FROM BATTLEFIELD TO CLASSROOM: DESIGNING PATHWAYS TO ENGINEERING FOR AMERICAN GIs

1.0 PROLOGUE

One of the most critical challenges of war is to re-integrate veterans of the armed forces into productive civilian roles and professions. Such an obligation is designed to repay soldiers for their voluntary service and significant sacrifice, which often define a lifetime and a generation, but also may have resulted in serious health and disability issues. We know from the first GI Bill of 1944 that increasing educational and training opportunities for veterans has also functioned to strengthen and expand the postwar economy, especially in science, engineering, and technology.[1] The Post-9/11 GI Bill, whose benefits begin 1 August 2009, offers the most comprehensive education benefit package since the original GI Bill of 1944, providing a range of opportunities and services for veterans and dependents. In fact, it is believed that many veterans will emerge from their military experiences with skill sets pitched toward engineering and other technical fields and will tend to favor engineering education, given their training.

These and other hypotheses were discussed at the *Veterans' Education for Engineering and Science Workshop* held in McLean VA on April 13, 2009 and sponsored by the National Science Foundation (NSF, 2009). The PI was a participant at this meeting. She was struck by the many uncertainties associated with the intentions, aspirations, and needs of the veteran *cum* engineering student, and by the fact that there are little or no data to support prioritizing and funding support mechanisms to aid the veterans in making successful transitions to life as engineering students. These mechanisms include activities and processes that could be undertaken by colleges and universities, by the National Science Foundation, by the Veterans Administration, and by other veteran-sensitive organizations. This proposal is a direct outgrowth of the discussions and activities held at the workshop and is intended to address many of the data gaps identified there.

2.0 INTRODUCTION

It is clear that in preparing for the influx of veterans into higher education, and engineering specifically, planning and implementation should hinge upon information and projections that are informed by a sound evidentiary base. That information baseline should, furthermore, include quantitative as well as qualitative data: estimations of numbers of potential engineering students, demographic composition, educational, services, and career needs, but also a deeper, more contextualized understanding of engineering aspirants, their skill sets, reasons, concerns, and career expectations in pursuing engineering. Most critically, this information must be synthesized in ways that make it relevant and usable for several stakeholders involved in the current process of helping our military men and women transition from active duty to higher education: engineering and related programs at colleges/universities, industry partners, NSF and other federal science and engineering agencies, veterans' service organizations, etc.

Another dimension of this project must also be addressed upfront. For too long, we in science, technology, engineering, and mathematics (STEM) education have ignored the armed forces as a critical and diverse talent pool for postsecondary education and advanced degrees. Not only do members of the armed forces possess technical experiences that rival what many first and second-year engineering students are exposed to in the classroom, making many veterans 'pre-qualified' for technical education, they represent a mature, professional, directed, and ethical cohort of future engineering professionals and educators. At the same time, we as a nation are coming to realize that our need for future scientists and engineers is urgent; that U.S. economic innovation, national security, and global competitive edge depend upon a robust science and engineering workforce (National Academies, 2007); and that a recent decline in student interest in these fields, competition for foreign students, projected retirements in the next decade,

[1] The 1966 Veterans' Readjustment Benefits Act, the Vietnam GI Bill, was also highly successful: 76% of those eligible participated, compared with 50.5% of World War II veterans and 43.4% of Korean veterans, and by 1980, the Vietnam GI Bill had trained 5.5 million veterans (U.S. Department of Veterans Affairs, *History of the Department of Veteran Affairs*, P6, http://www1.va.gov/opa/feature/history/history6.asp)

and rapidly expanding occupations poised to outpace the current workforce indicate troubling shortages in this area. (National Science Foundation, 2003). Moreover, given the long history of close collaboration between the science and engineering and defense sectors, and given the fact that innovative technical research drives economic growth, but also national security, this opportunity to think more carefully about integrating veterans into the science and engineering education pipeline is long overdue. The proposed project intends to join these trends at this critical juncture and as the newly expanded veterans' benefits enables educational institutions to serve those who have served and sacrificed.

3.0 PROJECT OVERVIEW: GOALS, OBJECTIVES, AND WORK PRODUCTS

This proposed project takes advantage of this set of converging historical opportunities to develop concepts, information sources and datasets, and program ideas designed to help stakeholders think proactively, creatively, and pragmatically about translating veterans' experiences and talent into technical and engineering career pathways. At the core of the proposed project is the premise that planning projections must be based on understanding—with depth and sophistication—the aspirations, needs, concerns, expectations, and hopes of veterans as they transition from active duty to higher education contexts and as these academic contexts define partnerships to guide them toward professional development. In this respect, the proposed project is designed as a planning initiative with multiple stakeholders in mind to achieve the following goal and objectives, with attendant work products:

3.1 Goals: Translating Veteran Technical Talent into Career Pathways in Postsecondary Engineering Education

This proposed project has three goals: to learn a great deal more about this untapped technical talent pool; to use qualitative and quantitative methods to develop and test innovative concepts for translating veterans' abilities, potential interests, and aspirations into viable career pathways in engineering; and to generate and evaluate new ideas for embedding professional development partnerships into customized career pathways in ways that reflect veterans' interests and the needs of the U.S. technical workforce.

3.2 Objectives:

1. Identify, define, and gather information and information sources necessary to learn more about the current talent pool of veterans in order to frame and inform the project goal of translating veteran talent into a technical career pathway
2. Develop, design, deploy, and analyze the results of transportable survey tools and multivariate qualitative focus groups composed of diverse and segmented target sub-groups
3. Determine factors and variables that may guide future projection studies and predictive research, and provide exploratory modeling results
4. Develop innovative concepts for guiding custom education programming, including program modules and priorities, and supportive institutional, industry, and government partnerships for professional development

3.3 Work Products:

1. Framework for NSF and other federal agencies for determining budgets and programs in future requests for veteran-related education proposals
2. Identification of preliminary factors and variables that diverse veterans use to define their own interests and aspirations for technical and engineering higher education
3. Exploratory data models that quantify relationships between the variables (identified in #2 above), and the likelihood that veterans will pursue an engineering or engineering technology program
4. Assessment tools for profiling veteran engineering aspirants for the purpose of stimulating a pipeline of veterans into STEM education
5. Identitification of support resources that diverse veteran engineering aspirants report as needed and/or helpful for engineering education programs and career planning

6. Engineering program concepts that address strategies and services for enhancing transition, recruitment, and persistence; curriculum and degree completion strategies tailored to the population (e.g., innovative use of credit-transfers and credit-bearing internships); university-industry-government partnerships for professional development and priorities for employee network
7. Journal articles, conference and workshop presentations, and white paper on evaluation results broadly accessible for various stakeholders. The PI, Dr. Laura J. Steinberg, is Dean of the College of Engineering and Computer Science at Syracuse University and intends to use the "bully pulpit" associated with this position to publicize and disseminate widely the results of this research effort.

4.0 BACKGROUND ON CRITICAL ISSUES:

The proposal draws on several literatures and interdisciplinary research-team expertise in engineering, higher education, sociology, and national security to examine the reciprocal relationship between postsecondary engineering and the military as a potential recruitment source in ways likely to offer insights into changes in engineering and higher education in general. We approach engineering education and military service in macrostructural and micro-contextual terms, looking at both national and demographic trends and their range of explanations, and examine education aspirations and military service through the life course framework, including how each shape individuals' life course trajectories (Elder 1974, 1987, Elder, Shanahan and Clipp 1994, Sampson and Laub 1996).

4.1 Post-9/11 GI Bill itself as Opportunity for Science & Engineering Education

The Post-9/11 GI Bill is the most comprehensive education benefit package since the original GI Bill of 1944. It is designed for all active duty servicemembers who have served since September 10, 2001 for at least 90 aggregate days on active duty, or were honorably discharged for a service-related disability after 30 continuous days. Benefits include tuition costs and fees (not to exceed the most expensive in-state undergraduate tuition at a public institution), a monthly housing allowance with dependents, and a yearly books and supplies stipend of up to $1,000 per year. The maximum benefit is earned after serving 36 months of active duty or after 30 days of continuous service for those discharged for service-related disabilities. Individuals serving between 90 days and 36 months of active duty will receive a percentage of the maximum benefit. Additionally, the Yellow Ribbon Program allows for a dollar-matching agreement between the US Department of Veterans Affairs (VA) and a higher education institution to cover tuition costs and fees above the highest in-state undergraduate tuition rate, so that students seeking private education will not be disadvantaged.

Veterans and active-duty and reserve (ADR) service-members may be strongly inclined to use their educational benefits for multiple reasons, including the generosity of the package, but also because the all-volunteer force (AVF) has attracted highly motivated individuals with unprecedented educational credentials in the history of the US military. In FY 2007, for instance, 98 percent of enlistees had a high school diploma or its equivalent (compared to 81 percent of 18 to 24year-old civilians), and 93 percent of active-duty officer corps had at least a four-year college degree (Defenselink.mil 2007) Yet, previous studies have shown that the percentage of veterans engaged in technical fields after leaving the military is consistently lower than the percent of enlisted members serving in technical fields, thus underscoring the importance of developing new degree pathways that maximize enrollment and retention of veterans in engineering (Walker 2008 and Black et. al. 2008). In fact, officers who already possess undergraduate degrees may be an important source for higher degrees in engineering. The service academies, particularly USMA, provide a considerably larger percentage of junior officers with engineering/technical degrees (BSs) than ROTC programs, which tend to graduate more social science majors (BAs)—though undergraduates with BSs often go on to different masters' degree programs, particularly business administration, instead of engineering.

4.2 The All Volunteer Force (AVF): Post-9/11 GI Bill as Opportunity to Address Diversity in Science & Engineering

Today's military bears little resemblance to the armed services of World War II or the Vietnam era, and active duty personnel and veterans returning to college will likely have different needs and expectations for higher education. Today's new "all-voluntary" force (1973) is "more educated, more married, more female, and less white than the draft-era military (Segal and Segal 2004)." Servicemembers are older and better educated, racial and ethnic minorities make up an increased percentage of servicemembers, as do women, and servicemembers are more likely to be spouses and parents today than in the past (GAO, 2005). The military comprises about 1 percent of the total US population, and as of February 2009, there were roughly 1.5 million active duty members with 850,000 serving in the seven reserve disciplines. (Dept. of Defense, 2009)The vast majority of active servicemembers (over 75 percent) are stationed in the US, not abroad, and current campaigns Operation Iraqi Freedom (OIF) in Iraq and Operation Enduring Freedom (OEF) in Afghanistan comprise 178,300 and 31,400 active duty servicemembers respectively, though these numbers (especially in Afghanistan) will change.[2] Army reservists in particular and those who reenlist are increasingly being relied upon for national defense strategy (Griffith, 2007).

The most significant change in the military since the advent of the all-volunteer force has been its demographic composition, namely the unprecedented proportion of women and racial and ethnic minorities in the four main branches of the armed services, and the fact that approximately half of all servicemembers are married, with dependents and families.[3] In 2000, women comprised about 15 percent of the active duty force, compared with 4 percent in 1974 (GAO, 2002). Likewise, the proportion of minority servicemembers increased from 20 percent to 35 percent of the active duty force between 1974 and 2000, with Latino/as, native Americas, and other groups increasing their numbers (GAO, 2002). To drill down on one important group, African Americans in 2002, for instance, made up 22 percent of enlisted personnel (20 percent of men and 34 percent of women), compared to African-Americans as 13 percent of the U.S. civilian population (ages 18 to 44). Within the service branches, the African American component ranged from 28 percent in the Army, 21 percent in the Navy, 18 percent in the Air Force, and 15 percent in the Marine Corps (Undersecretary of Defense, Personnel and Readiness, 2005). As analysts have noted, if it were not for African American contributions to the armed services, today's all volunteer force could not meet its manpower goals.[4]

The composition of the armed forces has important implications for understanding higher education goals and aspirations for this segmented population, but also the barriers to these goals, and program priorities. To take a brief example, we know that African Americans are overrepresented in the armed services with respect to their percentage of the national population, but are underrepresented in officer ranks—though their share of officers has been increasing from 3 percent at the beginning of the all volunteer force (1973) to 9 percent in 2002, which is similar to their share of civilian college graduates (Segal and Segal 2004). We also know that African Americans follow a very different pathway in becoming officers than their colleagues, though we do not know why: they are less likely than white officers to have been commissioned through the military academies, for instance, and they are also more likely than white officers to have been commissioned through ROTC without scholarship support (23 percent of blacks versus 14 percent of whites) (Evans, 2003). Some relevant questions which are potentially analogous to technical education are whether certain servicemembers are lacking pathways

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[2] Department of Defense, *Active Duty Military Personnel Strengths by Regional Area and by Country* (309A), 31 Dec 2008. Government reports are estimating an additional 17,000 servicemembers headed to Afghanistan.

[3] GAO-02-935 Active Duty Benefits: 2 & 5: "For each year between 1980 and 2000, married servicemembers, including both enlisted personnel and officers, made up at least half of the active duty force."

[4] David R. Segal and Mady Wechsler Segal, *Population Bulletin* 59(4) (Dec 2004), "America's Military Population," Population Reference Bureau (PRB): 18-20. African Americans in 2002 made up 22 percent of enlisted personnel (20 percent of men and 34 percent of women) compared to African-Americans as 13 percent of civilians ages 18 to 44 and the African American component ranged from 28 percent in the Army, 21 percent in the Navy, 18 percent in the Air Force, and 15 percent in the Marine Corps.

and resources for career advancement. Typically, African American men (and women in noncombat roles) perceive the military to be a more racially fair employer than civilian labor markets so the fact that they are experiencing some barriers in this context is significant for thinking about academe. Moreover, the unconventional nature of the Iraq and Afghanistan missions have brought significant injuries, both mental health and physical disabilities, to the forefront in contemplating veterans' educational needs and supports (Bell et. al., 2008a; Bell et. al., 2008b).

Another important issue is whether soldiers' motivations for joining the armed services offer relevant information for higher education decision making, goals, and aspirations—including appropriate program needs and supports in the academic setting. This issue has become particularly relevant with the shift from the conscription to the all volunteer force and in light of the September 11, 2001 attacks on the homeland. With the exception of the Youth Attitude Tracking Study (YATS), a survey administered yearly from 1975-1999 by the Defense Manpower Data Center (DMDC) that examined youth (16-24 years of age) attitudes toward military service, consistent national data are missing on this issue.[5] Some limited studies have examined public opinion support for the military in the post-9/11 moment, especially with respect to debates over restoring the draft (Simon and Lovrich, 2009; Wooeruff, Kelty, and Segal, 2006). Other research has, more importantly, found convincing evidence that personal commitment to service appears to be a key factor in servicemembers' motivations—though there are varied results in the literature. (Griffith 2007, 2009)The importance of intangible, normative, or values-based motives (i.e., commitment to country and cause) in decisions by Americans to serve are factors that have implications, not only for combat readiness, but for educational program design—for instance the potentially important role that cohorts, "unit cohesion," or "buddy relations," may play for this population both in choosing higher education and successfully navigating a degree program.[6]

5.0 RESEARCH DESIGN:

We propose three major coordinated research activities aimed at developing educational and career pathways and integrating supports for benefits-eligible veterans into science and, particularly, engineering. The proposed research makes use of three different data sources as well as a mixed methods approach, for conducting data collection and analysis: primary historical and statistical sources from the public record, including Department of Defense (DOD) reports; several targeted survey instruments developed by the research team and distributed both online and among focus group populations; and a coordinated focus groups strategy and approach that designs various questionnaire-based interview and discussion sessions, tailored to specific demographic populations.

The following section describes the datasets developed for each of the research aims and their projected goals, our projections about the constituencies involved, and a more detailed description of anticipated work-products. Through these public record and direct information sources in surveys and focus groups, the proposed research fills a large and critically significant gap in knowledge about the higher education intentions and motivating factors of Post-9/11 GI bill-eligible veterans pursuing engineering degree programs.

***5.1 Research Questions and Work Plan*:** Our specific research questions include:

Question Cluster 1: Explore the factors and barriers that are implicated in the educational aspirations and intentions among active military personnel and veterans. Specifically, we will ask:

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[5] DOD has also conducted the limited surveys: 2001, 2003, and 2004 *Department of Defense Youth Polls.*

[6] See Leonard Wong, Thomas A. Kolditz, Raymond A. Millen, Terrence M. Potter, *Why they Fight: Combat Motivation in the Iraq War*, July 2003, Strategic Studies Institute: vii, "contrary to previous studies of U.S. soldiers, notions of freedom, democracy, and liberty were also voiced by soldiers as key factors in combat motivation. The monograph concludes that soldiers continue to fight for each other, but today's soldiers are also sophisticated enough to grasp the moral concepts of war. The report suggests that this is a result of the transformation of the Army from a fledgling all-volunteer experiment to a truly professional force." Roger W. Little, "Buddy Relations and Combat Performance," in Morris Janowitz, ed., *The New Military: Changing Patterns of Organization*, New York: Russell Sage Foundation, 1964: 221.

- How do servicemembers describe their educational aspirations and intentions for using their educational benefits?
- What are their career pursuits, and do they think engineering is a viable path for them?
- Among those who indicate an interest in engineering, or the technical fields, what are the potential barriers and challenges perceived by them in achieving their plans, and what resources would they need to help overcome those barriers?

Question Cluster 2: Identify the predictors in active duty and veterans' decisions to go to engineering school. Specifically, we will examine:

- What are the predictors in the decisions of active military personnel and veterans to pursue undergraduate or graduate engineering education opportunities?
- Do these predictors change across demographic group, institution type (i.e., community college), and degree program?
- What is the nature and relative strength of the relationships between the predictors and the decisions of benefits-eligible servicemembers to pursue engineering education?

Question Cluster 3: Investigate ways to leverage the significant diversity of the armed forces for the engineering pipeline. In particular, we are interested in:

- What kinds of resources and programs are needed to promote the entry of traditionally underrepresented groups from the uniformed military into engineering education?
- Are there specific barriers and challenges to this population that impact their educational decisions within the larger servicemember population?
- How do health and disability issues factor into decisions about higher education and engineering, in particular?

For *Question Clusters 1 and 2,* several surveys (including web-based) will be administered to both active and discharged benefits-eligible military servicemembers to identify factors that influence the decision to use education benefits and to pursue engineering degree (or engineering technology) programs. In addition to providing important demographic, military branch, and military discipline and training area information, the surveys will differentiate respondents with college degrees, graduate degrees, some college education, and without college education, and determine interest in pursuing degrees at the community college, undergraduate, and graduate levels in engineering. The results will aid in the design and development of models for establishing predictive relationships between the demand for engineering/engineering technology education and key explanatory variables.

In addition to surveys, focus group sessions will be held to provide qualitative perspectives on *Question Clusters 1 and 2*. It is anticipated that these sessions, configured to enable benefits-eligible military servicemembers to provide qualitative, contextual, and life-narrative information, will be helpful in both designing the surveys and in analyzing and interpreting survey results.

Question Cluster 3 will be explored primarily through focus group sessions, which will invite discussion of special health and support services needs (including dependents) in the higher education setting, among other topics. As Stewart, Shamdasani, and Rook (2006) indicate, focus group research techniques lend themselves to education research, policymaking and policy driven research, among other fields, and, as Woodring et al. (2006) show, to disabilities-based research studies in particular. This work is particularly relevant given our emphasis on persons with disabilities as one subgroup of interest.

Moreover, the focus groups will be designed with several innovating precepts in mind. First, to enhance interactive dynamics to achieve substantive responses and to reduce potential conflicts among participants, some sessions will use homogenized groupings based on gender, ethnicity, ability, rank, and military network (Aken et. al. 1999). One focus group will be based on servicemembers with disabilities, for instance, invited through Syracuse University's Burton Blatt Institute's Entrepreneurship Bootcamp for Veterans with Disabilities (EBV). Second, as studies increasingly show that focus groups produce not only rich data results but prompt influence, attitudinal change, and even self-efficacy beliefs, sessions will invite traditionally underrepresented minority or high-risk groups in engineering to address potential barriers, challenges, and needs with respect to enrollment and success in engineering programs (Zorn et.

al. 2006). Special attention will be given to *esprit de corps* as a key component of this data collection effort, in part, because it has been postulated that servicemember population's unique *esprit de corps* may have a significant impact on how veteran and active duty students approach educational experiences (National Science Foundation, 2009).

A relevant baseline for all assessment instruments will be established from public data available from several sources but especially the Office of the Undersecretary of Defense, Personnel and Readiness for the current armed services population—including composition, education levels, demographic information, and other relevant factors.

5.2 DATASETS:

5.2.1 Historical and Public Record: Veterans' Affairs, Federal Defense Population and Demographic Studies, and Research Institutes

There are several key sources for population information regarding the armed services at the federal agency level and among research institutes. Some examples include: the National Center for Veterans Analysis and Statistics (*VA Benefits & Health Care Utilization*); the U.S. Census Bureau (*Statistical Abstract of the United States* 2009); the U.S. Bureau of Labor Statistics (*Employment Situation of Veterans*, *Employment Characteristics of Gulf War-Era II Veterans in 2006: a Visual Essay*); the Office of the Undersecretary of Defense, Personnel and Readiness's yearly reports, *Population Representation in the Military Services* and *Military Personnel Statistics,* and other data collected at the Manpower Research and Data Analysis Center (MARDAC); periodic reports to Congressional Requesters from the U.S. Government Accountability Office (*Military Personnel*: *Reporting Additional Servicemember Demographics Could Enhance Congressional Oversight*, Sept 2005); the Population Reference Bureau's (PRB) *Population Bulletin: America's Military Population* (Dec 2004); RAND reports (*The Evolution of the All-Volunteer Force: History and Analysis*, 2006) etc. For educational and workforce data in science and engineering, the NSF National Science Board, Division of Science Resources Statistics (SRS), offers the consistent, high-quality standard that includes a detailed range of reports, notably, the annual *Science and Engineering Indicators.*

What is important to note, however, is that in the case of collected population information on servicemembers, no research has attempted to synthesize population and demographic data from the various sources, or to analyze this information in ways that offer conclusions relevant for higher education, planning purposes, and critical issues identification in science and engineering. Moreover, the descriptive educational content of the military population sources is extremely limited—typically addressing only educational background (i.e., high school diploma) and degree levels among the various active duty and veteran military ranks and branches, or servicemembers currently using pre-Post 9/11 GI Bill educational benefits. Neither DOD, the VA, nor the Department of Labor specifically collect and report information on educational degree programs that veterans enter and complete. While there is aggregate data on military occupational specialty, no attempts have been made to correlate that information to educational program and degree choices that servicemembers ultimately make, distinguish between undergraduate and graduate study, or examine how they fare in these programs (BLS, 2008; Dillon, 2007).

Table 1. Military officer personnel by broad occupational category and branch of service, January 2007

Occupational Group - Officer	Army	Air Force	Coast Guard	Marine Corps	Navy	Total, all services
Combat specialty occupations	19,421	2,861	81	4,684	1,260	28,307
Engineering, science, and technical occupations	20,189	19,852	1,057	3,639	7,873	52,610
Executive, administrative, and managerial occupations	11,262	9,013	231	2,572	5,437	28,515
Health care occupations	9,953	8,970	5	—	7,737	26,665
Human resource development occupations	2,151	2,275	184	293	643	5,546
Media and public affairs occupations	237	408	19	170	265	1,099
Protective service occupations	2,611	1,229	96	327	275	4,538

Support services occupations	1,596	768	—	38	884	3,286
Transportation occupations	13,112	23,540	1,736	7,188	27,049	72,625
Total, by service	82,884	69,284	7,853	18,998	51,558	230,577
(1) Occupational employment does not sum to totals because occupational information is not available for all personnel. Source: U.S. Department of Labor, *Occupational Outlook Handbook, 2008-09 Edition*, Job Opportunities in the Armed Forces: 5-6; U.S. Department of Defense, Defense Manpower Data Center						

Table 2. Military enlisted personnel by broad occupational category and branch of military service, January 2007

Occupational Group - Enlisted	Army	Air Force	Coast Guard	Marine Corps	Navy	Total, all services
Administrative occupations	8,912	23,366	1,683	9,460	22,512	65,933
Combat specialty occupations	120,297	427	856	47,250	5,508	174,338
Construction occupations	16,848	4,979	—	5,597	5,927	33,351
Electronic and electrical repair occupations	35,932	37,722	4,351	14,656	51,424	144,085
Engineering, science, and technical occupations	36,451	46,304	1,110	22,915	38,853	145,633
Health care occupations	29,242	16,805	821	—	24,950	71,818
Human resource development occupations	16,464	12,741	1	6,113	6,756	42,075
Machine operator and precision work occupations	5,727	7,134	1,583	2,301	7,913	24,658
Media and public affairs occupations	6,541	7,574	136	2,340	4,726	21,317
Protective service occupations	25,455	31,483	3,050	5,872	13,122	78,982
Support services occupations	12,014	1,608	1,268	2,289	9,930	27,109
Transportation and material handling occupations	58,237	32,464	11,479	22,344	43,026	167,550
Vehicle machinery mechanic occupations	49,679	44,025	5,821	19,340	49,166	168,031
Total, by service	421,855	271,009	32,477	160,484	287,118	1,172,913
(1) Occupational employment does not sum to totals because occupational information is not available for all personnel. Source: U.S. Department of Labor, *Occupational Outlook Handbook, 2008-09 Edition*, Job Opportunities in the Armed Forces: 5-6; U.S. Department of Defense, Defense Manpower Data Center						

There is one interesting, recent exception: the US Department of Education's "Issue Tables: A Profile of Military Servicemembers and Veterans Enrolled in Postsecondary Education in 2007–08," describes military servicemembers and veterans enrolled in undergraduate education at institutions eligible for Title IV federal funding for financial aid from 2007–2008, just prior to the Post-9/11 Veterans Educational Assistance Act's implementation (Radford and Wun 2009). The Report draws its data from the National Postsecondary Student Aid Study (NPSAS), a program focused on how students finance their education. From this source, the *Report's* explicit purpose was to offer "baseline data" for comparing currently enrolled military undergraduates with their "future counterparts who will enroll." For instance, during the 2007–08 academic year some 660,000 undergraduates were veterans, constituting about 3 percent of all undergraduates, and about 215,000 (or 1 percent of all undergraduates that year) were military ADR servicemembers. About 329,000 or 38 percent of all military undergraduates used veterans' education benefits during the 2007–08 academic year—a number that analysts expect to rise (though no one has predicted how much) with the new, more generous Post-9//11 Bill. Still, we do not know the correlation between servicemembers' occupational category and veteran and ADR undergraduates and graduate students' choice of educational degree program and discipline; nor do we have any basis to make estimations about projected academic discipline interest area, major, or minor, given military training sector. Moreover, we have virtually no equivalent information with respect to veteran and ADR graduate study and degree programs.

While the proposed project cannot remedy what is a national-level problem of aggregate data collection and analysis, it can begin preliminary projections, and it can study and understand this target educational population in their educational decision making processes, including identifying the factors and variables by which servicemembers are making decisions, and the relationship (if there is one) between military occupational category and educational degree program choice from which to generalize. The proposed research can also recommend guidelines for future data collection, including more detailed information on veterans' education (enrollment, degrees, disciplines, by demographics) for federal

agencies, for instance, but also, perhaps, a new "veterans" category in the National Science Board's annual *Science and Engineering Indicators.*

What we do know about the current population of servicemembers is that, because the new Post-9/11 GI Bill benefit is significantly more generous than the current one, a higher percentage of eligible veterans are likely to use the program. This means that we may see an increase beyond more than the one-half million of the nation's 23.4 million living veterans who used VA educational benefits in fiscal year 2008—perhaps as many as 125,000 new applicants for benefits in August 2009, with numbers likely to grow after that (NSF, 2009). The VA estimates that some 2.1 million of today's veterans have served for at least 30 days on active duty after September 10, 2001, making them eligible for educational benefits to support postsecondary study and degree programs (National Center for Veterans Analysis and Statistics, 2008). We also know that benefits-eligible veterans will also be a diverse group, evident in the demographic makeup of those currently serving in the military: for instance, more than 14 percent of active-duty servicemembers are women, 30 percent come from racial minorities, and 10 percent are Hispanic (Segal and Segal, 2004; Office of the Under Secretary of Defense, Personnel and Readiness, 2007). And, we know that service-related health and disability issues comprise a significant portion of this population, but we have very little information regarding how these issues and their concerns may impact veteran students in the educational context. Contemplating how issues of diversity may interface with technical and particularly engineering educational programs is an important priority of the proposed research.

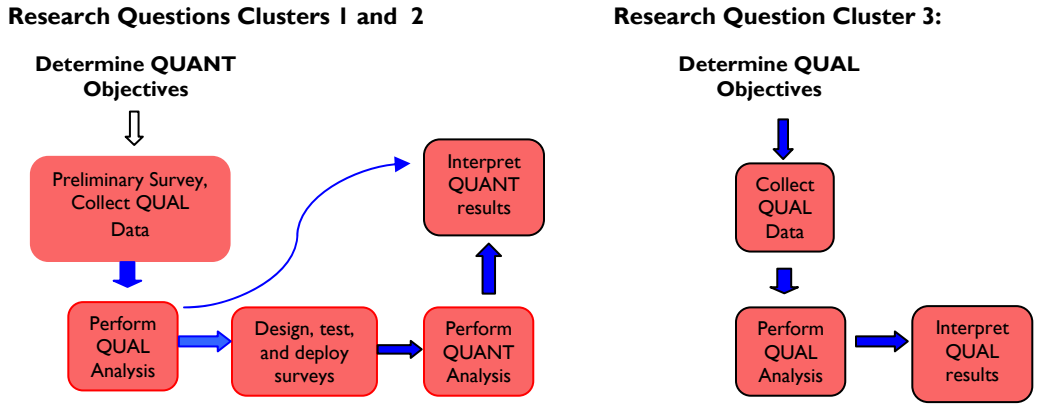
5.2.2 Targeted Survey Instruments and Comprehensive Focus Group Strategy

The research design employs a mixed-method approach to explore the research questions posed above. Combined with the information from historical and public record, the mixed-method approach includes several surveys and a comprehensive focus group strategy, allowing for a rich and complex portrait to emerge.

- An iterative survey development process is designed to collect quantitative information, with the aim of identifying factors in the decision to pursue education in engineering/engineering technology, and providing data to test hypotheses about the likely effectiveness of proposed interventions in enhancing veterans' educational experiences and in encouraging their successful progression through the engineering education pipeline.
- The focus group sessions are intended to gather qualitative information, with the aim of gaining contextual understanding of the issues pertaining to servicemembers' education aspirations, as well as perceived or potential challenges and barriers in engineering/engineering technology education. The results will be used to refine the preliminary surveys to better reflect choices and factors likely to enable a comfortable transition for veterans from the military to the academic setting.
- The focus group sessions are also geared towards developing a deeper understanding of the difficulties for traditionally underrepresented groups in engineering, such as women, racial minority groups, and persons with disabilities.

For both the survey process and the focus group sessions, determining the sampled population will be critical for the integrity of the study results. Recent methods research has explored the many successful approaches to sampling in the mixed method context (Teddlie and Yu 2007; Collins et.al. 2007). Indeed, as Kemper, Stringfield, and Teddlie (2002) show, nearly any complex social research question "requires more than one sampling technique and often involve(s) both probability (i.e., representative) and purposive sampling techniques." For clarification purposes, probability techniques involve "selecting a relatively large number of units from a population, or from specific subgroups (strata) of a population, in a random manner where the probability of inclusion for every member of the population is determinable," and they aim at achieving "representativeness, the degree to which the sample accurately represents the entire population" (Tashakkori and Teddlie 2003; Teddlie and Yu 2007). Purposive sampling techniques used in qualitative studies, by contrast, select units (e.g., individuals, groups of individuals, institutions) based on specific purposes associated with answering a specific research study question and which, as Maxwell (1997) notes, "particular settings, persons, or events are

deliberately selected for the important information they can provide that cannot be gotten as well from other choices" (Teddlie and Yu, 2007). Insofar as we develop, employ, and integrate quantitative and qualitative tools, we include both sampling techniques based on specific research goals, which is particularly important when analyzing underrepresented populations. The following mixed-method design matrix provides an illustration:



A preliminary form of the survey will be created based on the theoretical and empirical literature described above. This initial survey will contain questions that relate to factors which extant data and theoretical considerations indicate may be important in understanding the servicemembers' interests, aspirations, and challenges in attending engineering programs. These questions will be explored in the focus groups, and as the results of the focus groups become clear, we will incorporate them into our survey instrument in order to sharpen its focus.

We will begin collecting and analyzing historical and public record data in August 2009 to provide, not only general trends and macro contexts, but to inform and guide our survey design process. Data sources include those discussed above and current literature in the social sciences, including education and learning scholarship, as well as national security research that offer historical and theoretical background for the survey design. Many of these sources have been referenced in the proposal, but a more intensive literature search will be part and parcel of the survey design. In fall 2009, the team will design the preliminary survey and, at the same time, begin work on focus group sessions design.

5.2.3 Focus Group Design and Analysis

We will employ both focus group formats—planned discussion and group interviews—as our assessment and the needs of our respective participating populations require (Hughes and DuMont 1993). Insofar as this data collection approach is designed to elicit contextual and life-narrative information and is widely used in the formative stage of research to guide survey development and to obtain perspectives from underrepresented or hard-to-reach groups, our interests will be, accordingly, to tap into the educational and career aspirations of servicemembers in ways that provide as full a description as possible of the many voices and perspectives that comprise this population.

In particular, we seek information on benefits-eligible servicemembers' decision making processes with regard to using their education benefits, their perceptions of engineering in relation to educational goals and aspirations, as well as career options, and their concerns about potential obstacles and barriers. We also intend to collect information regarding:

- Special health and support services needs (including for dependents) in the higher education setting
- What makes servicemembers think engineering is or is not a viable career path for them to transition from military service to civilian professions
- For those who consider other professions as more desirable or realistic than engineering, what make them think so?

- For those who show interest and intention to pursue engineering education, what resources or support systems do they believe would help them actualize their intentions?

This information will not only help to answer the overarching research questions, but will help survey design and content.

Judicious selection of focus group members will allow us to differentiate between the needs, aspirations, and experiential drivers of particular subsets of active servicemembers and veterans, including underrepresented minorities and the disabled. This may mean that a particular focus group will take into consideration military branch or rank divisions, those who have expressed interest in technical/engineering education, or regional-geographical considerations—we will need more information from public databases and from early discussions with respondents to determine exact focus group session design. But we will likely organize some focus groups on the basis of individuals sharing similar demographic characteristics such as race, gender, military cohort, and disabilities. As Koppelman and Bourjolly (2001) note, group interaction is enhanced by an arrangement in which participants feel more comfortable with "others who they perceive to be like themselves." Extant literature recommends placing attention on four issues when planning focus groups: *needs of the participants*, *pragmatic issues*, the *challenge of recruiting participants*, and *expected turnout rate*. It is probable that disabled veterans may require special services or personal assistants to participate meaningfully.

Our goal is to recruit 70-100 participants total, averaging 6-12 individuals per focus group, planning for 8-10 focus group sessions, and taking guidance from common recommendations to compensate for no-shows by over-recruiting by 20 percent in the relevant subgroups (Morgan, 1997). In addition to group numbers and size, recruitment and screening processes will be implemented to strengthen the likelihood of a data rich discussion. There is evidence that the use of intermediaries to recruit, screen, and invite participants to a focus group is warranted (Mactavish et al. 2000; Koppelman and Bourjolly 2001). We plan to collaborate with SU Burton Blatt Institute's Entrepreneurship Bootcamp for Veterans with Disabilities (EBV), take advantage of the Maxwell School of Citizenship's Institute for National Security and Counterterrorism's (INSCT) ample network of veterans at SU and elsewhere, and to tap into veterans regionally through web-based networks affiliated with our local VA and the military branches. We will employ a voluntary component in the recruitment process so that participants will contact research staff so as to mitigate any compulsory dynamic that may occur. Sessions will be conducted in several sites: US military bases in the U.S., Syracuse University, and a location to be determined in Central New York, with the help of our military and VA contacts. These include Keith Wilson, Director of Education for the Veteran's Administration and General John Abrams (Ret.), President of Abrams Learning and Information Systems. Both were participants and speakers at the NSF/VA workshop on the GI Bill attended by the PI and both indicated strong suppport and willingness to provide help and guidance for this project. We are also considering video-conferencing to conduct distance-based focus groups, which has been conducted very successfully at SU through available software technology and virtual conference spaces on campus.

The focus group model proposed hinges upon strong, but measured, group facilitation, sensitive to established issues as well as the nuances and unexpected particulars that go along with research on servicemembers; we will use two facilitators per session, as suggested by Kruger (1994), and all sessions will be digitally recorded and transcribed with an appropriate coding architecture. We will create a unique identifier (code) for group participants to identify participant contributions, without revealing identity, for instance, and tapes from focus group sessions will be transcribed verbatim and will be used to highlight major issues and emerging themes.

5.2.4 Survey Design Process and Analysis

We will design and deploy a survey to collect quantitative information, administered to both active and discharged benefits-eligible military servicemembers, to identify factors that affect the decision to use education benefits and to pursue engineering degree programs. The survey will be designed to reach a broad cross-section of military personnel in both overseas and homeland military bases. The target population may exclude veterans with severe mental handicaps and those whose physical or emotional

problems may make it unduly difficult to participate in the survey—though we will endeavor to include this population in focus group sessions. Information collected will include respondents' demographic background, health conditions, education background, and military experience, as well as future educational and career plans. The survey will also differentiate respondents with college degrees, graduate degrees, some college education, and without college education, and determine interest in pursuing degrees at the community college, undergraduate, and graduate levels in engineering. The results will aid in the design and development of a model for establishing predictors for engineering education, one key outcome of the proposal, as discussed in *Question Cluster 2*.

At present, we intend to administer a web-based survey in order to reach the broadest possible cross-section of servicemembers, while keeping the cost/response low. Given both the potential limitations of web-based survey in response rates (Spera 2009) and the particular challenges and opportunities posed in surveying ADR servicemembers, we plan to consult with DOD and VA contacts regarding the survey plan upon receipt of the grant. For example, we know that ADR servicemembers spend much time in the field using computer/internet technology to research and assess educational opportunities available to them upon returning to civilian life, and, indeed, some universities have established recruitment sites abroad for this purpose. The fact that servicemembers have internet access and participate in identifiable websites (VA, but also several blogs, and news-sharing venues) enables us to administer a web-based survey—though we are prepared to conduct paper-based surveys (which will necessitate a smaller sample size or supplemental funding).

Once the survey instrument has been created and refined via the focus groups, we will deploy it first to a small set of local soldiers at SU's ROTC division and local NY Army and Air National Guard units here in Syracuse, and, potentially, servicemembers from the Fort Drum military installation in New York State (permission sought ahead of time) to ensure that questions are well-formulated and convey their expected meanings to respondents. After assuring that the survey investigates the appropriate issues and is worded in a clear, unambiguous manner, we will work with DOD and the VA to deploy it in the field, both at home and abroad.

For the survey data analysis, the dependent variable will be whether engineering education is considered a likely option for education. It is a dummy (indicator) variable generated from such a survey question as "Do you think you will use your education benefits to specialize in engineering?" Since the outcome is a binary variable, we will use a logistic regression model specification for our statistical modelig. Let *p* denote the probability of planning to undertake an engineering curriculum. (As noted below, *p* may take on several definitions, depending on the level of engineering education to be undertaken i.e. engineering technology (2 year degree), engineering undergraduate degree, or engineering graduate degree. Let *D* denote a set of variables for demographic backgrounds, including gender, race/ethnicity, age, marital status, number of children, citizenship status, socio-economic status, *H* denote a set of variables for health information including disability conditions, *M* denote a set of variables for military experience including duration of service, rank, specialty, experience with technology, *E* denote previous education backgrounds and education expectation, and *C* denote a set of variables for the possible curriculum offerings catering to the military personnel, such as internships in companies as the built-in curriculum offering and the year-round (summer included) academic calendar. Then, the model specification is:

$$logit\left(\frac{p}{1-p}\right) = \beta_0 + \beta_1 D + \beta_2 H + \beta_3 M + \beta_4 E + \beta_5 C$$

This is the preliminary model focusing on the set of covariates centering on health, education, military background, and curriculum offering. As we pursue the project activities and gain greater understanding of the motivations and aspirations of the veterans, we will modify and update the covariates.

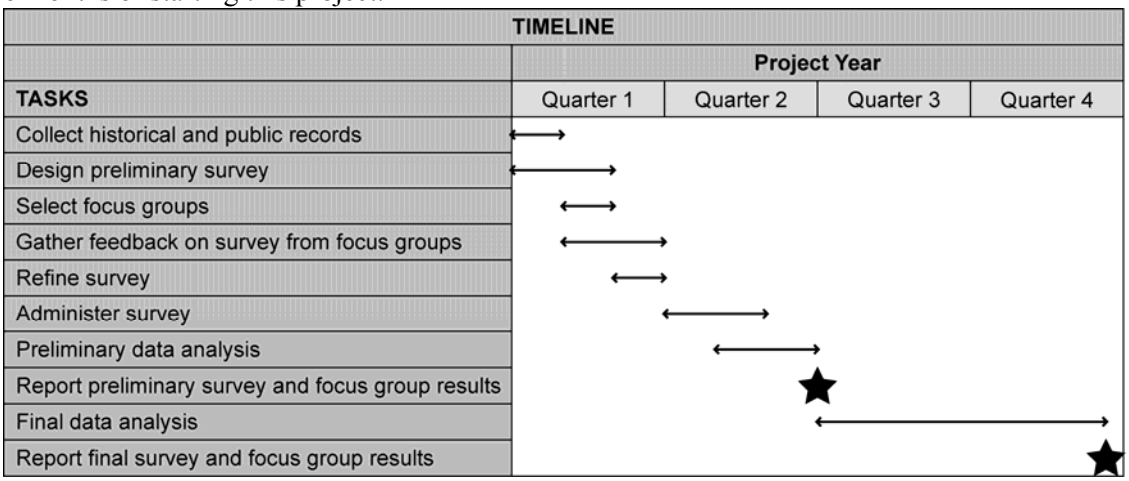
The parameter estimates of this model (the β's) will allow us to identify the characteristics and attributes among military personnel that predict their intention to specialize in engineering. Also, once the the parameter estimates have been determined and input into the model, the model may be run to produce estimates of the numbers of GIs likely to undertake an engineering education. These results will provide information on whether certain programs would be considered helpful in the eyes of military personnel.

For example, we can see whether the year-round academic calendar would be helpful in enlarging the likelihood of servicemembers to choose engineering education, if the corresponding coefficient is positive in a statistically significant way.

Military personnel vary quite a bit among their education backgrounds. Among the active-duty officer corps in 2007, 93 percent had at least a four-year college degree (Defenselink, 2007). Therefore, as a modeling strategy, we will treat those without undergraduate education and those with undergraduate education as two separate samples. We will examine the likelihood of pursuing an engineering 2 year degree, an undergraduate engineering degree and that of pursuing an engineering graduate degree for each sample accordingly. For those who already have 4-year bachelor's degrees, we recognize that they constitute a "selected" group. We will take into consideration the selection effects, namely, the unobserved characteristics that are associated with those military personnel with college education, such as innate ability or dispositions, by using Heckman's two steps procedure (Heckman 1979; Ouhani, 2000). With this technique, we hope to make unbiased estimates for the outcome of pursuing engineering education among those with and without 4-year degrees.

5.3 Project Management and Timeline

The Post-9/11 veterans' educational program begins in August 2009. The timeline below has been carefully designed to address the immediacy of this need through rapid delivery of the expected outcomes. Stars represent major reporting dates for dissemination of analyses to NSF and others. In particular, we are sensitive to the fact that NSF is likely to issue RFPs for further studies of GI educatonal opportunities in the spring of 2010, and hence it is important to have preliminary results available within 6 months of starting this project.



5.3.1 Project Team Responsibilities and Expertise; Project Advisory Board

The project team is headed by Laura J. Steinberg, Dean of the LCS College of Engineering and Computer Science. Dean Steinberg holds appointments as Professor of Civil and Environmental Engineering, and Professor of Public Administration in the Maxwell School of Citizenship and Public Affairs. Dean Steinberg will have overall responsibility for the successful completion of the study and for meeting the schedule shown above. Dean Steinberg has extensive experience in leading multi-disciplinary research groups focused at the intersection of technology and social issues, as well as an academic speciality in statistical modeling. Tim Eatman, Assistant Professor of Education, and Cori Zoli, Research Fellow in the Institute for National Security and Counterterrorism (INSCT), will run the focus groups. Dr. Zoli has substantial training and experience with focus groups. Dr. Yingyi Ma, Assistant Professor of Sociology and the holder fo an MS in Applied Mathematics and Statisticis, will have primary responsibility for deploying the surveys and analyzing the survey data. Dr. James Henderson, Assistant Professor of Bioengineering, will lead the project component on engineering curriculum and engineering student life, providing the important engineering education perspective for the project. Dawn Johnson is Senior

Personnel on the project and is an Assistant Professor in the College of Education. Her research is focused on under-represented students in undergraduate STEM majors, with a particular interest in the experiences of women of color.

All PI's will participate in the focus group and survey design, contributing their disciplines' theory, body of knowledge, and contextual understanding to the designs as well as to the interpretation of analysis results. Based on these results, they will also all help develop a transportable programmatic framework and set of recommendations for other agencies and institutions, as well as produce the white paper, research and conference papers, and final reports. In this manner, the project will be done in a truly interdisciplinary and collaborative manner.

In addition to the PIs, the project will be advised by an Advisory Board composed of the Deans of the Whitman School of Business and the College of Education; representatives of companies with whom the LCS College of Engineering and Computer Science has an extant relationship including JPMorganChase, IBM, and Lockheed Martin; William Banks, the Director of INSCT; the Associate Director of the Syracuse U. Burton Blant Institute for Disability Studies; representatives from the VA (as designated by Keith Wilson of the VA) and the DOD (as recommended by Gen. John Abrams).

6.0 NSF MERIT REVIEW CRITERIA

6.1 Intellectual Merits

The intellectual merit of the proposed research and the subsequent programming and studies that it will facilitate includes the following elements:

(1.) Understanding the impact of career aspirations and decisions of American GIs as they relate to technical skills developed as part of their military experience. The current paucity of data for a rich understanding of servicemember education and career planning is striking and represents several missed opportunities. Most obvious among these is the inability to anticipate capacity, to ensure that transitioning servicemembers are well counseled about educational career options, and that they are well received on campus. Moreover, the technical skill sets that many servicemembers possess as part of their service training may offer a dynamic dimension for science and engineering education programs. There is some evidence that projections related to the analysis of future conditions and job demands to identify critical performance predictors of knowledge, skills, and abilities (KSAs) that may be developed into selection and promotion criteria have been developed by military based research (Ford et.al. 2000). Similar projections for post-military career activity are warranted. The proposed research will provide a springboard into this genre of inquiry.

(2.) *Mapping the pipeline from the battlefield to postsecondary education programs in science and especially engineering.* In part because the transition of technical background (abilities and interests) into engineering degrees seems like such a suitable fit for many servicemembers, it is important to map that pipeline with sensitivity to the nuances that occur in subgroups of military personnel—namely, individuals from traditionally underrepresented groups in higher education and STEM fields in particular. A key intellectual contribution of the proposed study is that it will illuminate these dynamics and provide important data upon which policy and programming can be established.

(3.) *Extending the concept of "health" beyond the important, well-researched physical and mental needs of servicemembers to address their educational health.* The proposed research introduces an important opportunity to broaden our conception of servicemember health to the domain of education. There is a robust and growing literature that examines the health implications that military service imposes on servicemembers. This is important work that provides an evidentiary base for policy and programs that address physical needs. Moreover, the literature that underscores connections between educational attainment and quality of life, including physical health and economic resources, should be applied within a post-military framework (Belfield and Levin 2007; Pascarelli 2005).

(4.) *Relating the acute recovery needs of the American economy with well-trained and highly committed human assets within the armed forces.* It is important to note that this research also touches the intersection of escalating debates about immigration policy and American workforce needs (NSF 2003). A comprehensive review by The National Science Board (NSB) initiated in October 2000 recognized that

global competition for STEM talent was intensifying, while the number of native-born graduates entering the technical workforce was declining, and, thus, called for "national-level action to ensure the nation's capacity in these critical fields in the face of an increasingly competitive global market." The proposed research will meaningfully contribute to addressing complexities of human capital needs in a time of continuing international conflict.

(5.) *Investigating the catalyzing role that GIs are likely to play in the emergent movement within Academe toward public engagement.* There is a movement taking place within higher education that urges colleges and universities to develop a greater sensitivity (buttressed by action) to revisit the civic purposes of postsecondary education. This movement builds upon the legacy of the initial GI Bill and the establishment of the NSF as the first two important partnerships between the federal government and higher education (Erlich and Jacoby 2009). The current research presents a unique opportunity to explore the role that military personnel play within that movement as a key target group with a demonstrated commitment to protecting our democracy.

6.2 Broader Impacts

It is anticipated that NSF and other agencies and institutions will apply the outcomes described above in planning for the influx of veterans into higher education and engineering, specifically. As described throughout the proposal, the project will provide data to inform future program solicitations and scale programmatic content to need. In addition, the project will allow stakeholders to perform the following three critical activities:

(1.) *Maximize enrollment and retention*: Very little is known about the motivation for servicemembers to pursue an engineering degree, as well as the factors most important to determining satisfaction with the educational experience. The proposed project will assess the impacts on these issues of factors such as:

- internships and research activities, and year-round programs with start-to-finish support
- integration of support services to help veterans transition from military service to academia
- credits for knowledge and skills acquired as servicemembers
- special training for faculty members who will spend significant time working with veterans
- career development and networking
- methods to encourage and leverage the veterans' *esprit de corps*

By beginning to elucidate the impact of these and other factors, the project will provide information that institutions can use to develop new associate, bachelors, and graduate level degree pathways with associated support services that maximize the enrollment and retention of veterans in engineering.

(*2.) Engage industry partners:* Industry partners represent potential employers for veterans trained in engineering, but also a valuable resource through which veterans can gain career development experience and academic institutions can gain investment to support educational programs. In return, industry partners will benefit as the veterans trained in engineering become available for hire. However, industry is unlikely to engage substantively with agencies and academic institutions if the population being serviced is poorly defined or if enrollment and retention outcomes are uncertain. By projecting the enrollment of benefits-eligible veterans in higher education engineering degree programs, by identifying criteria to design and improve methods of attraction benefits-eligible veterans to these programs, and by providing preliminary identification of the structure and resources required to provide services that enhance engineering persistence and degree completion, the proposed project will provide quantitative information needed to engage industry partners early in the development of new programs.

(3.) Track educational programs veterans enter or complete: Currently, there is a severe paucity of data on the educational programs veterans enter or complete. Consistent tracking and analysis of data on veterans' choices with respect to educational programs will be critical to evaluating the efficacy of those programs. The proposed project will produce a survey tool that can be used, not only to acquire data for the present study, but also to track the educational programs veterans enter or complete. The survey tool will also provide a means for communicating with veterans regarding the special educational opportunities provided by the new educational benefits.

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