BATTLEFIELD PERCEPTIONS OF ENGINEERING: AN INSTITUTIONAL RESPONSE TO ABSENT PATHWAYS AND MISSING ENGINEERING STUDENTS

SUMMARY:

World War II veterans formed the backbone of an era in which the US became a technological powerhouse and global superpower. As Edward Humes, author of *Over Here: How the G.I. Bill Transformed the American Dream*, notes 14 Nobel Prize winners, 91,000 scientists, 67,000 doctors, and 450,000 engineers got their start with GI Bill benefits. Through that process the US reaped many benefits, including the democratization of universities, conversion to a nation of home-owners, and the expansion of the middle class from 10 to 30 percent. These developments required two linked mechanisms: the historic 1944 GI Bill which educated nearly 8 million veterans and the availability of meaningful educational and professional pathways for students.

This project aims to boost the second mechanism by developing programs that establish and strengthen meaningful pathways to engineering at Syracuse University—with implications for other universities and STEM programs for underrepresented populations. At the core of our research is the realization that making good on the great expectations for US servicepersons to use their Post 9/11 GI Bill benefits to pursue engineering requires—first and foremost—understanding what GIs think about engineering.

Intellectual Merit: Through focus group interviews at US military bases and veterans' conferences, our research will identify the 'knowledge gap' between what engineers do and what servicepersons know about engineering and, in turn, develop programs to bridge this gap.

1) Given a missing literacy about engineering among US military servicepersons, our programs will help GIs make the connection between their military training and skill-sets and the value of an engineer degree and what it may offer them professionally.
2) We are the only project currently assessing military servicepersons' educational aspirations nationally and through rich data collection and only one of two programs conducting education needs assessment on this population at all (RAND 2009).
3) Data-Driven Program and Curriculum***:*** Drawing on data results, we will develop and deploy:

- *Engineering as a Career Fairs and Workshops*: a transportable curriculum to introduce and inform active duty personnel and veterans about engineering as an education and occupational field;
- Select *Battlefield to Classroom Scholar-Mentors* from the serviceperson population as leaders and mentors for other student engineering veterans;
- Develop a *Leadership Seminar* to provide an institutional venue to hone veterans' leadership skills for application to professional engineering and partner with regional universities and businesses to support veterans' career pathways.

Broader Impacts: It is anticipated that other universities and institutions will apply these research tools and program results in planning for the influx of veterans into higher education. This project will enable stakeholders to perform some of the following critical activities:

1) Design, develop, and deploy transportable data collection tools for diverse, segmented populations

- Determine broad factors for guiding future program development and research frameworks for university engineering programs
- Develop assessment tools for profiling GI engineering aspirants for stimulating a pipeline of veterans
- Develop criteria to design and improve methods of attraction for benefits-eligible GIs and identify factors that diverse veterans use to define their own aspirations

2) Develop innovative concepts for guiding custom education programming

- Develop innovative concepts for guiding custom education programming and supportive partnerships
- Develop a knowledge base of support resources that GIs report as helpful for enhancing recruitment, transition, persistence, degree completion, professional development, and academic support.
- Develop strategies to leverage the diversity of veterans for the engineering pipeline
- Maximize enrollment and retention by learning about GI motivations to pursue technical education
- Engage industry partners as potential employers, valuable resources for veterans' career development, and partners in academic institutional investment to support new educational programs
- Map the pathway from the battlefield to postsecondary education, with sensitivity to traditionally underrepresented groups in science and engineering

1.0 INTRODUCTION: Lack of Data-Driven Research on Engineering Aspirations

There is great hope from all sectors—universities, industry, and government—that U.S. military servicepersons and veterans will take advantage of the Post 9/11 GI Bill[1] to pursue engineering education and help to increase the numbers of engineers in this country (National Science Foundation, Workshop on Enhance the Post 9/11 Veterans Educational Benefit, 2009). It is often assumed that technical capacity is part and parcel of the rigorous training programs (known as military occupational specialty or MOS in the US Army and US Marines) for servicepersons, and that this training may be easily transferred to an engineering degree program.[2] There is even interest in the prospect that these engineers will be ready to work immediately in the defense and homeland security sectors, as they may already possess or are able to quickly gain security clearance (SU-NSF GI Bill Advisory Board meetings 2009).

Yet, the reality is that there is surprising little data—especially at the national level and across military branches—available to support these suppositions. We are currently engaged in an mixed-methods study funded by IEECI (NSF Award 10502) to determine just that: (1.) whether US active duty servicepersons and separated veterans have an interest in using their Post-9/11 GI Bill benefits to pursue engineering education; (2.) what their aspirations are for engineering fields and career trajectories; (3.) what their needs are once they arrive at universities to pursue technical degrees; and (4.) how we might support them in these endeavors. We are in the process of visiting US military bases (representing several service branches of the military) and regional conferences for student veterans to conduct focus groups that address these questions. In addition to these 500 data points from focus groups interviews, we are in the process of disseminating an online survey to the national veteran population that will yield approximately 10,000 responses. As far as we know, we are the only project (see a recent RAND study, Tanielian & Jaycox 2008, for health issues) collecting data on US servicepersons' educational aspirations and needs.

The preliminary data from this project indicate many fascinating observations and insights. First, there is an educational divergence among servicepersons between officers and enlisted personnel: officers among all service branches tend to hold bachelor's degrees and are typically interested in pursuing graduate degrees with their educational benefits. Many of these officers seem well aware of business programs (i.e., the MBA), but have little familiarity with the prospects of engineering education.[3] By contrast, most enlisted servicepersons do not hold bachelor's degrees, and many are uncertain about whether they wish to pursue higher education at all. Second, most servicepersons do not understand what an engineering degree entails, what aspects of their technical training in the military it may leverage, and their career prospects in engineering. When we asked active duty personnel at the combat installation Fort Drum, including those with an engineering-related MOS, whether they had an interest in pursuing an engineering degree we were told that "even though I'm a truck mechanic, I didn't do that on tour—I spent my time getting goats out of trees, building roads, or helping infantry squads do scouts." We were surprised to learn there is a missing literacy when it comes to what an engineer does and what engineering education might entail among US military servicepersons, especially at the enlisted level. In fact, our data indicate that even servicepersons with MOS's that indicate a technical specialty do not perceive themselves to be ready to pursue an engineering degree and do not in fact understand the job of an engineer. It is therefore clear that a program is needed to help both active duty military servicepersons and veterans make the connection between their military training, experiences, and skill-sets and the value of an engineer degree and what it may offer them professionally. It is also clear that prior military service offers enormous potential talent for the field of engineering and the technical fields in general. Making such links would go a long way in helping veterans recognize their potential for success in engineering and for universities to realize the technical talent of the all volunteer force. We propose to create just such a program.

1.1 Need for Curriculum on Engineering Leadership

We have also learned from our preliminary data that servicepersons have multiple concerns—practical, financial, emotional, social, academic, health and family-oriented—about campus life. As one enlisted soldier at Fort Drum said about the prospect of finishing his bachelor's degree: "I have to compete with kids fresh out of high-school when I've been out of academics for 5 years; I have to support my family while I'm doing it and find a job, and keep my head on straight—that's a lot of pressure and stress; the only difference is that I'm not getting shot at while I do it." Of particular interest to this proposal is the recurring theme we heard in the focus group that GIs wish to build upon the supportive network and leadership skills attained during military life.

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[1] Post-9/11 Veterans Educational Assistance Act of 2008, Pub.L. 110-252, H.R. 2642, an Act of Congress (June 30, 2008) that act amended Part III of Title 38, US Code to include a new Chapter 33, which expanded educational benefits for military veterans who have served since September 11, 2001 (effective 1 Aug 2009).

[2] For example, the MOS designation 15B (E3-6) is an Aircraft Powerplant Repairer; 15M (E3-6) is a UH-1 Helicopter Repairer; 25U (E3-8) Signal Support Systems Specialist, etc.

[3] This is likely a product of active recruiting by MBA programs, some in theatre (O'Keefe 2010; Damast 2009)

Our preliminary findings show that there are a number of core reasons why leadership is important to servicepersons and even understood as a code of trust among them. First, the general concept of leadership is part of military training, part of the premise in the US Army that you are a "cut above," you strive for excellence in your work and life, and others' lives depend on your ability to exhibit leadership, especially under austere conditions. Leadership is a source of personal empowerment and agency, a matter of self-identification and trust among servicepersons, a concept tested in combat circumstances. The second aspect of this commitment to leadership is a deep respect for the chain of command, an understanding that an organized system makes for the best possible output of the team as a whole, and that their accomplishments together will often far outweigh any individual contribution. This aspect of leadership underpins the famous *esprit du corps* so core to military life. As numerous focus group participants told us, "you found yourself tested and going above and beyond, doing things you never thought you were capable of, to protect a buddy or a comrade—even if you didn't like the guy."

A third aspect of leadership that is particularly relevant to this project is the unique prestige servicepersons feel is associated with it. US military men and women were overwhelmingly proud of their service to the United States—even when they were critical of problems or inefficiencies of the US Army—and they believe that they are, because of their training and experiences, leaders among their peers. Over and over again, they told us: "part of civilian life that's hard to deal with is people not being focused and disciplined, wasting opportunities, not working together in a way to make things happen; not taking their job, even if that job is school, seriously—like some girl talking on her cell during class or a guy crying over a girl or some other petty thing; my thought is, man, get some perspective and direction. No one's trying to kill you, so how bad can it be? And realize that your job, even though it may seem small, is critical—others' lives depend upon you doing it well." In our interviews, servicepersons were extremely articulate about the pivotal role they believed their leadership training, philosophy, and abilities could contribute to campus life. Yet, their concern is that having served the United States may be perceived as a stigmatizing condition on college and university campuses.

The GIs' identification with leadership skills is complementary with the leadership theme that runs throughout current thinking regarding the modern engineering curriculum. Indeed, the development of leadership is a well-documented and critical element of engineering education, especially as we look to the future (ABET, EC2000; Jamieson, Lohmann et. al 2009, p. 18). It has been argued that such abilities should be considered a core component of engineering problem solving (Jablokow 2007). Such skills are increasingly in demand in a global, competitive environment (Bowman & Farr 2000) and, as recent studies indicate, play an increasing role in many engineering careers (e.g. Bellinger 2002, Wearne 2004). Some have even suggested that engineers may be at a disadvantage for career advancement in management, as compared to those from other fields such as business or law, which provide greater training on so-called "soft" leadership skills (e.g. Summers et al. 2004; Kumar & Hsiao 2007).

Equally important, there is a significant body of literature that now shows how engineering leadership, technological change, and economic development (nationally and globally) are intertwined (Frankel 1993, Hilton, 1995, *Engineer of 2020*; Freeman 2006; Roessner et al. 2002). Some have argued, for instance, that while the US remains dominant in technological innovation we are behind in applying new technologies because of a lack of engineers in decision-making roles in industry and government (Frankel 1993). Others note the decreased hiring of engineers in government sector leadership roles (which have been assumed by professionals with little or no engineering experience), even in overseeing major public-works facilities. Such trends not only retard the ability of the nation to maintain the quality, reliability, and resilience of engineered systems (from public-works facilities to national security measures) but indicate a lack of understanding or preparation among engineers of the importance of principles and practices of leadership (Hilton 1995).

The impact of leadership skills on career trajectory takes on particular importance when considering specialized groups and underrepresented minorities in science and engineering education. Numerous studies demonstrate that women, African Americans, and Latinos make up a disproportionately small percentage of undergraduate engineering degree recipients, have lower retention rates, make up a very small fraction of the science and technology workforce, and have higher levels of unemployment (Babco 2001, NSF 2009). Current demographic trends in the US underscore the importance of rectifying these trends to increase the diversity of engineers and to fulfill the national demand for engineering skills in the public and private sectors (NAE 2005). It has also been argued that increasing the diversity of engineers is an important part of creating cultural competence and maintaining competitiveness in an international labor market (Chubbin et al. 2005). If engineering leaders in the next decades must carry much of the responsibility for executing the path of US innovation in science and technology, it is likely that leaders with broad perspectives may be instrumental in enhancing the status of the engineering profession in the US (Jablokow 2007).

Given the fact that many minority groups underrepresented in science and engineering have significant representation in the armed services, the post 9/11 GI Bill presents a critical opportunity to contribute to the diversity of engineering leadership. This project intends to leverage that prospect by raising awareness of engineering as a career path and by offering an academic.