an officer... serving my country... My dad said to me, "Well, what the hell are you gonna do with history or whatever...if you [get injured]?... And so, he said, "Well, ...just look at... environmental engineering... we have one planet and we have more people and you'll have a job, you know?" ...it was just that...one little seed...*

Karl then explains how he began being interested in helping others through engineering, rather than just seeing engineering as a smart path to becoming a commissioned officer in the military. His service-based international senior design project grew into an undergraduate research project, for which he traveled internationally:

*I did very well [in environmental engineering], liked it, but then ... in my senior design class there was this opportunity... to do an [Engineers Without Borders] EWB project. ... having an opportunity to do a potentially **real** project, I was hungry for that...*

when I was in Nicaragua I saw... well, on the way down I read about what the Marines did in Nicaragua with the Contras... no one in my boot camp talked about that. So, it was kind of an eye opening thing about U.S. influence and I...I mean, I still am very driven and patriotic and all that, and I still serve my country, but at the time it just kind of made me open my eyes and realize the military is probably not gonna be for me... to travel abroad and see U.S. influence on a third world country... you are immersed in [poverty] and then... if you take it a step further and think how can I help these people, other than just be in poverty and experiencing that... for me it was an eye-opener... And so I just realized, ... there's a lot more need for a guy doing water and sanitation work than for another officer in the military...

Karl described mixed reactions by his ROTC peers to his interest in helping others through engineering:

...a good number of my classmates in ROTC were really excited about [it] because all of them kind of have that service streak in 'em, and so to think that one of their brethren was gonna go and do something cool like that in regards to helping the poor, there was a lot of them that were okay with it... pretty encouraging, in fact. One of them became a Navy SEAL...he was like 'you could be a great officer, but there's a higher calling for you', and I... it was true, I really felt a greater calling, for me, my skill set, to do engineering and EWB related things just because of the engineering....

Karl's post-college military service did not go as planned. Due to an injury, he was discharged from the military, and then became a civilian civil/environmental engineer:

I was just still enamored with this idea of helping people... both my parents got jobs because they needed to pay the bills, it wasn't because they actually cared about what they were doing... and I didn't want to go that path... so I wanna pick something I can really take a lot of pride in and work the rest of my life in and feel proud in and then also be able to tell my kids what I do....

Karl described links he saw between his civilian engineering job and national security, as well as realizing there were similar paths to SR and helping through the military:

...a lot of my buddies, ...especially my Marine buddies, ... I told them I was in engineering and I...you know, I'm working to become a professional civil engineer ...and I'm still doing this EWB thing, and they're like, "What the hell you doing that for?" and I'm like, " 'cause there's people that are impoverished and they need help and I can easily help them," and then I said... "I'm fighting terrorism... the reason why you have the terrorist stuff going on is 'cause they have no other options... if I can provide an environment in which they can live and thrive, they'll be less likely to become terrorists." One of my buddies was like, "Yeah..." and he went through this long story about, you know, seeing that kind of thing in Iraq ... that was at the time that the military started evolving... [to] nation building. I wish there was a better way for my passion to have been routed that way because I really could've done that for the military and I would've then loved it...

Moving back to the survey, another student veteran described his views of SR:

I have served in multiple tours overseas with the U.S. Army. The U.S.A. generally and college campuses especially, in my experience, are indifferent to the actual needs, hopes, and desires of foreign entities. As a rule of thumb, Americans tend to think that throwing money or soldiers at the world's problems is the best solution and, unfortunately, it is rarely the case. If a society wanted to be sincerely responsible and service some community then they would turn military and financial aid into educational aid so that the community in need could service itself and become a self-sufficient, responsible, productive, and participative member of the global community.

There were also veterans whose statements when defining SR pushed back on the idea; e.g.: "I don't believe that any individual has a responsibility to society. As a veteran I think that it would be nice if individuals felt a desire to serve their community. But that isn't the norm in the United States. Just look at the only civic responsibility I can think of, Jury duty. Everyone makes a joke out of it and seeks to get released from service." However, this individual seemed to have a strong personal service ethic. Describing events that had influenced his/her views of community service and social responsibility, the response was: "Serving in the military. / Serving as volunteer first responder. / Getting away from the world you are use[d] to for extended periods allows you to see the world in ways you wouldn't otherwise."

Another individual who "enlisted in the National Guard to serve my state in times of crisis and my country when called upon" stated: "Social responsibility is an obligation to your community. I think it's a politically correct way of shaming people who have worked hard into thinking they owe something to others. I have no problem with helping the community, but that should come from a desire to see things improve and not pressure to seem like 'a good person.'" He later elaborated on this idea as he described reading *Atlas Shrugged* as an event that had shaped his understanding of SR, "…promoting a culture of social RESPONSIBILITY is a problem. If you want to be charitable, be charitable. That idea of responsibility or guilt assumes that you are better than the people you are 'helping' and I don't think that is ever the case."

RQ3b. Military Veterans Descriptions of Criticism Towards Their Service
On the survey, one of the veterans described a negative experience he had encountered based on his military service:
*When I was in a sociology class I found that there are those that believe that they are doing the right thing but hurting others and they believe so strongly that their way is right that they will be very negative to you if you don't think the way they do. The professor and I had a heated discussion because he **called me a baby killer in class** after he found out that I had served as an infantryman in the Army. He didn't know me or why I did what I did but he judged me.*
This student went on to describe his military service as influencing his views of social responsibility, "*I was a soldier that was injured ... If you want to see true social service go to the VA and look at the men and women who were willing to give all to make sure you had a future.*"

This story indicates that institutions may need to create professional development training for faculty to increase their sensitivity in facilitating discussions, such that veterans feel comfortable sharing their rich experiences and students can discuss opposing views, without faculty imposing their personal beliefs.

Implications

The research shows that individuals being trained to serve in the military had definite ideas about their social responsibilities, both related to the military profession and as engineers. It appears that courses through the military academy and ROTC explicitly address ethical issues around war and armed conflict, but enlisted veterans may not have received this training through an engineering lens. Also, given that a high percentage of engineering students may later encounter these issues through their work [32], it seems worth having these intentional discussions. One good example is the 'landmines' case in Catalano [42]. The discussion prompts encourage students to explore many sides of the issue, rather than absolutes.

Another teaching style that may be particularly relevant is to give assignments that allow students the opportunity to select topics of interest, and reflect. This autonomy will allow veterans to both access their "funds of knowledge" and select topics of personal interest. To further enhance the reflection and value of military perspectives, the instructor could lead a discussion that allows for deeper listening. If this feels too open and undefined, instructors may want to provide a range of optional readings, and one or more could include military themes. A good resource for this might be the online short course *Ethical Challenges for Military Engineers* [43].

Conclusions

This study found that engineering students attending one of the military service academies had average professional connectedness scores higher than students attending public and secular private institutions and similar to students attending Jesuit-affiliated institutions. In contrast, the average PC scores among a small number of military veterans were lower than average engineering students. Qualitative information provides more nuanced insights into the perceptions of social responsibility among students participating in ROTC and interested in contributing to the military. These students looked forward to serving their country and using their engineering skills to reduce casualties among service members. Veterans also discussed their commitment to serve, but some disliked the notion of obligations to society versus voluntary contributions. Both ROTC students and veterans shared cases where peers and/or faculty denigrated their involvement with the military. The lengthy story of one veteran showed how his notions of service evolved over time, acknowledging multiple ways to apply engineering to helping society through volunteer organizations (i.e. EWB), practice as an engineer, or through the military. As institutions seek to recruit returning veterans into their programs and engineering student participation in ROTC remains strong, an awareness of their unique perspectives on social responsibility may inform engineering ethics instruction. Instructors should be prepared to facilitate discussions where strong opinions and beliefs both for and against the military may be shared (inclusive of service in the military and engineering technologies with potential military applications).

Veteran who served during the Gulf War. Their conversations enriched her understanding of military perspectives on social responsibility issues.

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