How the "Needs of the Force" Impact Navy and Marine Corps Veterans' Decision to Major in Engineering

Dr. Catherine E. Brawner, Research Triangle Educational Consultants

Catherine E. Brawner is President of Research Triangle Educational Consultants. She received her Ph.D.in Educational Research and Policy Analysis from NC State University in 1996. She also has an MBA from Indiana University (Bloomington) and a bachelor's degree from Duke University. She specializes in evaluation and research in engineering education, computer science education, and technology education. Dr. Brawner is a founding member and former treasurer of Research Triangle Park Evaluators, an American Evaluation Association affiliate organization and is a member of the American Educational Research Association and American Evaluation Association, in addition to ASEE. Dr. Brawner is also an Extension Services Consultant for the National Center for Women in Information Technology (NCWIT) and, in that role, advises computer science and engineering departments on diversifying their undergraduate student population. She remains an active researcher, including studying academic policies, gender and ethnicity issues, transfers, and matriculation models with MIDFIELD as well as student veterans in engineering. Her evaluation work includes evaluating teamwork models, broadening participation initiatives, and S-STEM and LSAMP programs.

Dr. Susan M. Lord, University of San Diego

Susan M. Lord received a B.S. from Cornell University and the M.S. and Ph.D. from Stanford University. She is currently Professor and Chair of Integrated Engineering at the University of San Diego. Her teaching and research interests include inclusive pedagogies, electronics, optoelectronics, materials science, first year engineering courses, feminist and liberative pedagogies, engineering student persistence, and student autonomy. Her research has been sponsored by the National Science Foundation (NSF). Dr. Lord is a fellow of the ASEE and IEEE and is active in the engineering education community including serving as General Co-Chair of the 2006 Frontiers in Education (FIE) Conference, on the FIE Steering Committee, and as President of the IEEE Education Society for 2009-2010. She is an Associate Editor of the IEEE Transactions on Education. She and her coauthors were awarded the 2011 Wickenden Award for the best paper in the Journal of Engineering Education and the 2011 and 2015 Best Paper Awards for the IEEE Transactions on Education. In Spring 2012, Dr. Lord spent a sabbatical at Southeast University in Nanjing, China teaching and doing research. Dr. Lord received the IEEE Undergraduate Teaching Award.

Dr. Catherine Mobley, Clemson University

Catherine Mobley, Ph.D., is a Professor of Sociology at Clemson University. She has over 30 years experience in project and program evaluation and has worked for a variety of consulting firms, non-profit agencies, and government organizations, including the Rand Corporation, the American Association of Retired Persons, the U.S. Department of Education, and the Walter Reed Army Institute of Research. Since 2004, she been a member of the NSF-funded MIDFIELD research project on engineering education; she has served as a Co-PI on three research projects, including one on transfer students and another on student veterans in engineering.

Dr. Joyce B. Main, Purdue University-Main Campus, West Lafayette (College of Engineering)

Joyce B. Main is Assistant Professor of Engineering Education at Purdue University. She holds a Ph.D. in Learning, Teaching, and Social Policy from Cornell University, and an Ed.M. in Administration, Planning, and Social Policy from the Harvard Graduate School of Education.

Prof. Michelle M. Camacho, University of San Diego

Michelle M. Camacho is Professor of Sociology at the University of San Diego. She began her career at UC San Diego in 1999 as a postdoctoral fellow at the Center for US Mexican Studies, and later as a UC Faculty Fellow in Ethnic Studies. In 2015-16, she returned to UC San Diego as a fellow of the American

Council on Education. As a bilingual/bicultural Latina, Camacho has 30 years of experience in higher education advocating for underrepresented groups and first generation college students. For over a decade, her work on institutional transformation has received funding from the National Science Foundation to examine and address inequities in higher education, specifically as they relate to Science, Technology, Engineering and Mathematics (STEM). She served the NSF ADVANCE grant initiatives as a co-Principal Investigator, working to improve practices to recruit and retain women of color in STEM and enhance institutional climate at USD. Other current research grants support pathways for veterans in higher education, and the NSF program called, "Revolutionizing Engineering & Computer Science Departments." Her co-authored books include The Borderlands of Education (with Susan Lord), Mentoring Faculty of Color, and Beginning a Career in Academia: A Guide for Graduate Students of Color. She is past-Vice President (2017) of the Pacific Sociological Association, and an appointed consultant to the American Sociological Association's Departmental Resources Group. Fluent in both quantitative and qualitative research methodologies, her research uses theories from interdisciplinary sources including cultural studies, critical race, gender and feminist theories. Central to her work are questions of culture, power and inequality. She is affiliated faculty with the Department of Ethnic Studies, Women's and Gender Studies, and Latin American Studies.

How the "Needs of the Force" Impact Navy and Marine Corps Veterans' Decision to Major in Engineering

Abstract

The Navy and Marine Corps are both branches of the US Department of the Navy. However, they have different missions in support of national defense and thus sailors and Marines have very different job responsibilities during their service. This study investigates how these different roles impact their future choice to major in engineering. We explore three research questions. 1) What reasons did student veterans in engineering give for first enlisting in the Navy or Marine Corps? 2) What factors influence their job placement in the service? 3) How does military service influence their decision to later major in engineering? We find that patriotism and a desire to attain a sense of direction influences these veterans to join both services but that Marine Corps veterans are more likely to report doing so out of a sense of pride and a desire to engage in combat than Navy veterans. Placement in military jobs is determined by the needs of the force and the capabilities of the sailor or Marine. Those who score well on the Armed Services Vocational Aptitude Battery (ASVAB) have more choices and, in the Navy, are encouraged to join the nuclear program. Marines are more likely to be assigned where they are needed. Participants cited their technical training and a desire to improve processes and products as key reasons for pursuing engineering. Veterans in the nuclear Navy indicated that they were also encouraged through their training to seek higher education in engineering whereas Marine Corps veterans received little encouragement to seek higher education outside of the Marine Corps. Colleges of engineering can use this information to tailor their recruiting of former service members by connecting the dots from training to engineering education for those with technical training. The services are likewise encouraged to connect the dots between training and future education explicitly. For those without technical training, university recruiting messages could emphasize the assets of discipline and hard work gained in the military as well as the opportunity to improve processes they may have encountered in their service.

Introduction

The United States Marine Corps and the United States Navy have an intertwined history that goes back to the founding of the country. The Marine Corps is one of the two services under the Department of the Navy. Historically, the Marines have provided protection on board ships (e.g., fending off enemies trying to board) and are charged with all landings on foreign shores. While some duties overlap (e.g., piloting and maintaining certain aircraft), others are unique to each service. For instance, only Navy personnel provide medical and pastoral care and only Marine personnel guard US Embassies around the world [1]. Because the services are relatively independent administratively, but connected at the top, they provide an opportunity to contrast policies, procedures and outcomes as they relate to the educational trajectory of their veterans seeking an undergraduate engineering degree.

Following their time in the service, many veterans pursue higher education. According to Cate, between August 2009 and December 2013, slightly more than 18,000 student veterans used their Post 9/11 GI Bill benefits to earn an engineering or engineering-related degree [2]. These

veterans often bring significant training and skills to their studies, including discipline, [3] leadership, [4] - [6] problem solving, [5], [6] teamwork, [5] - [7] and practical knowledge [3], [8], [9]. Because veterans are more likely to be older, first generation college students, disabled, African-American, or Latino, they also can serve to diversify undergraduate engineering programs.

In this paper, we explore three research questions: 1) What reasons did student veterans in engineering (SVEs) give for first enlisting in the Navy or Marine Corps? 2) What factors influenced their job placement in the service? 3) How does military service influence their decision to later major in engineering? This paper expands the literature about veterans in engineering by contrasting the experiences, motivation, and corresponding educational pursuits of veterans in two different branches of the armed services, rather than treating them as a monolothic group. This paper adds to the literature on student veterans transitioning to engineering degree programs by investigating the influence of military job placement and career pathways on the decision to choose an engineering major specifically for Navy and Marine Corps veterans.

Background

All recruits into the armed services must take the Armed Services Vocational Aptitude Battery (ASVAB). This 2-1/2 hour test measures aptitude on 10 domains, including arithmetic reasoning, mathematics knowledge, paragraph comprehension, mechanical comprehension, and electronics information that helps determine job placement once a recruit enlists. A composite of the word knowledge, paragraph comprehension, mathematics knowledge, and arithmetic reasoning subtests yield an Armed Forces Qualifying Test score, which is a percentile rank relative to a reference group and determines eligibility to enlist [10]. For the Marine Corps, the required score to enlist is 31 while in the Navy, it is 35 [11]. In general, recruits with higher scores on the total battery have more options regarding placement into a Military Operational Specialty (MOS, Marine Corps) or Navy Enlisted Classification (NEC, more commonly referred to as “rating” or “rate”) and scores on subscales help determine where a recruit is placed following basic training (auto mechanics vs. cybersecurity, for instance), subject to the needs of the force and the interests of the recruit [12, p. 21].

High scoring recruits are particularly prized in the Navy where they are encouraged to pursue a rating in the nuclear field [12, p. 61]. Navy “nukes” qualify for substantial enlistment bonuses and relatively rapid promotion if they successfully complete the two years of training required [13]. The Seaman to Admiral (STA-21) program pays for an engineering degree (among others) for very highly qualified enlisted personnel who wish to become officers [14]. Marine Corps recruiters are ordered to present a career where “technical training, education, and other rewards are available for those who work and desire to make their own way” [15, p. 1-6]. Marine Corps recruiters are not permitted to make promises related to incentives, promotions, bonuses, placement, or educational opportunities unless expressly permitted. Though both the Navy and Marine Corps offer guaranteed placements, those of the Navy are spelled out in detail in the recruiting manual [12, pp. 412-424] whereas the needs of the Marine Corps change from year to year and are not codified in the recruiting manual but rather as annual bulletins to the recruiting command [16].

Service members all receive training following boot camp in their assigned MOS or Rate which may be as little as a few weeks or as long as two years. Although the Navy is changing its training approach, these Navy veterans described the training they received after basic training. The first school is "A-school" where the fundamentals of a job are taught. For sailors in the nuclear field, "pipeline" training consists of A-school, followed by "power school" and finally "prototype" where they have an opportunity to practice on a prototype nuclear reactor before being assigned to the fleet. All Marines must attend infantry school after boot camp. Those not continuing in the infantry then go to specialty training [17]. The military trains its members to be technically proficient in whatever occupation they are assigned [18]. This training is used as a recruiting tool, particularly for those without a clear direction who want to gain workplace skills. Zoli and colleagues' ongoing study of veterans [19] finds that 45% of their sample acknowledges some Science, Technology, Engineering, and Math (STEM) training, which they believe underreports the actual number of veterans and service members with such training because "many servicemembers lacked familiarity with both STEM and engineering education degree programs and professional careers" [19, p. 25].

Methods

Navy and Marine Corps veterans were interviewed at four institutions across the USA participating in a larger study of student veterans in engineering. Interviewees were recruited through various channels, including university staff and faculty, Student Veteran Association chapters, flyers on campus, and reaching out to students who had volunteered for prior focus groups as part of an earlier phase of this study. All volunteers were asked to fill out a screening survey that asked for demographic and service information in addition to contact and availability information.

The interview protocol followed a semi-structured format. Pilot interviews were conducted in the Fall of 2014 and the interview protocol was revised based on the results and feedback from our external advisory board. Students were asked to describe their life history as an ice breaker to open the discussion and questions followed about, among other things, their transition out of the service, their educational pathway, and the impact of the military on their choice of college major. The relevant Institutional Review Boards approved the study protocol. The majority of interviews were conducted between the spring of 2016 and the spring of 2017. Participants were paid $50 for their participation.

Data Analysis

Each interview was transcribed by a professional transcriptionist. Project team members and their student assistants verified the accuracy of each transcript. Verbal prompts from the moderators (e.g., uh huh), irrelevant digressions (e.g., conversations about parking), and false starts were omitted from the analysis. Members of the project team wrote episode profiles [20] for each person whom they interviewed that highlighted the core narrative of the interview as it related to the initial research questions and also chose key quotations that epitomized the flow of the narrative.

Following Miles, Huberman, and Saldaña [21, pp. 107-119], data displays were created that looked at the key research questions by branch of service and participant; by technical/non-technical MOS and branch; and also by participants, MOS, and branch of service to get an understanding of the differences in military and educational trajectories that were experienced by veterans in different types of military jobs, with particular attention to contrasting technical and non-technical jobs. In addition, transcripts were coded using the primary research questions as a priori codes and analysis was assisted by Atlas.ti™, a qualitative software analysis program.

Sample description

Table 1. Demographic characteristics of study participants

Demographic Characteristic		**N**
Military Branch	Navy	20
	Marine Corps	15
Years of completed service	1-5	20
	6-10	10
	>10	4
Last or current rank	E3	1
	E4	10
	E5	10
	E6	10
	E7	1
MOS/Rate includes technical, mechanical, or electrical training	Yes	23
	Marines	7
	Navy	17
	No	12
	Marines	8
	Navy	3
Deployed in support of an armed conflict	Yes	19
	Marines	12
	Navy	7
	No	16
	Marines	3
	Navy	13
Engineering Major	Mechanical	16
	Electrical/Computer/ECE	11
	Civil	2
	First-Year	2
	Aerospace, Agricultural, Industrial, Materials Science, Nuclear, Textile (1 each)	6
Sex	Male	30
	Female	5
Race	White	28
	Black	3
	Asian	2
	Other/More than 1	2

Note: Incomplete data available for four participants

For this study, we included only former or current enlisted personnel whose service included active duty beyond training (i.e., not solely National Guard or Reserves). The study group consisted of 15 Marine Corps veterans and 20 Navy veterans enrolled across our four study institutions. Most were non-commissioned officers. Six SVEs were concurrently serving as part of the Navy STA-21 program or in the Reserves. The respondents ranged in age from 23 to over 40 years old. A job was considered to involve technical, mechanical, or electrical training based on participants' descriptions of their work and training. Table 1 highlights the salient demographic characteristics.

Findings

In this section, we address our three research questions. SVEs are identified by their interview code, with the letter (W, X, Y, Z) representing their anonymized institution and the number representing their interview number; branch of service; and, as appropriate, their MOS or Rate. The respondents' actual words appear in italics below.

Research Question #1: What reasons did student veterans in engineering give for first enlisting in the Navy or Marine Corps?

Among the reasons cited for these veterans to choose to enlist were the events of September 11, 2001 a desire to give back to their country, and a longing for discipline and direction, and as a means to pay for college. Marines and sailors differed on their relative desire to engage in combat.

But then September 11th happened and that was the tipping point. (X10, Marine)

Veterans in their early 30's at the time of the interviews were coming of age at the time of the terrorist attacks of 9/11. Veterans who are older had typically joined the military prior to that time, while for younger veterans, those events and the resulting wars are simply a fact of life. For two veterans who had graduated high school in June of 2001, the events of September 11th were the impetus to join the Marine Corps. For X10, quoted above, the cost of college was out of reach for his family, and he had already been in contact with military recruiters to explore options to pay for college. A different pathway to the same result was experienced by Z11, who had wanted to join the Marine Corps following high school but worked as a firefighter and emergency medical technician (EMT) for five or six months instead before deciding that the medical field did not suit him and *just decided to go[to the Marines]*. Two other SVEs joined a few years later but felt that *9/11 was still resonating* (W14, Marine) with them and they *wanted to be part of the war effort* (Z8, Marine)

It's my personal belief that I should give back in a way…it's about the greater good of things. (X4, Navy)

Unlike the SVEs above, for whom a single traumatic event in the nation's history was a deciding factor in their decision to enlist, some of the SVEs in their mid-to-late 20's by contrast had familial, altruistic, and patriotic reasons to serve their country. Y1 (Marine), Y3 (Navy), and W17 (Marine) describe *rich military traditions* (Y3) in their families citing a number of relatives

who had served. Two conflated their call to serve with their faith. X6, a Marine, *felt very much called to join the Marine Corps,* citing his religion as a key factor while Z15 (Navy), having spent his youth serving as a missionary with his parents, believed *growing up in third-world countries* made him *proud and happy and grateful to be an American* and he *just wanted to give back.*

I failed out of college the first time and I realized that I needed some more discipline, and I went to the Marines and got it. (Z7, Marine)

An extremely common narrative among these students was one of joining the military because of failing in early college experiences or disinterest in school generally and a desire to find a sense of direction and purpose through military service. A few, like X6, realized that he went to college the first time *because that's what everybody else was doing and I was told to do after high school,* but he only completed one class successfully before deciding to go to the Marine Corps recruiter. Similarly W2 declared an art history major to secure a scholarship at community college and *failed out immediately* after realizing that was not a good career path for him and he went to talk to the Navy recruiter and *went to processing three days later.*

"*Lack of direction*" specifically was a common refrain. X1 joined the Marine Corps because

> *I felt like it was the best route to get myself out of the position that I was in which is I was 240 pounds, just I* ***had no direction*** *because I couldn't go to college out of high school [due to poor grades], I had this image that that would give me discipline I needed that I felt I was lacking.*

Similarly, W5 (Marine) had gotten himself *into some bad social situations and I kind of* ***needed some direction*** *and somebody to smack me around and put me back in line.* W14 (Navy) said *the biggest factor was probably the* ***lack of direction*** and *Z*3 (Navy), rather than experiencing failure in his prior college pursuit of a finance degree was simply bored and was *looking for something else; I* ***had no direction***. The same sentiment was credited to a lack of maturity by W12 (Navy), who *couldn't focus* and *figured the military would probably give me some much needed personal responsibility and maturity*.

There's really only one option for me to [go to college] and that would be military and GI Bill. (W10, Navy)

Among the common recruiting pitches from military recruiters is the ability to use the GI Bill to pay for college once veterans have finished their active service (e.g., [22], [23]). This exchange of service for college financing was a critical factor particularly for SVEs who were on the college pathway from high school, but found that they would be unable to pay for college without substantial debt. W10, quoted above, describes in more detail how important the future GI Bill benefits were to him:

> *The only reason I joined the military is because I was poor. I tried the hardest I could. I did scholarships. I started doing scholarships and trying to get money for stuff in eighth grade. And, I did at least 40 scholarships when I was in freshman year, and I was doing*

> *more when I was in sophomore and junior years. … I did all that working to try to get into school and by end of senior year, I calculated all the cash I got, and tried to see if I can get anywhere that I really wanted to go. And I found out I was short.*

In a similar vein, W6 (Navy) describes how he overheard his parents discussing dipping into their retirement savings to pay for his college and, at the behest of a friend, went to a Navy recruiter who told him "*it pays for you college and you get a paycheck right away*" which made him decide to enlist.

Others did not describe such dire financial circumstances in their families, but decided to join in order to avoid taking out student loans to pay for college (e.g., X5, Navy), *a little bit of patriotic service and getting the college benefits* (Y1, Marine), *as a stepping-stone…to go back to college to get a degree* (W14, Navy), or as a fresh start to get the college education he had always wanted but *had already screwed that up from the get go* (by dropping out earlier) (W12, Navy).

I didn't really want to be getting shot at. (W14, Navy)
I joined the Marine Corps because I'm dumb and proud. (X1, Marine)

While patriotism, direction, and GI Bill benefits were reasons to join that were expressed by both Navy and Marine Corps veterans, the prospect of being shot at – or not – very much distinguished which branch these SVEs chose to join. X2 (Navy) did not believe that *running around with a gun* was the best thing he could do for his country while Y3 (Navy) considered how worried his mother would be about the *potential of being sent over to Iraq and Afghanistan*.

In contrast, Marine Corps veterans expressed a sense of pride in *how Marines carried themselves* (W11) and a desire to prove themselves *to be among the best* (X1). X10 asked his Marine recruiter why he should be a Marine and the recruiter replied "*The only reason people enlist to be Marines is to be Marines*" at which point, X10 was convinced that this was the right service for him. Y2 *didn't want to halfway do it.* He *wanted to do enlisted for the Marine Corps* and *wouldn't do anything outside of that.*

<u>Research Question #2 What factors influence SVEs' job placement in the service?</u>

Recruiters were influential in helping recruits choose their job placement. ASVAB scores and performance during training helped sailors and Marines get certain Rates or MOSs and the needs of the force also affected whether someone was placed in their desired job. Some students were strategic in their requests, asking for certain jobs that they believed would better prepare them for their future outside of the military.

The Navy recruiters came and talked to me and they told me about their Nuclear Program, so it sounded pretty interesting. (X4, Nuclear Machinist Mate)

Outside of family members who have served in the military, recruiters are the primary information source about potential job placement. For the Navy, in particular, recruiters look for highly capable people, as measured by ASVAB scores, to be trained as electrician's mates, machinist's mates, and electronic technicians to support the nuclear Navy. As Y12 indicated,

they always need people in the nuclear engineering, so they try to push whoever's got higher grades into there. X7 initially had no desire to be a nuke *because I'm afraid of radiation*, but then the recruiter explained the job to her and said *"it's not like we're having leaks all over the place"* and *that's why I'm a nuke now.* She ultimately became an instructor at Prototype school and was chosen for the STA-21 program. Others found it *interesting* (Z14, X4, Y12) and were willing to *give it a try* (Y3), in spite of the additional two-year commitment on their enlistment to compensate for the additional training.

Before I enlisted I picked Nuclear and then at boot camp we take a test and then they ask us what we want to do and they try and match that to the needs of the Navy as much as possible. X5

The recruiting manuals and recruiting documents are very clear that there are no promises of a specific MOS/Rate placement, particularly for the Marine Corps, unless it is part of the signed enlistment contract [15, p. 4-23], although the Navy has a relatively large number of technical and specialty rates that can be guaranteed for people who meet certain physical and ASVAB score standards [12, pp. 412-424]. X5, quoted above, and described by her peers as a brilliant and outstanding officer candidate in the STA-21 program, goes on to say *I was selected to be an electronics technician based off probably just my request for electronics technician.*

Choose your rate, choose your fate is how Y12 (Navy) describes the 10 minutes he was given to decide what rate he wanted even though he had *no idea what you're actually gonna learn or what your gonna do* based on the limited job description provided. W14 (Navy) had originally signed up for nuclear propulsion when *the recruiter told me I wouldn't have to go in a submarine*. When he received his assignment, he was assigned to a submarine, but was given a chance to reclassify as an Aviation Electrician *because they don't go on subs*. Although service members' requests may be taken into account, the needs of the force are primary, particularly in the Marines, as X6 discovered after boot camp. He had *initially wanted to be a combat engineer* rather than in the infantry because he *wanted to have a skill set.* After boot camp, he was assigned a job as a heavy equipment operator, which he believed was in the engineering field, but felt that they *had kind of switched* on him.

As in other situations, people with high ASVAB scores, specific skills, or good performance in A-school are better able to choose their pathway. W5 became a translator in the Marine Corps because languages were his *strong suit.* Y2 (Marine, Composite Repair Technician) describes how he got his preferred MOS:

> *When you go in, they don't really know where exactly you're gonna end up…. [E]veryone goes through the same basic A school, the first initial school. Then based on the slots they have available [and] based on your class rank, you get to pick [from] the slots that are available. I worked hard to get to that position because I didn't [just] want to work on the aircraft. I wanted to do the actual repairs…just because it's a lot more technical skills and learning all the carbon fiber stuff and the welding and everything.*

I knew there was a war going on and …didn't want to go to a job that was not going to prepare me for combat. (W4, Marine)

Similar to the reasons for enlisting in the Marine Corps relative to other branches of the service, future SVEs chose to be in the infantry because *there's real Marines – infantry Marines, combat arms, …artillery – and then there's other Marines* which he somewhat apologetically referred to as *POGs or Personnel Other than Grunts* (X1, Marine). X1 chose the infantry because he *wanted to be on the front lines fighting* and also *felt that just the stress and the intensity of the infantry would prepare me better for everything I would do in life as well as give me the skills to defend my family if ever I had to.* W4, quoted above, could have prepared for combat in the Army, but chose to be a Marine because *it's a much smaller organization, the standards are held higher just because there's no place to hide.*

I knew I didn't really want to make a career out of the Navy and so it was really just a stepping stone to get to where I could be a more desirable [job] candidate. (W7, Navy, Nuclear Machinist Mate)

While needs of the force are influential in determining one's MOS or Rate, Marines and sailors are often strategic about the choices they make insofar as they are able. W7 exemplifies this strategy noting that his *desire to be an engineer drove me to do what I did in the Navy than the Navy drove me to be a civil engineer*. Similarly, X10, an ejection seat mechanic, shared that he

> *knew I needed a skill outside of the Marine Corps. And I knew I liked aviation, and I wanted to be a pilot, and I didn't have a degree so I couldn't be an officer and fly planes, so I chose the next best thing which was to work on them.*

<u>Research Question #3: How does military service influence the decision to later major in engineering?</u>

In this section, we discuss how military services directly influenced SVEs decision to major in engineering. We do not address the experiences and rationale of the SVEs who were committed to engineering prior to their time in the service nor those for whom the inspiration came as a result of post-service job requirements or schooling.

The Navy showed me that there's this other branch called nuclear, and this is what nuclear technology can do. (X4, Nuclear Machinist's Mate)

Beyond the specific requirements of the STA-21 program, many of the former Navy nukes chose engineering because of the training in the pipeline as well as the day-to-day aspects of their job on board a ship or sub. X4, quoted above, goes on to say

> *…it's like not just building bombs and blowing things up but we can use them to power our plants and they're a very … efficient resource instead of burning coal or gas. And they were able to take that and put them on aircraft carriers and submarines, and it's pretty fascinating once you think about all that goes into building a power plant, especially a mobile one.*

She decided to continue in the nuclear field as a nuclear engineering major, in part because she was encouraged by her pipeline instructors to *do well in my job* and learn *the theories, and math,*

and reasons why certain things function the way they do which *goes into the engineering aspects …more than they would normally teach us through the pipeline*. During the two years of pipeline training, a future as an engineer, as well as the potential for promotion to officer, is made explicit through interactions with instructors. *When you join the Nuke Program, it's one of the things that they kind of offer as an incentive, that it's very easy to transition into an officer program and get commissioned* (X2, Navy, STA-21).

The nuclear field provides many excellent private sector job opportunities as a technician for former enlisted personnel. Both X4 and Z1 chose to pursue an engineering degree rather than a job as a nuclear technician, which would be both readily available and pay well, following their service. Z1 decided to go back to school when his contract was up because *while I was in realized I wanted to move up… the technicians kind of have a glass ceiling.*

Out of all the Marines that did what I did, I was among one of the few that had such a working relationship with the engineers because . . . I was always talking to them, working with them, asking them questions, learning what they knew. (X10, Ejection Seat Mechanic)

X10 was exposed to engineers in the day-to-day aspects of his work because *if something was wrong and we couldn't fix it then we would have to call the engineers*. He was told this was because they had designed and built the thing he was working on, which made him think *that's really cool; I can do that*. Once he realized that he wanted to become an engineer following his service, he *was always asking [the engineers] questions…about what they did* because he *didn't know what an engineer was…it was a new understanding of how things got done and how things were made.*

In contrast to X4, who felt encouraged to pursue engineering as a field from her pipeline instructors, in his interactions with the engineers, X10 said *we never talked about me…we were always talking about them.* He used his opportunity to soak up knowledge about the engineering field, but was never directly or systematically encouraged to pursue engineering in the ways that people in the nuclear pipeline were.

I think the thing that the military influenced the most in my decision in engineering was to be a mechanical engineer because my job… exposed me to mechanical systems. (W12, Navy Damage Controlman (Firefighter))

Outside of the nuclear Navy, a number of jobs in both the Navy and Marine Corps provided training in mechanical systems and electronics, which influenced the SVEs desire to pursue an engineering degree in these fields. Z5 (Avionics Technician) credits the Navy with showing him that he *has a knack for electronics*. Z8, a former Marine in charge of Explosive Ordnance Disposal, chose to be an electrical engineer because he took *advanced electronics classes for my job [which] piqued my interest at first and…I saw it was like the tip of the iceberg and then I wanted to just know more about it and get better with it.*

It's more important to me to finish off the [STA-21] program and get commissioned than it is to be specifically like a mechanical engineer. (X2, Navy)

The most direct relationship between the Navy and engineering is through the Seaman to Admiral (STA-21) program. Sailors participating in this program are strongly encouraged to choose a technical major and must complete their degree program within 36 calendar months of beginning [14]. Other branches, have enlisted-to-officer options (e.g., Green to Gold in the Army), but because two of our study sites are approved locations for the STA-21 nuclear option, we interviewed three students who were participating in that program, all of whom had come through the nuclear pipeline and had been staff instructors.

If I can prevent [back injuries], I'd be doing a lot of good for my brothers. So, . . . that was the point that I decided I wanted to go into engineering and I wanted to design these new systems that would prevent that. (X1, Marine, Infantry Assaultman)

Improving processes and products motivated some of these students to choose engineering. X1, quoted above, describes the back and other injuries he sustained from the body armor he was required to wear in a combat zone that could weigh 80-90 pounds. As a student, he was in significant pain that he had to manage. He chose textile engineering because he

> *knew that there was a market for something that could possibly prevent people having the same issues as me further down the line because people who are in their 20s now that are perfectly fine [when they are] in their 30s and 40s [are] going to have the same issues as me from the same exact thing – it'll just take longer to show its ugly head.*

X10, who likewise experienced back problems as a result of being an ejection seat mechanic, chose mechanical engineering due to his *frustration with the way things were designed, or built, or put together*, noting that *there was so many times that we were working on something, or… we're trying to put something together or take something apart, and you spend man-hours, upon man-hours, upon man-hours trying to accomplish this task*, wondering why things were the way they were and believing he could do a better job. Z4 (Navy, Sonar Tech) also talked about the difficulty and occasional danger of accessing certain equipment on board a ship when it is rocking and said *that was the first thing that tipped me off because I love to fix things [and thought] You know what? We can do something better.*

Limitations

All five researchers in this study are women and none of us served in the military. Qualitative research, by its nature, is designed to explore in depth the experiences of a relatively few people. Therefore, the opinions and experiences of these students may not reflect those of all Marines and sailors. In addition, we were limited to studying only publicly available recruiting documents and more current or non-public ones may reflect different priorities.

Discussion and Conclusion

The reasons that people join the military and choose to major in engineering are multi-faceted and interwoven into their life histories. While a few of the veterans we interviewed had a planned and linear pathway both to the service and to engineering, most came to each decision through a series of detours brought on by personal choices and circumstances. Failure, often

coupled with lack of direction, was a common motivator for some of our interviewees to join either service. The opportunity to fund a college education through the GI Bill was also an incentive for some interviewees.

What most distinguished the Marines from the sailors we interviewed was wanting to be in the middle of combat action rather than wanting to serve in other ways. Sailors more often wanted to serve and do their patriotic duty while doing so relatively safely. Marines embody their motto, "The Few, The Proud." They are proud of their service and proud of being a fighting force. Because of this dichotomy, the recruiting of future sailors and Marines emphasizes different aspects of service. The recruiting manuals for both services (e.g., [12], [15]) detail explicitly how recruiters should find prospects, communicate with prospects, interact with influencers (e.g., schools, parents), etc., but as X10's recruiter said, *the only reason to join the Marines is to be a Marine.* By contrast, for Navy recruiters, recruiting to the Nuclear Power Program is second only to total recruits among their seven recruiting goals. "Recruiters are encouraged to recommend the Nuclear Field to all applicants they perceive as likely to qualify" [12, p. 61]. Third on the list is recruiting people with "high mental aptitude and education" [12, pp. 61-62]. People who qualify can thus enter the Navy with a guaranteed placement in a nuclear or other technical or highly skilled rate once they exit basic training.

Once in the service, all sailors and Marines are well trained and expected to do their jobs. Certainly, training is very specific to each job. However, no Marine we interviewed indicated that anyone during their training or on the job encouraged them to continue their education after the Marine Corps nor did anyone help them to "connect the dots" about the relationship between the work and training that they did and a future in engineering. Some Marines, who joined for the purpose of the educational benefits, were strategic in their choice of MOS so that they could learn concepts and skills that would help them in the future, whether or not they knew in advance that that future would involve engineering. Navy nukes, by contrast, were told often during their pipeline training about how well it would prepare them for engineering jobs or study after their Navy career. In fact, that was part of the recruiting pitch for those rates. Because the nuclear training is so valuable in the private sector, the Seaman to Admiral program is introduced and discussed regularly during the pipeline and people who would be good candidates are encouraged to apply. This helps to ensure that the Navy retains highly qualified and well-trained people for a longer time and also makes the direct connection to future engineering for many others.

The mission of the Marine Corps is to "Make Marines, Win Battles, and Return Quality Citizens to their communities" [15, p. 1-4]

The mission of the Navy is "to recruit, train, equip, and organize to deliver combat ready Naval forces to win conflicts and wars while maintaining security and deterrence through sustained forward presence" [24].

Nowhere do these mission statements say that the mission is to prepare Marines and sailors for engineering education, nor is it reasonable to expect that they should. It is beyond the scope of this paper to talk about the transition experiences of service members as it relates to their education. However, it is fair to say that outside of the nuclear pipeline, we heard little of

systemic help given to service members to connect the dots between their training and a future as an engineer. Everyone leaves the service eventually, whether through retirement, reductions in force, contract expiration, or injuries, so at some level, they need to be prepared to be the "quality citizens returned to their communities."

If we had one recommendation for the Navy and Marine Corps, it would be to help their service members early to connect the dots between their training and their future. This echoes recommendations made by [25]. Many of our interviewees indicated that the formal programs they attended as they were transitioning out of the service had little emphasis on future education beyond a brief discussion of the GI Bill. What information they did receive about pursuing a 4-year degree came too late for those who did not already have a plan in place. However, as engineering educators, we also shoulder some of the responsibility for helping former service members to see a future as engineers. Our research has shown that the line is rarely drawn between technical MOSs and Rates during a Marine or sailor's time in the service. However, what often seems obvious to the engineering education community can be made clear to the veteran community through recruiting messages from colleges of engineering that highlight how military training relates to engineering education. In addition, engineering programs should consider how to adequately value the technical training that many veterans have received. Only one of the institutions in this study gives academic credit at the introductory engineering level for such training. While the reasons for not accepting more of the training as academic credit are generally and probably rightfully due to a lack of calculus in most of the military training, engineering departments could explore providing lab credit for the practical experience that some sailors and Marines have or other ways to value the assets that veterans bring. Certainly it is important for engineering advisors and faculty to explain to the veterans why their training credits are not equivalent to certain college courses and point out how the practical experience can be beneficial for helping them to understand the theoretical concepts introduced in engineering education.

Veterans who did not serve in technical positions can be recruited to engineering using other messages. In particular, the concept of product and process improvement for those who follow would resonate for many who saw ways to improve things but were restricted by protocol and chain of command from making or sometimes even suggesting changes. For these veterans, helping them understand that the self-confidence, focus, and discipline gained in the military are assets that will carry them far as they face new challenges in engineering education.

Acknowledgements

The authors thank the National Science Foundation for support of this research (Awards 1428512 and 1428646). The views expressed herein are solely the authors'. We are also grateful to Col. Casey Roberts, USMC (ret.) for his helpful feedback on earlier drafts of this paper.

References

[1] C. Roberts, "RE: Navy-Marine paper," Personal email (August 2, 2017).

[2] C. A. Cate, S. Lyon, J. Schmeling and B. Y. Bogue, "National Veteran Education Success Tracker: A report on the academic success of student veterans using the Post-9/11 GI Bill," Student Veterans of America, Washington, 2017.

[3] C. E. Brawner, C. Mobley, J. Main, S. M. Lord and M. M. Camacho, "Exploring the Intersection of Veteran Status, Age, and Engineering Study," in *Proceedings of the ASEE/IEEE Frontiers in Education Annual Conference*, Erie, PA, 2016.

[4] J. B. Main, M. M. Camacho, C. Mobley, C. E. Brawner, S. M. Lord and H. Kesim, "Technically and Tactically Proficient: How Military Leardership training and Experiences are Enacted in Engineering Education," *International Journal of Engineering Education*, vol. 35, no. 2, pp. 446-457, 2019.

[5] D. B. Stringer and M. McFarland, "Veterans' Contributions to Enhancing the Capstone Learning Experience of Engineering Cohorts," in *Proceedings of the ASEE Annual Conference*, New Orleans, 2016.

[6] T. L. Davis, D. B. Stringer and M. R. McFarland, "Integrating Veteran Experiences into Engineering Design: Veteran-led Student Development of High-power Rocket Competition Team," in *Proceedings of the ASEE Annual Conference*, Salt Lake City, 2018.

[7] J. Main, C. Mobley, C. Brawner, S. Lord and M. Camacho, "Using Focus Groups to Understand Military Veteran Students' Pathways in Engineering Education," in *Proceedings of the ASEE Annual Conference*, New Orleans, LA, 2016.

[8] C. E. Brawner, C. Mobley, S. M. Lord, J. B. Main and M. M. Camacho, "Transitioning from Military Service to Engineering Education," in *Proceedings of the IEEE EDUCON Conference*, Athens, Greece, 2017.

[9] N. Salzman, T. B. Welch, H. Subbaraman and C. H. G. Wright, "Using Veterans' Technical Skills in an Engineering Laboratory," in *Proceedings of the ASEE Annual Conference*, Salt Lake City, 2018.

[10] ASVAB, "ASVAB Fact Sheet," [Online]. Available: http://official-asvab.com/docs/asvab_fact_sheet.pdf. [Accessed March 7, 2018].

[11] Military.com, "ASVAB Test Explained," [Online]. Available: https://www.military.com/join-armed-forces/asvab/asvab-test-explained.html. [Accessed 7 March 2018].

[12] Navy Recruiting Command, Navy Recruiting Manual - Enlisted, Vols. I-V, Millington, TN: United States Navy, 2016.

[13] T. Fraser, "Recruiting a 'Nuke,'" 7 July 2014. [Online]. Available: https://www.navy.mil/submit/display.asp?story_id=79643. [Accessed August 17, 2017].

[14] United States Navy, "Seaman to Admiral-21 Program," [Online]. Available: https://www.sta-21.navy.mil/education.html. [Accessed January 29, 2019].

[15] Marine Corps Recruiting Command, Marine Corps Recruiting Command Enlistment Processing Manual, Quantico, VA: United States Marine Corps, 2011.

[16] C. Roberts, "RE: Navy-Marine paper," February 6, 2019.

[17] MarineParents.com, "What's After Boot?" [Online]. Available: http://whatsafterboot.com/.

[Accessed February 1, 2019].

[18] C. H. Dillon, "Military Training for Civilian Careers (or: How to gain practical experience while serving your country)," *Occupational Outlook Quarterly*, vol. 51, no. 1, pp. 7-17, 2007.

[19] C. Zoli, R. Maury and D. Fay, "Missing Perspectives: Servicemembers' Transition from Service to Civilian Life - Data-Driven Research to Enact the Promise of the Post-9/11 GI Bill," Syracuse University Institute for Veterans and Military Families, Syracuse, 2015.

[20] R. C. Maietta, A. Hamilton, K. Swartout, P. Mihas and J. Petruzzelli, *Sort and sift, think and shift: Let the data be your guide*, Carrboro, NC, 2017.

[21] M. B. Miles, A. M. Huberman and J. Saldaña, Qualitative Data Analysis, 3rd ed., Los Angeles: Sage, 2014.

[22] United States Navy, "Becoming a Navy Sailor (brochure)," [Online]. Available: https://www.navy.com/sites/default/files/2018-03/enlisted-brochure.pdf. [Accessed January 29, 2019].

[23] United States Department of Defense, "Paying for College," Today's Military, [Online]. Available: https://www.todaysmilitary.com/living/paying-for-college. [Accessed January 29, 2019].

[24] United States Navy, "Who We Are," [Online]. Available: https://www.navy.com/who-we-are. [Accessed January 30, 2019].

[25] American Society for Engineering Education, "Transitioning Veterans to Engineering-Related Careers: Next Steps," ASEE, Washington, DC, 2014.