

Pilot Programs for Veterans Transition to Engineering Fields

Dr. Vukica M. Jovanovic, Old Dominion University

Dr. Jovanovic received her dipl.ing and M.Sc. in Industrial Engineering - Robotics, Mechatronics and Automation from University of Novi Sad, Serbia. She received a PhD in Mechanical Engineering Technology at Purdue University, while working as a PhD student in Center for Advanced Manufacturing, Product Lifecycle Management Center of Excellence. Dr. Jovanovic is currently serving as Assistant Professor of Engineering Technology, Frank Batten College of Engineering and Technology at ODU. She is teaching classes in the area of mechatronics and computer aided engineering. Her research Interests are: mechatronics, marine mechatronics systems education, product lifecycle management, manufacturing systems, engineering education.

Dr. Anthony W Dean, Old Dominion University

Dr. Anthony W. Dean has had several roles in academia. His previous appointments include Associate Professor of Engineering Technology and as Associate Director of the Institute for Ship Repair, Maintenance, and Operations at Old Dominion University (ODU). He is currently on assignment with the Office of the Dean, Sponsored Programs and Associate Professor of Practice Engineering Fundamentals Division, Batten College of Engineering and Technology (BCET) at ODU. His research has focused mostly on control systems (integration and testing) and the reliability and maintainability of complex systems. He has been selected as both a NASA and an ONR Faculty Fellow. He regularly teaches courses in Marine Engineering and in Maintained Systems. Most recently Dr. Dean was on the Headquarters Staff the American Society of Naval Engineers. He received his Ph.D. from the Department of Engineering Management and Systems Engineering, and a B.S. in Nuclear Engineering Technology, from the Batten College of Engineering and Technology at Old Dominion University. Additionally, Dr. Dean received an MBA from the College of William and Mary. Prior to his academic career Dr. Dean was Director of Operations and Business Development for Clark-Smith Associates, P.C., and served as an Electrician in the US Navy aboard the USS South Carolina and the USS Enterprise.

Ms. Carol L Considine, Old Dominion University

Carol Considine is an Associate Professor of Engineering Technology at Old Dominion University. She has a Bachelor of Science in Civil Engineering from Virginia Tech and a Master of Science in Civil Engineering from University of California, Berkeley. She has fifteen years of industrial experience and is a LEED AP BD+C. Her area of specialization is construction.

Dr. Karina Arcaute, Old Dominion University

Dr. Petros J Katsioloudis, Old Dominion University

Petros J. Katsioloudis is an Associate Professor, Department Co-Chair and the Industrial Technology Program Leader, Department of STEM Education and Professional Studies, Old Dominion University, Norfolk, VA. His research focuses on improving teacher and student performance in STEM education, and enhancing the development of a national STEM-educated workforce.

Dr. Mileta Tomovic, Old Dominion University

Dr. Tomovic received BS in Mechanical Engineering from University of Belgrade, MS in Mechanical Engineering from MIT, and PhD in Mechanical Engineering from University of Michigan. Dr. Tomovic is Professor and Director of Advanced Manufacturing Institute, F. Batten College of Engineering and Technology, Old Dominion University, Norfolk, VA . Prior to joining ODU Dr. Tomovic had seventeen years of teaching and research experience at Purdue University, with emphasis on development and delivery of manufacturing curriculum, conducting applied research, and engagement with Indiana industry. While at Purdue University, Dr. Tomovic served as W. C. Furnas Professor of Enterprise Excellence, University Faculty Scholar, Director of Digital Enterprise Center, and Special Assistant to Dean for Advanced Manufacturing. He has co-authored one textbook on materials and manufacturing processes that has been

adopted by over 50 national and international institutions of higher education. In addition, he has authored or co-authored over 60 papers in journals and conference proceedings, focused on applied research related to design and manufacturability issues, as well as issues related to mechanical engineering technology education. Dr. Tomovic made over 20 invited presentations nationally and internationally on the issues of design optimization and manufacturability. He has co-authored four patents, and over 100 technical reports on practical industrial problems related to product design and manufacturing process improvements. Dr. Tomovic is also serving as Honorary Visiting Professor at Beihang University, Beijing, China.

Mr. Thomas B. Stout, Tidewater Community College

Thomas Stout is the Dean of Science, Technology, Engineering and Mathematics at Tidewater Community College in Chesapeake, Virginia. Previously he was the Program Head and Associate Professor of Electromechanical Controls Technology at Tidewater Community College in Chesapeake, Virginia. He has worked in industrial maintenance, mechatronics and safety. He earned his BS degree from Old Dominion University in 2004 and his MS in Electronics Engineering from Norfolk State University in 2007. He served 20 years in the United States Navy working on aircraft and surface ships.

Mr. Connor Schwalm, Old Dominion University

Connor Schwalm earned his B.S. in Physics from Old Dominion University in 2014. Currently, he is an Graduate Student in the Engineering Management and System Engineering Program at Old Dominion University working towards his M.E. in Systems Engineering with an expected graduation of August 2016. Currently, he works as a Graduate Research Assistant for Dr. Tony Dean on Stern2STEM, a pilot program to increase the student veteran population and retention rates in STEM disciplines. His interests include, Cyber Security Resiliency, Risk and Vulnerability Governance, Academia-Industry Connections, and Broadening Participating in Engineering and Engineering Technology.

Dr. Jennifer Grimsley Michaeli P.E., Old Dominion University

Dr. Jennifer G. Michaeli, PE is the Director of the Naval Engineering and Marine Systems Institute (NEMSI) in the Batten College of Engineering and Technology at Old Dominion University. NEMSI's focus is to develop and promote government-academia-industry partnerships to further the advancement of naval and marine engineering and foster the future professional engineering workforce. Dr. Michaeli, a licensed Professional Engineer in the state of Virginia, spent 15 years as a Naval Engineer and Program Manager, both in the government sector and in the shipbuilding industry, where she provided leadership and technical expertise on the design, construction, testing and fielding of high-performance marine vessels and advanced technologies for U.S. and foreign navies. For her contributions to naval engineering, she was honored with the Rosenblatt Young Engineer of the Year award by the American Society of Naval Engineers and the RADM Melville Award for outstanding technical achievement by the Naval Surface Warfare Center, Carderock Division. Dr. Michaeli completed her PhD in Mechanical Engineering from ODU, her MSc in Ocean Systems Management from MIT, and her BSc in Naval Architecture and Marine Engineering from Webb Institute. At ODU, Dr. Michaeli oversees the marine engineering curriculum, teaches courses in ship design and construction, and is actively involved in funded Navy research and STEM initiatives to encourage students to pursue careers in naval engineering. For her contributions to ODU and Batten College of Engineering and Technology she was the College's nomination for the Provost's Award for Outstanding Faculty Research Mentor for 2014-2015 and is the University's nominee for the State Council for Higher Education of Virginia (SCHEV) Rising Star award for 2016.

Prof. Yuzhong Shen, Old Dominion University

Yuzhong Shen received his B.S. degree in Electrical Engineering from Fudan University, Shanghai, China, M.S. degree in Computer Engineering from Mississippi State University, Starkville, Mississippi, and Ph.D. degree in Electrical Engineering from the University of Delaware, Newark, Delaware. His research interests include computer graphics, visualization, serious games, signal and image processing, and modeling and simulation. Dr. Shen is currently an Associate Professor of the Department of Modeling, Simulation, and Visualization Engineering and the Department of Electrical and Computer Engineering of



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Old Dominion University. He is also affiliated with Virginia Modeling, Analysis, and Simulation Center (VMASC). Dr. Shen is a Senior Member of IEEE.

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Abstract:

Veterans, through their active service, frequently receive training in highly skilled technical areas. However, they may lack a theoretical background in underlying engineering principles. They also need additional support with the transition from a highly structured military environment to an environment with more ambiguous time constraints and different sorts of responsibilities. Moreover they are facing challenges which are specific for their student population. Therefore, enabling multiple mechanisms which would support them and provide them necessary guidance are especially important at universities with large veteran populations such as at Old Dominion University in Norfolk, Virginia. Hence, there is a need for programs which build on the specialized training that veterans received and aid in their academic journey. This paper will introduce three pilot programs for advancing engineering education for military veterans focusing on forming a support base for veterans to assist them in overcoming traditional educational barriers.

Introduction

Various studies have been done focusing on phenomenological research related to the veteran student and their transition from military service to the academic environment in higher education (Jones, 2013). The studies focused on identity development related to the connecting complex experiences such as service member, then veteran, and forward to the student identity. The American Council of Higher Education's recent data has shown that there are around two million military veterans who are enrolled in courses at the undergraduate level, (ACE, 2008). This number will probably increase due to the troop reduction initiatives (Kirchner, 2015). It is estimated that over five million of post 9/11 service members are expected to transition out of military by 2020 (Molina, 2015). Under the Post-9/11 Veterans Educational Assistance Act of 2008, the U.S. Department of Veterans Affairs provides eligible veterans with housing allowance, books and supplies stipend and full tuition and fees (DVA, 2011). In 2007-08 four percent of all undergraduates and four percent of all graduate students were veterans or military service members (DVA, 2011). Some veterans reported that veteran's educational benefits were the primary reasons that they have joined the military (Heitzman & Somers, 2015).

Veterans generally face some challenges which are not commonly found in other student populations which can influence the success of their transition to student role, which was reported in more than 55% of veteran students (Kirchner, 2015; Lemos, 2013; Miles, 2014). Often they have to face some stereotypes and they might have difficulty in transitioning to a more unstructured academic setting (Kirchner, 2015; Rumann, Rivera, & Hernandez, 2011). Other issue in this transition might be related to the military culture that scorns weakness and does not encourage asking for help (Heitzman & Somers, 2015). Moreover, thousands of veterans who are enrolled in undergraduate education are students with disabilities who are facing even more difficulties in their transition into the academic learning environment (Branker, 2009; O'Rourke, 2013). Veterans who were involved in direct combat might also face Post Traumatic Stress Disorder (PTSD) which makes integration even harder for them (Heineman, 2016). Another difference reported by veteran students, especially by the wounded warriors, was

that since their average age is 25, it is hard for them to make friends with other students which average age is 17 to 18 (Branker, 2009; Heitzman & Somers, 2015). Instilling a sense of belonging in the military student population would be key, since sense of belonging has been shown as one of the predictors for later academic success and retention (Durdella & Kim, 2012).

A statistical analysis based on data retrieved from U.S department of Education and the National Center for Education Statistics, year 2011-12 is shown in Figure 1 (Molina, 2015). A majority of veterans are currently enrolled in associate degree or certificate programs (54 %), and only 19 % are enrolled in public 4-year colleges. Their average age is 25, the majority of them have dependents (52%), are U.S. born (94%), white (63%), and male (79%). Only 20 % of veterans are enrolled in STEM fields.

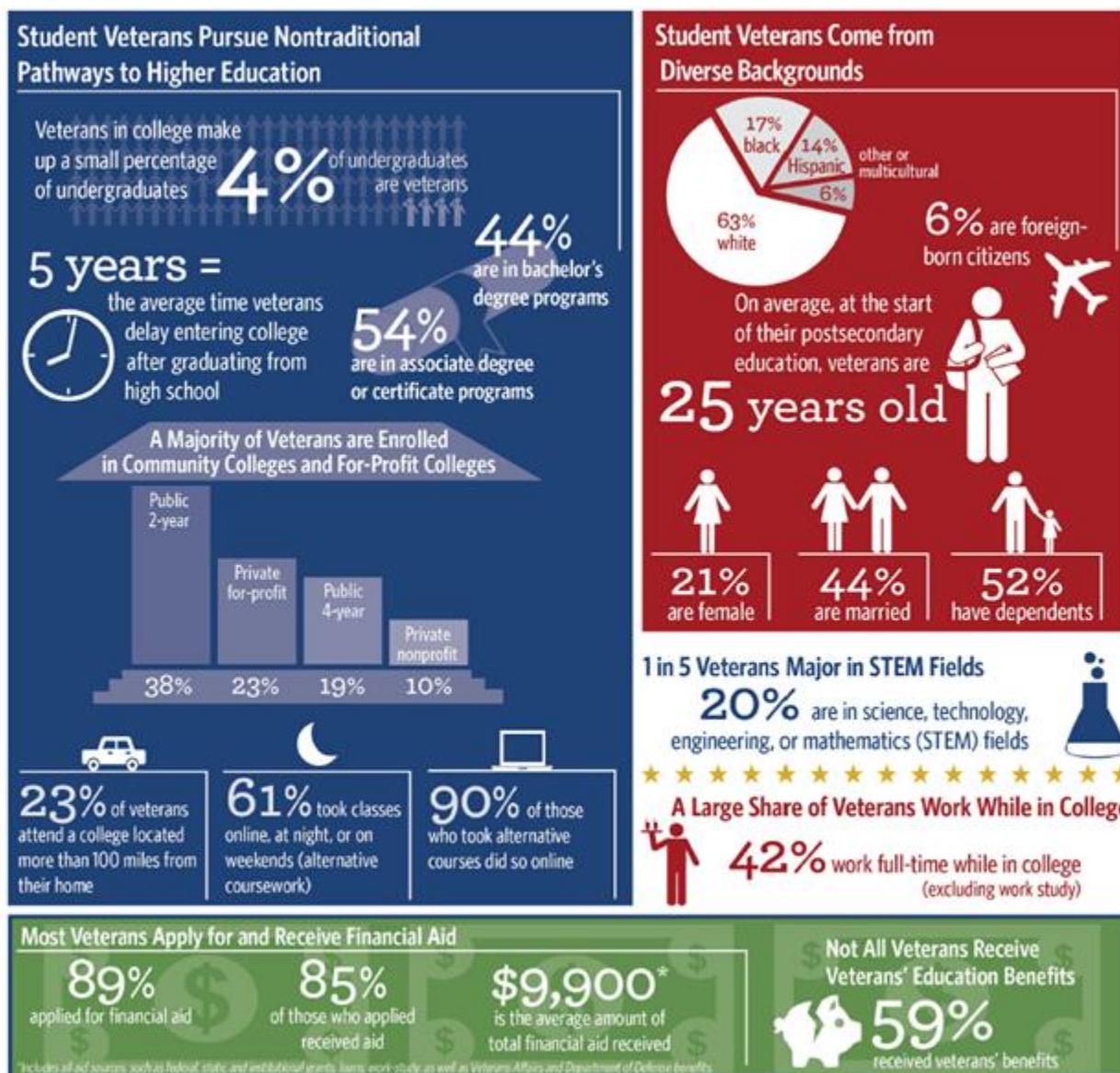


Figure 1: Undergraduate student veterans by numbers (Molina, 2015)

Strategies recommended for institutions to serve as a veteran friendly include: a) enabling of transfer credits and experiential credits; b) taking a community-based approach with comprehensive programs and services for student veterans and their families which include housing, health care, employment during the college; c) enabling veterans' voice to be heard through roundtables, veteran associations, etc; d) have strong web presence easily accessible to the veterans; e) establish a specific point of contact; e) expand housing options; and f) implement tuition deferment plan to accommodate the GI Bill (Servicemen's Readjustment Act of 1944) payment schedules; g) provide veteran focused orientations; h) provide faculty training related to veterans (ACE, 2008; Heineman, 2016; Olin Earl & Committee on Veterans' Affairs, 1949). Veterans, especially female veterans suggested that the university should provide more information in admission materials about family housing and daycare options (Heitzman & Somers, 2015).

Old Dominion University (ODU) is uniquely positioned to achieve these aims. It is strategically located in the Hampton Roads region of Virginia. The Hampton Roads area is home to one of the world's largest military populations, with approximately 83,000 active duty military personnel. Every branch of the military is represented in this region having one or more major command centers within its borders. ODU maintains close partnerships with the US Navy (and all other branches of the military), the maritime, shipbuilding and repair industries, with many of their representatives serving as members on ODU's institutional advisory boards. Hampton Roads is also home to the largest Naval base in the world and the only NATO (North Atlantic Treaty Organization) command on US soil. Major military units and headquarters include NATO's Allied Command Transformation, U.S. Joint Staff J7 Suffolk, U.S. Fleet Forces Command, the U.S. Air Force's Air Combat Command, U.S. Marine Corps Forces Command, and the U.S. Army Training and Doctrine Command. The region boasts the only site in the US for aircraft carrier building, repair and maintenance, one of the two sites for the construction of submarines, and one of four public shipyards. The military currently has 64 ships home ported in the area, 36 aircraft squadrons, as well as a variety of Navy Special Forces and support units (Chamber, 2016). Figure 2 shows the Hampton Roads region and the location of different major military units and headquarters. Each year, [in the Hampton Roads region] roughly 13,000 military personnel leave their respective branches of service and enter the private sector, offering businesses in the region an abundance of skilled, experienced, and highly disciplined workers. More than 20% of the entire US Navy is located in the Hampton Roads area and within a 30-minute commute to ODU (US Navy, 2016). The total DoD population in the Hampton Roads, including active duty and civilian personnel is approximately 150,000 in an area with a total population of 1.6 million. The Hampton Roads regional economy has become increasingly dependent upon defense spending over the past decade, with DoD spending accounting for 45.6% of all regional economic activity (Chamber, 2016).

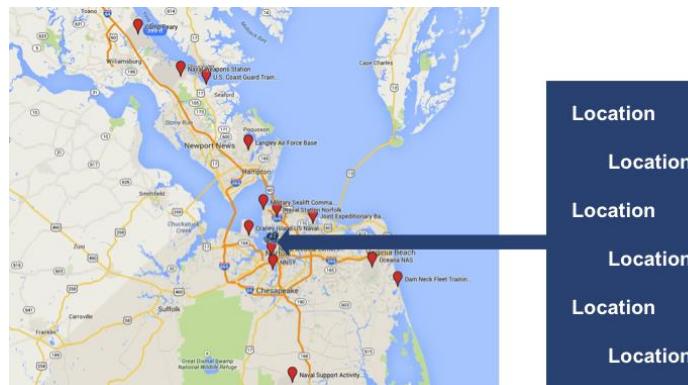


Figure 1. The Hampton Roads region - markers in the map show the location of different major military units and headquarters, as well as the location of Old Dominion University where the proposed program will be housed.

Stern2STEM: Overcoming Barriers to STEM Education for Veterans Program

This pilot/proof of concept program aims to advance STEM education and outreach to veterans, improving the next generation of the Navy's STEM workforce. The proposed *From Stern to STEM* program, funded by Office of Naval Research, will prepare veterans to pursue a baccalaureate STEM degree and support the re-employment of these veterans into the Department of Defense (DoD) and the wider defense support industry. The program builds on the training that veterans have received in highly skilled technical areas, both in the classroom and "on-the-job" to develop systems level expertise in their respective rating classifications. Ultimately, veterans participating in the proposed pilot project will provide closure to the mid-career gap of the DoD and Department of Navy (DoN). Veterans from this program will possess STEM professional training and a greater system level expertise than those engineers typically coming from high school to college and will bring a level of leadership maturation that comes from their years of service in the military. Key project components are:

(1) Recruitment of bright and motivated veterans from highly technical enlisted and officer ratings into the naval and marine engineering degree plans. Establish the mechanisms for reaching out to veterans in the most productive ways, using the capabilities and interests of the individual stakeholder communities to maximum advantage.

Initial outreach efforts to veterans on campus utilized email distribution lists to inform veteran students about the components of the program, specifically highlighting the academic support offered. Toward the end of the Fall 2015 semester, the project team conducted the University's first Engineering College "Active Duty and Veteran Spring Preview Session" with twenty students who started taking courses at ODU in Spring 2016. Participants in the program have been effective in recruiting fellow veteran students to take advantage of the program. In order to continue reaching a broader proportion of the over 250 veteran students in the University's Engineering College, the project team has started the development of marketing and outreach materials, to include a program website to host information and resources for student veterans.

(2) Provide leveling, tutoring, mentoring and support for students through degree completion. Develop degree pathways for veterans in engineering to take advantage of the specific technical proficiency and leadership characteristics that many veterans bring from their time in service. Many enlisted veterans already have a year or more of college. Their experience in the military may qualify them for additional college credits (SMART Transcript). This can be used to reduce the time to degree completion in some instances. The degree pathways include leveling curriculum intended to prepare the student to pass the CLEP exam for Pre-Calculus prior to beginning their first semester in the engineering curriculum. One-on-one tutoring will also be made available to the veterans – particularly during that crucial first year to ensure success. We will instill confidence in the student early in the program and prepare them for the rigors ahead.

The program has provided over 200 hours of individualized tutoring to student veterans during Fall 2015. Two graduate students with specialties in science and mathematics have been tasked with the primary responsibility of tutoring and providing academic support to the program's student veterans. During each session, the tutors utilize Surface Pro 4 tablets and technology-enhanced applications, such as Microsoft OneNote, for reinforcing concepts presented in the student's classes, thus further supporting the students' understanding and retention. In order to support the academic leveling-requirements of student veterans, the team has started development of the first educational gaming module with the assistance of two doctoral students, which is scheduled to be delivered in beta version in Spring 2016 (Smith, Shen, Shull, 2016). These

educational games will enable student veterans to remediate any foundational academic deficiencies prior to beginning coursework at the University as well as supplement the individualized remedial tutoring sessions for each student.

Anecdotally, the academic support provided to the student veterans has led to an increase in self-perception, academic ability, and final course grades for students who have consistently taken advantage of the program. These student veterans are better positioned to meet the performance and retention objectives of the program. In addition, in seeking to maximize the efficient utilization of veterans' educational benefits the program has provided resources and support for student veterans to fulfill degree requirements through the College Level Examination Program (CLEP) tests and the transfer of credits from the veteran's Joint Service Transcript (JST), which contains transferrable credits obtained during military training. This mitigates one of the risk factors for student veterans, which is running out of educational benefits prior to completion of a degree program due to the requirement to take a significant number of leveling courses.

(3) Teaching and learning through proven pedagogical practices. Upon completion of the leveling course, students will then be integrated into the various ABET-accredited engineering and technology programs offered by the college. However, a strong support system for veterans will remain in place to provide additional academic assistance, as needed, with year-round/start-to-finish program support from academic success mentors to help ensure degree completion. Students veterans are matched with advisors who have experience working with veterans; tailored academic advising has been provided to forty veteran and active duty students during Fall 2015 through the program.

(4) Partnering with the Navy and the naval engineering community to facilitate student career placement in the Navy STEM workforce. Assist students to start their new careers in Engineering and Technology through directed mentorship. The large community of Navy partners can encourage veterans to pursue their interests, work to their potential, enhance their abilities, and help them to get started on their new careers. The ODU-American Society of Naval Engineers (ASNE) Student Chapter is one of the largest in the country and provides an additional opportunity for students to enhance their professionalism. Another component of this project is focused on enabling student support which is needed for the successful project completion. The Veterans Administration, through the VA Work Study Program, provided 2 part-time student workers to augment the project, this will allow for additional graduate support in the Spring 2016.

5) Providing workforce development for Naval STEM professionals. The program will also assist veterans in applying for specific programs (e.g. Pathways, SMART and Naval Research Enterprise Internship Program - NREIP) to provide additional opportunities for the students to gain further insight into NAVSEA careers. Thus far, an informational session with a representative from Combat Systems Readiness which highlighted several internship opportunities: the Naval Research Enterprise Internship Program (NREIP), the DoD's Science, Mathematics And Research for Transformation (SMART) Scholarship Program, and the Pathways Programs. As a result of these efforts, five students who are involved in *From Stern to STEM* have accepted Office of Naval Research (ONR) NREIP positions for Summer 2016. One student worker/peer mentor is a DoD SMART recipient.

Marine Mechatronics Pathway Program

Veteran engineers can address shortages in the engineering workforce, especially in the area of advanced manufacturing which is one of the identified areas with skill shortages (Lord *et al.*, 2011). As indicated earlier the majority of veterans in higher education are currently enrolled in community colleges, some of which are making this choice because of the lower tuition rates (Heineman, 2016; Miles, 2014). One avenue to getting them enrolled into undergraduate engineering and engineering technology programs would be to create integrated educational pathways which would provide opportunities for stackable credentials.

One such efforts is the project “Higher Education pathways for Maritime Mechatronics Technicians (MechTech)”, funded by the Office of Naval Research. Two institutions are involved in this effort: Tidewater Community College (TCC), Chesapeake, Virginia and Old Dominion University (ODU), Norfolk, Virginia. These two institutions are investigating industry constituents in the areas of marine and advanced manufacturing with the Modified Delphi Panel research method, and defining and testing sets of standards and outlining the curriculum needed for a Mechatronics educational pathway with Develop a Curriculum (DACUM) study. These two institutions currently have educational pathways defined in Mechanical Engineering Technology – Computer Aided Drafting but they do not have similar pathway for the area of Mechatronics. Tidewater Community College does have a Department of Mechatronics. At the same time, the Mechanical Engineering Technology program at Old Dominion University has an Area of Specialization in Mechatronics Systems Design. Researchers will investigate different levels and competencies needed for mechatronics, starting from an Associate of Applied Science degree (A.A.S.) to mechatronics courses and competencies needed at the Bachelor of Science degree (B.S.) in Engineering Technology program. The project also includes an outreach component which includes mapping of mechatronics-related activities with high school students enrolled in Science and Career and Technical Education classes, as shown in Figure 3.



Figure 3: Two undergraduate MET students Joseph Musso and Anthony Meno at Granby High School assisted students in learning basic mechatronic concepts in Professor's Roger Lagesse class

Green Infrastructure Program

The Environmental Protection Agency launched a Strategic Agenda to Protect Waters and Build More Livable Communities through Green Infrastructure in April of 2011. This initiative supports local communities in using green infrastructure to manage rain water while creating co-benefits of green space, which makes communities more attractive and livable. (EPA) In the fall of 2014 the Environmental Protection Agency along with the U.S. Department of Agriculture, U.S. Department of Defense, U.S. Department of Energy, U.S. Department of Housing and Urban Development, U.S. Department of the Interior and U.S. Department of Transportation signed a federal letter of support for green infrastructure recognizing it as an important tool for building resilience to climate change impacts such as increased heavy rainfall and heat island effect. Each agency committed to taking specific action to promote green infrastructure including but not limited to: creating alliances, providing community assistance, funding, training, development of metrics to assess performance of green infrastructure, and promotion best practices. (Federal)

The City of Norfolk, the Green Infrastructure Center Inc. and Old Dominion University have collaborated on a National Fish and Wildlife Federation Grant titled “Developing a Green Infrastructure Plan and Network for the Lafayette River Network”. As part of the project Old Dominion University will provide a training program to prepare veterans and other small and disadvantaged businesses for the green jobs of the future. Green infrastructure projects can provide business and employment opportunities for veterans. This project includes a 20 hour educational course for veterans to educate them about the green infrastructure industry, business and employment opportunities in green infrastructure and green infrastructure storm water management techniques. Hands-on training will be incorporated in the course work. As indicated earlier, Old Dominion University has a strong tie to the veteran community and the project will take advantage of ODU’s Veterans Business Outreach Center which provides entrepreneurial development services such as business training, counseling & mentoring for veterans. This program will develop a base level certification that will qualify recipients for more advanced and specialized programs. Following the recommendations of the Emmit Environmental Law & Policy Clinic, this green infrastructure training certificate will be coordinated with other green infrastructure education certifications and programs in a “stackable” manner to provide a transparent track for career advancement, which will benefit employers and the green infrastructure industry. Participation of youth and veterans may include commitments such as employment opportunities or internships that are designed to educate and provide hands-on experiences that can aid youth and veterans in finding future employment in natural resource conservation, natural and cultural history and related fields.

Programs Assessment

In order to perform evaluation and assessment of Stern2STEM, several metrics will be collected via surveys, interviews between veteran students and advisors, and evaluations of student's transcripts. These metrics include:

- number of veteran students that apply to program;
- number of veteran students that enroll in the program;
- number of veteran students that take the initial optional pre-calc leveling and compare this number to the number of students that take the CLEP or College math placement and either place in Calc I or receive credit for Pre-calc via CLEP and begin in Calc I;

- number of veteran students continuing toward a STEM Degree from previous year;
- number of veteran students in the program applying to NREIP, DoD SMART, Pathways, Department of the Navy, DoD internship programs;
- number of veteran students that apply for a federal position upon completion of the program;
- number of veteran students that apply to broader DoD STEM careers (to include contractors and support);
- number of veteran students that complete the program.

The project has the potential to have a significant impact on the broad DoD STEM community, as many of the principles, lessons learned, and tools developed will prove valuable for other institutions which have a large population of student veterans. By developing the materials, testing their effectiveness, and having a proven model for the recruitment of veterans into the educational pipeline and re-employment into the wider defense industry, this program will validate a model of systematic interventions for student veterans and develop scalable best-practices which can serve as the foundation for policies at other institutions of higher education. As the project continues, further validation of the model will take place through analysis of the program's progress on the metrics above, and increased resources will be created to support to academic performance of student veterans.

The evaluation of MechTech program will consider the resources, techniques, procedures, and strategies employed to accomplish the goals and objectives of these three programs, as well as the outcomes of the activities and their impact on the participants. The evaluation plan will examine accountability, effectiveness and impact. The formative evaluation will assess ongoing project activities and provide information to monitor and improve the project. Long-term or summative outcomes, such as total enrollment, completion, graduation and employment figures and percentages will be assessed on a yearly basis and at the conclusion of the programs.

The Green Infrastructure Program evaluation will be based upon metrics that are collected via participant surveys, assessment of program objectives and outcomes and the number of participants in the program. Assessment of program objectives and outcomes will be completed each time the course is offered and used to improve the course offerings.

Conclusion

Three programs with emphasis on undergraduate veteran student populations were presented in this paper. Their synergistic activities are focused on important aspects of veteran student engagement and retention. The first program develops more focused support mechanisms for careers in various engineering fields. The overarching theme establishes mechanisms for outreach and recruitment of highly skilled veterans in an engineering career. This is established by providing leveling, tutoring, mentoring and support for veteran students, as well as by determining what transfer credit can be awarded to program enlistees based on previous academic or military experience. Students are integrated into accredited engineering and technology programs offered by the University, with a support system so that they can finish their degrees. In this effort, the “mid-sized institution” is partnering with the community college programs, Department of Defense agencies, and the regional engineering community to facilitate student career placement in the STEM workforce. The second program is focused on development and implementation of a set of standards to build an educational pathway from an Associate degree in Applied Science to

a Bachelor of Science in Engineering Technology degree, with design specialization on Mechatronics. It focuses on assisting veterans who are transitioning to the advanced manufacturing industry. In addition, it includes outreach components to high school students to expose them to different career pathways: apprenticeships, associate and bachelor's degree programs. The third program is focused on educating veterans on the growing career and business opportunities in the area of Green Infrastructure and includes training in green infrastructure techniques. The EPA has identified this area as a unique opportunity for veterans and as a critical tool in climate resiliency.

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