

NAVAL SCIENCE AND TECHNOLOGY

# FUTURE FORCE™

SPRING 2016

LET'S WIDEN THE  
APERTURE FOR DIVERSITY

HOW CAN WE IMPROVE  
THE MILITARY-ACADEMIA  
RELATIONSHIP?

IT'S TIME FOR A  
TECHNOLOGY SCOUT TOUR



ROBOTICS

INNOVATION

SCIENCE  
TECHNOLOGY

ENGINEERING

CYBER

BIOLOGY

MATHEMATICS

$$E = mc^2$$
$$a^2 + b^2 = c^2$$
$$\Delta y = \frac{y}{n}$$
$$\Delta x = \frac{x}{n}$$
$$f(x) = 1, \begin{cases} 0 \leq f(x) < 1, \\ \varphi(x) \leq g(x); \end{cases}$$
$$M^*(X) = \bar{X} = \frac{\sum_{i=1}^n n_i x_i}{n}$$
$$M^*(Y) = \bar{Y} = \frac{\sum_{i=1}^n m_i y_i}{n}$$
$$-b \pm 2\cos^2 \alpha - \dots$$
$$3\cos^2 \alpha + 4\sin^2 \alpha$$
$$f(x) = 1, \begin{cases} 0 \leq f(x) < 1, \\ \varphi(x) \leq g(x); \end{cases}$$
$$M^*(X) = \bar{X} = \frac{\sum_{i=1}^n n_i x_i}{n}$$
$$M^*(Y) = \bar{Y} = \frac{\sum_{i=1}^n m_i y_i}{n}$$

# BUILDING

THE NAVAL S&T

WORKFORCE



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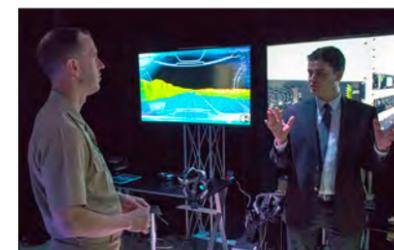
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**Future Force** is a professional magazine of the naval science and technology community. Published quarterly by the Office of Naval Research, its purpose is to inform readers about basic and applied research and advanced technology development efforts funded by the Department of the Navy. The mission of this publication is to enhance awareness of the decisive naval capabilities that are being discovered, developed, and demonstrated by scientists and engineers for the Navy, Marine Corps, and nation.

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Front Cover: Designed by Jeff Wright

As our naval forces shrink in size, their reliance on technological superiority to maintain their capability and dominance increases.

This dynamic presents new and pressing challenges to today's Naval Research and Development Establishment (NR&DE). We are the 41,262 scientists and engineers from across the naval warfare centers, systems centers, and labs who work together to explore, discover, develop, and deliver the ships, aircraft, combat vehicles, weapons, and C4I systems of the greatest naval force in the world. We work hand in hand with our academic and industry counterparts to discover new science, develop new technology, transition technologies from prototypes to fielded systems, and deliver and maintain game-changing combat capabilities.

This issue of *Future Force* is dedicated to the tremendous talent and expertise of the Department of the Navy's science and engineering workforce. The pace of technology and the nature of the threat require a dedicated workforce committed to high-velocity learning. This can only be accomplished through an academic foundation in science and engineering, state-of-the-art laboratories and facilities, hands-on technical work that permits discovery and creation of new knowledge, and collaboration with peers from across the NR&DE, academia, and industry.

Twenty-eight percent of our workforce has earned master's degrees in their field of expertise, and nearly three percent possess a doctoral degree. We also are focusing efforts on increasing our labs' and facilities' capabilities, and providing leading-edge models and simulations to advance our engineering and analytical capabilities. Equally important are our efforts to encourage knowledge sharing and interaction throughout all technical communities to spawn innovation and increase the speed of solving complex naval problems.

As we continue to take on the technical challenges facing our naval forces today, we also must give equal attention to our naval forces of tomorrow. We must not only widen the gap in technological superiority, but also offer capabilities that fundamentally change the nature of naval warfare to ensure operational advantage of our naval forces. This is both a challenge and an opportunity to our NR&DE and to their counterparts in academia and industry. I am convinced we will live up to this challenge and create and capitalize on opportunities to significantly advance the technology capabilities of our future forces.

**Dr. Burrow is the Deputy Assistant Secretary of the Navy for Research, Development, Test, and Evaluation.**

Photo by John F. Williams



## BUILDING THE NAVAL S&T WORKFORCE OF THE FUTURE

"Science and technology" is a term that represents the collective insights and inventions of human beings. Scientific discoveries and technological innovations occur because of the ideas and actions of scientists and engineers, and of the many more people who support them. Building an S&T workforce is more than about hiring—it starts at a young age by fostering the curiosity of those who will seek jobs in science fields, and it continues long after with the training and continuing education of personnel throughout their careers.

Above, Lindsey Groark, with the Naval STEM coordination office at the Office of Naval Research, watches as a young visitor explores a ship of the future exhibit during the USA Science and Engineering Festival held at the Walter E. Washington Convention Center in Washington, DC.



Photo by John F. Williams

Dr. Scott Walper, a molecular biologist in the Naval Research Laboratory's center for biomolecular science and engineering, advises Ebony Stadler, a biomedical engineering senior from North Carolina Agricultural and Technical State University, as part of a summer research program held at the laboratory. This is one of a number of current formal programs that connect Navy research personnel with academia.

# HOW CAN WE IMPROVE THE MILITARY-ACADEMIA RELATIONSHIP?

By Lt. Adam T. Biggs, MSC, USN

Science and technology advancements in the modern world are rarely the product of individual effort. Research projects often require teams working together toward a common goal to achieve success—and the bigger the project, the more teams are needed to complete it. This personnel prerequisite makes deepening our network of partners a priority for naval operations, something the chief of naval operations outlined in his strategic guidance, “A Design for Maintaining Maritime Superiority.” We should, the document states, “deepen the dialogue with private research and development labs, and academia.”

Academia is a vital partner in Navy research. Some of the best and most impactful ideas originated from people who have never worn the uniform. So we need to ask: how do we currently conduct research involving academia, and how can we strengthen this relationship?

Working with academic collaborators has many advantages. Foremost among these is that academic institutions have some of the best and brightest scientists, who are in turn training the next generation of best and brightest scientists. The Navy benefits by tapping into

this wealth of expertise and enthusiasm for scientific endeavors. In addition, universities sometimes have easier access to available research subject pools than government installations. This aspect occasionally allows research (particularly basic research in fields such as psychology) to move forward at a faster pace than what a government laboratory might be able to accomplish.

There also are disadvantages to consider when evaluating military-academic collaborations. The obvious concern is that academic collaborators will likely not have the clearance to be involved with more sensitive projects. In addition, academic and military collaborators often have very different primary goals: the former group seeks insights and discoveries for their own sake, while the latter is driven by a need to work toward practical results for Sailors and Marines. The two goals are not necessarily incompatible, but making them work toward a common outcome can be a challenge. The peer-review-centered metrics of academia must be meshed with the technology-focused goals of the Navy and Marine Corps.

## Solutions

The solutions to these issues are relatively straightforward. Classification problems can be solved by vetting academic collaborators through the clearance process, and working out the kinks of differing agendas may not be a large-scale issue at all. A more prominent but related concern involves the essential knowledge gap between academic pursuits and military applications. The civilian and military worlds are separated by a common language—jargon, acronyms, and terms that complicate communication. Civilians may not have the situational awareness to truly innovate for military research and development. One example of this problem involves new methods of dealing with in-flight mishaps in naval aviation. Spatial disorientation contributes to a significant number of flight accidents, yet many cognitive scientists who specialize in spatial processing do not properly understand naval aviation, nor do they have the knowledge to sort through military acronyms and easily learn about the subject. The disconnection creates a gap between the military and academia that hinders productive collaborations.

Bridging this knowledge gap and guiding academic researchers helps to accomplish the core mission of the Office of Naval Research (ONR). One way ONR provides this guidance is by identifying areas for grant submissions in agency announcements. Given the increasingly high cost of conducting even relatively straightforward experiments, academic researchers regularly seek out external funding to complete their projects. In turn, scholars contour various research interests to align with

corresponding interests of various funding agencies. Funders thus maintain a subtle, yet firm grasp on the direction of university research while leaving appropriate levels of freedom to the academic investigators. This approach serves as the first layer of finding synergy between academia and the military.

Beyond aligning academic activities with the needs of the Navy by soliciting and awarding grant funds, the next question involves what the military's level of involvement should actually be. One possible method is the “fund and forget” model, where ONR could fund an academic project and then receive only project updates and a final report. This hands-off approach has the advantage of leaving academic scholars the freedom to pursue the ever evolving changes in scientific knowledge. No proposal ever perfectly predicts what will occur or what the outcomes will be—life alone intervenes to prevent flawless projections, and there are the inevitable realities of asking questions to which we do not know the answers. A laissez-faire philosophy would allow academic researchers to ask a question and then continue wherever the answers might lead.

The other end of the spectrum would be to embed military members as direct contributors to the project, thereby creating a true collaboration rather than military-funded, academic-conducted projects. Military scientists can help civilians parse through the jargon and provide insights that academic researchers can use to understand the problem better. Furthermore, a Navy collaborator can keep the Navy's interests at the forefront and continually steer project goals as needed to align with naval interests. The end result will be projects with more tangible improvements to naval operations without sacrificing the ingenuity and creativity of the academic collaborators.

The Department of the Navy gets a better final research product by investing more than just our funds—we also invest our time and personnel in the research to ensure that it proves valuable to the Navy and Marine Corps. An excellent example of this form of public-private partnership is at the Air Force Center for the Sustainment of Trauma and Readiness Skills in Cincinnati, Ohio, where embedded Air Force physicians, nurses, and medical staff members not only train for field operations, but actively participate in clinical and basic research on trauma care. Daily on-site research collaborations between the active-duty military personnel and University of Cincinnati researchers have kept the research relevant to the combat environment. The novel techniques, equipment, and protocols developed in Cincinnati have contributed to military medicine's tremendous successes in treating trauma casualties as well as advancing trauma care here at home.

## Training Initiatives

Either approach (fund-and-forget or including Navy collaborators) has its advantages, but these differing involvements may not be practical solutions. I doubt that anyone would advocate for a true fund-and-forget approach across all projects—handing over Navy money to scientists with little military knowledge or oversight would be tantamount to putting people who have never driven behind the wheel of a vehicle. Likewise, it is not feasible to provide a Navy billet to every Navy-funded project, nor would every project need such thorough military interaction. Between these two extremes exists what may be a more practical middle ground. That is, we could focus on certain training mechanisms to provide our academic collaborators with procedural knowledge about the problems they are trying to tackle.

These training initiatives take many different forms, including small workshops, conferences, or direct involvement in training operations. For example, a workshop could explain how Marines attempt to locate improvised explosive devices for visual search scientists, or basic aviator operations for spatial cognition scientists. Another option is to pursue more talk and poster formats at various conferences. Many scientists, both military and civilian, often attend only a handful of conferences. This consistency sometimes prevents appropriate crossover between communities and exposure to new findings. In this



The author (standing, left) discusses how the Reduced Oxygen Breathing Device can assess hypoxia among naval aviators with Nathan Andrews (right), an intern from the University of Florida. (Photo by Megan Mudersbach)

case, limited conference attendance could prevent proper dissemination of military priorities to civilian collaborators. Our increased presence at primarily civilian conferences immediately creates opportunities for military-academic interactions. Any such involvement could help bridge gaps between the Navy and academia without requiring full, continued military involvement in the project.

## Getting It Right

On the continuum of fund-and-forget to providing a full Navy billet, what is the right level of involvement between academia and the military? Unfortunately there is no single answer here. Some projects need more guidance than others, and some projects require more direct military involvement. The right level of involvement will change based on the project. Increased involvement with the military, however, will likely never be a bad thing for ONR-funded projects. Project managers could favorably evaluate academic scientists if they: include military collaborators, seek out specialized training to enhance their procedural military knowledge, or have scientists who are veterans themselves. Individual project managers will have to determine the right level of Navy and Marine Corps involvement for any particular project, although increased involvement will almost certainly yield increased benefits. Our increased involvement thus provides the second layer of synergy between the military and academia.

Beyond vast improvements for translating scientific findings into improved Navy and Marine Corps operations, military-academic collaborations carry another significant advantage through recruitment. When building the naval science and technology workforce of tomorrow, we will need to recruit heavily from academia. We need scientists with skill sets that come from, or at least begin with, a top-notch university education. Unfortunately, 30-second television ads and recruiting posters are not enough to attract top-tier scientists. We have to explore alternative methods other than mainstream recruiting when pursuing a science and technology workforce. So what is the best way to recruit scientists and other technical personnel into the military?

Greater involvement is the Navy and Marine Corps' best recruiting tool for pursuing scientists and technical personnel. Many scholars who chose to join the service, in one capacity or another, first reached out to someone they knew who conducted military research and development. Consequently, military-academic collaborations are our front line when it comes to recruiting the science and



Former Chief of Naval Operations Adm. Jonathan Greenert tours Pennsylvania State University's Applied Research Laboratory facilities for the manufacturing of antitorpedo torpedoes and unmanned undersea vehicles. The Navy has close, decades'-long relationships with a handful of university affiliated research centers (of which Penn State is one), but it could improve its relationship with the many hundreds of other universities where naval research takes place. (Photo by MCC Peter D. Lawlor)

technology workforce of tomorrow. We gain greater presence and visibility to potential recruits by becoming directly involved with university research. Scientists can then approach someone they know and ask the myriad of questions they have when determining the path for their personal careers. We could provide guidance about the many different options, from working at a Navy or Marine Corps laboratory to actually serving in uniform. Academic scientists then would better understand our mission, and we would gain built-in prominence more effective than any recruiting brochure can provide.

This presence also would enhance recruitment by dispelling many common misconceptions about the military. For example, one common misconception is that joining the Navy would immediately require serving aboard ship or heading into a war zone—even though Navy researchers are far more likely to be in a laboratory than on the front lines. Scientists, along with the general population, also often tend to have unrealistic views about the military through popular culture. By becoming more directly involved with academic researchers, we become real people with whom they can interact and ask questions.

We can enhance how scientists view the military while also enhancing research quality and the ability to translate academic findings into military applications.

Another advantage to greater involvement will be in the type of scientists we recruit. Some scholars prefer basic research, which is essentially the pursuit of knowledge for knowledge's sake. Conversely, military research and development will always have real-world applications. Some scientists prefer this type of applied science, and these individuals are exactly whom we want to recruit into the Navy and Marine Corps. All scientists relish seeing their work make a difference, yet there is a critical distinction between seeing your work cited by other scholars and seeing your work make a change in the real world. Not everyone in academia has the chance to see what tangible changes occurred because of their work. With a greater presence at universities, we will have more opportunities to help academics see the transition from laboratory experiment to changes in naval policy, procedure, or technology. Some will relish these opportunities, some will not. Those who enjoy the opportunity will start asking their military collaborators the very questions we want them asking, such as how is being a Navy scientist different from working at a university? And what sort jobs are available? The Navy will, in turn, have attracted those scientists most eager to make a difference in the real world. Therein rests the third layer of finding synergy between the military and academia.

Ultimately, the future science and technology workforce will rely heavily on academia. Significant scientific and technical training, if nothing else, will have to occur at universities, which makes academia an exceptionally important link in naval research and development. Finding the proper synergy with this prominent research partner will involve continued elite performance at the three levels described here (guidance through funding, increased military involvement in the research process, and as a passive recruiting tool) and more. This enhanced synergy could yield numerous benefits, including a better final product and better recruiting tools. It is a win-win scenario all around as we move toward building the Navy and Marine Corps of tomorrow.

## About the author:

**Lt. Biggs** is a research psychologist at the Naval Medical Research Unit Dayton in Dayton, Ohio.

# WIDENING THE APERTURE ACHIEVING DIVERSITY IN THE SEARCH FOR EXCELLENCE



Photo by Joseph Bullinger

**A DIVERSE WORKFORCE IS AN ABSOLUTE NECESSITY IN TODAY'S COMPETITIVE ENVIRONMENT. MAKING DIVERSITY SUCCEED TAKES MORE THAN GOOD INTENTIONS—IT INVOLVES CREATIVE THINKING AND THE WHOLE ORGANIZATION WORKING TOGETHER.**

**F**or 70 years, the Office of Naval Research (ONR) has diligently pursued a single vision: Sailors and Marines carrying a decisive technological advantage into every battle wherever they are engaged. While this mission is laser sharp, this always will be an evolving challenge. A wide open aperture to a workforce of excellence without boundaries is an essential prerequisite. Our goal as the ONR Diversity Council is to ensure that that aperture remains open, and to find ways to make it even wider.

## **A Growing Sense of Urgency**

Sustaining our historically decisive edge depends on a future capacity for technology innovation. Senior leaders across the Department of Defense are sounding alarms about the need to accelerate advances in technology. The Secretary of Defense has called for a "Third Offset Strategy" to regain and accelerate America's military technology lead. Task Force Innovation, created by the Secretary of the Navy, aims to leverage good ideas from all levels of the Navy and Marine Corps. The Chief of Naval Operations is championing "high-velocity learning" as a means to accelerate organizational improvement while becoming inherently receptive to innovation and creativity. The Commandant of the Marine Corps has stressed the importance of leveraging their superb talent to enhance quality and diversity to remain the nation's preeminent force.

Cutting-edge capabilities emerge from excellence in the science, technology, engineering, and mathematics (STEM) disciplines. To ensure continued excellence in the future, ONR acknowledges the necessity of opening our aperture ever wider to attract talented people, wherever and whoever they may be. Diversity of thought, and the commensurate ability to attack complex problems from multiple perspectives, is rooted in a diverse culture and a broad base of educational and workplace experience. Only a welcoming, dynamic, and inclusive organization will sustain our high standards. In other words, we must ensure that people of excellence everywhere know that "diversity is welcome here."

By John Barth, Karl Berry, Will Brown, Dr. Sarwat Chappell, Cmdr. Michael Files, USN, Dr. Roderick French, Curtis Howard, Mickale Jones, Michael Meyers, Catherine Mule, Dave Nystrom, Dr. John Pazik, Debbi Rafi, and Joe Wojtecki

### A Perspective on Diversity

Diversity can be an awkward subject. The conventional definition focuses on categorical differences among people, which often drives a quota-based approach to staffing. This is “identity diversity,” and while it serves the useful purpose of presenting an outward portrait of an organization in which more people might “see” themselves fitting inclusively, it also has become the basis for negative stereotypes, biasing us to think about diversity superficially. Some of these misperceptions emerged in a recent employee survey. While most respondents saw ONR as a diverse organization, concerns remain that diversity focuses on numbers rather than talent.

As a science and technology (S&T) organization focused on the primacy of excellence, we transcend stereotypical, traditional paradigms and understand the importance of cognitive diversity (diversity of thought) and its role in technology innovation. In our quest for cognitive diversity we have a responsibility to open our aperture and remove barriers in our search for talent. This is not to suggest that everyone can be a great scientist or engineer, but that we must recognize great science and engineering can come from anywhere.

“Across the Naval Research Enterprise [NRE\*], our desired end state is to be a high-performing S&T organization,” said Chief of Naval Research Rear Adm. Mat Winter. “Diversity is an essential enabler to getting there and staying there. Only with a culture of open, inclusive, and collaborative engagement can we achieve true critical thinking. Critical thinking leads to the solution space from which emerges the innovative ideas that enable our decisive competitive edge.” This, simply stated, is the case for diversity.

Cognitive diversity is our ultimate goal. We believe the best outcomes emerge when differing ideas and perspectives contribute to the solution. More importantly, cognitive diversity brings with it a new culture of inclusion and fosters greater opportunity for employees to work collaboratively toward successful solutions.

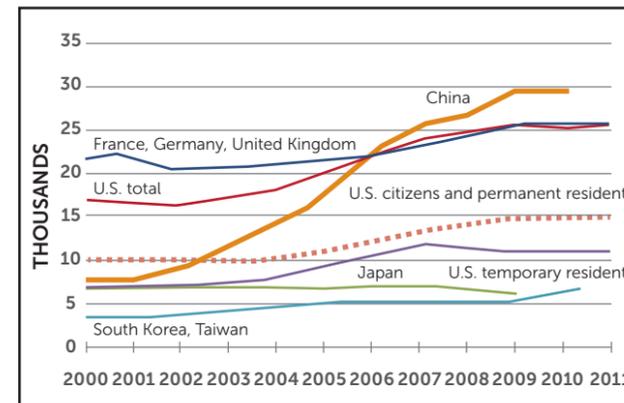
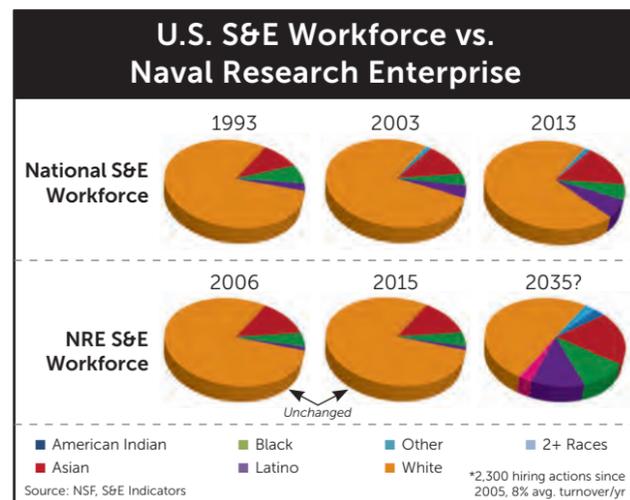
Cognitive diversity contributes to knowledge in four ways: access to a broader range of knowledge leads to a greater accumulation of information; interaction among diverse individuals leads to deeper and shared understanding; analysis is enhanced when diverse individuals discuss and deliberate viewpoints; integration of the best knowledge through debate and discussion creates the best solutions.

The pursuit of cognitive diversity requires access to STEM performers who, for a variety of reasons, may have been overlooked, or prevented from participating in naval S&T research by barriers of which we’re not necessarily even aware. Discussing biases openly and acknowledging that excellence includes diversity can help us fully answer leaders’ call for enhancing our technology advantage.

Achieving S&T excellence through cognitive diversity presents three challenges. One is finding STEM excellence, sometimes in new and unexpected places. Another is attracting STEM excellence—can diverse people “see” themselves as an integral part of our organization? A third challenge is elevating the appreciation of cognitive diversity above the barriers of stereotypes and breaking up antiquated hiring stovepipes.

To meet all three challenges, we must acknowledge the misperceptions and stereotypes we are all familiar with and not allow them to impose barriers. The NRE aspires to reflect the promise of America—that excellence defies boundaries. Talented people from around the world or with different life experiences can flourish here in a melting pot of diversity. We need to leverage this advantage, one that is not found in abundance among some competitor nations. In short, diversity is our collective national strength.

Currently, our journey to cognitive diversity is largely aspirational; we see the potential, but we have yet to surmount all the challenges. Our progress to date as a diversity council has deepened our understanding of the true nature of these challenges and illuminated our path forward. We would like to share some of these insights.



World-Wide Growth in Natural Science and Engineering PhDs: In the US, only 57 percent of doctorates were earned by citizens or permanent residents; temporary visa holders earned the remainder.

Our research uncovered some stark realizations, both external and internal:

**External:**

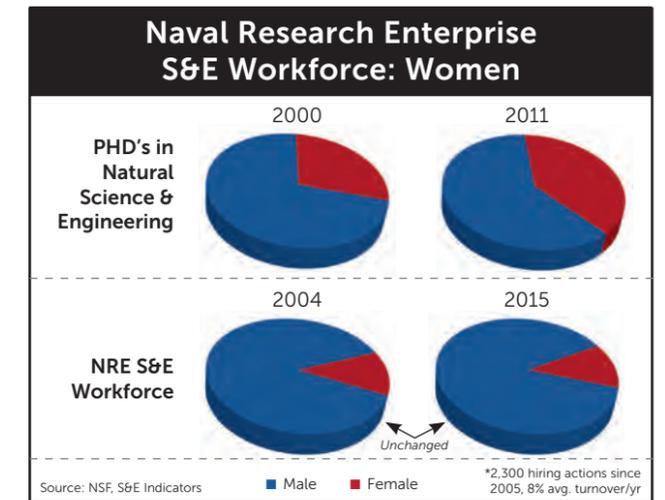
- Our adversaries are closing the technology gap. It is imperative that we accelerate technological innovation.
- Diversity of thought and perspectives drive an innovative S&T workforce to greater excellence. Research shows that the top 50 most diverse companies consistently outperform major stock indexes.
- We must open the aperture even wider to world-class STEM talent, wherever they may be. The international science and engineering workforce is growing larger and more diverse much faster than in the United States (see chart above).

**Internal:**

- The NRE appears to be limiting its search for talent; this is not sustainable.
- International and national science and engineering workforce diversity is growing rapidly (15 percent increase), yet the NRE’s diversity identity remains stagnant (see chart opposite).
- Women are earning a growing portion of the natural science and engineering doctorates (8 percent increase), yet the ratio of women employed in the NRE as scientists or engineers remains unchanged (see chart at right).

On the surface, showing pie charts implies we should be more quota-driven in recruiting and hiring our science and engineering workforce—but that would be the wrong conclusion. What these data suggest is the pool of talent the NRE is drawing from is changing and growing faster than we are, and our current course places our continued success at risk if we fail to change with it. This requires us to change the way we think about diversity.

Maintaining leadership in the S&T community raises a chicken-or-egg conundrum. Is an S&T organization excellent because it is diverse, or is it diverse because it is excellent? In other words, does being diverse automatically result in improved S&T support for warfighters, or does the course to excellence lead to diversity as a natural consequence? There are numerous studies that show differing perspectives and viewpoints can improve outcomes.



As we move forward we must distinguish further between cognitive and identity diversity. The worldwide pool of STEM talent continues to grow and become more diverse in both regards. Consequently, cognitive diversity will include identity diversity as a natural consequence. At the same time, we believe in the power of identity diversity—that is, diversity engenders more diversity. When people of STEM excellence with diverse identities look at the NRE, can they see themselves comfortably and inclusively working here? The answer must be yes.

Over the years, diversity efforts have been viewed merely as a socially valued stance to promote cultural/ethnic equality; e.g., occasional guest speakers and ethnic food samples. Beyond fulfilling legal requirements and Navy policy, and being the right thing to do, gaining cognitive diversity makes good business sense.

## A Competition for Talent

Organizational excellence calls for dealing with diversity as a strategic business issue. Naval S&T is engaged in a competition for talent. As reflected in a 2015 Manpower, Inc., survey of 5,000 hiring managers, a talent shortage already exists in the American workplace. Thirty-two percent of companies reported difficulties recruiting in technology skills areas such as engineering. A recognized leader in benchmarking research, reporting on difficulties in recruiting talented workers, Bersin & Associates identified the energy, oil and gas, telecommunications, manufacturing, and the federal government as “at risk industries.” As we move deeper into areas such as cyber and information technology, we are competing with major industries and a global marketplace for the best talent.

This talent shortage comes at the same time growth in the US labor force is slowing down, according to the Bureau of Labor Statistics. The labor force is anticipated to grow at an average annual growth rate of 0.5 percent over the 2014-24 period. The growth is projected to be smaller than in the previous 10-year period, when the labor force grew at a growth rate of 0.6 percent annually. It also comes as the existing workforce is rapidly aging. The Office of Management and Budget’s most recent statistics (2013) show the average federal civilian employee was 47.3 years old. The Department of the Navy’s civilian workforce average was 47. While wisdom is valued, a constant influx of fresh ideas and perspectives from younger minds is critical to the innovation process.

Based on data compiled by ONR’s Human Capital Strategy team in September 2015, aspects of the NRE’s own demographic profile need to be carefully evaluated:

- Average age of NRE employees: 47.2 years
- Almost 48 percent are more than 50
- 30 percent of NRE’s total workforce is female, but only 15 percent of the science and engineering workforce is female
- Only 9.8 percent of the workforce is under the age of 30
- 17 percent of the NRE is already retirement-eligible.

Looking out over the next few years, 34 percent of the NRE’s civilian staff will be retirement-eligible by 2020. These figures parallel the Bureau of Labor Statistics’ 2014 research that projects the following replacement rates for in-demand skill sets:

- Scientists and engineers 27 percent and 24 percent respectively
- Acquisition professionals 28.5 percent
- Financial professionals 24 percent
- Information Technology and Mathematical professionals 14.7 percent.

In short, the NRE will face ever-increasing challenges to maintain a cutting-edge S&T workforce. Private industry knows that diversity makes good business sense. As an example, the Top 50 Companies for Diversity Index consistently outperforms two of the major indexes—the Dow Jones Industrial Average and the NASDAQ 100. Naval S&T has a business case for diversity: the bottom line is measured by innovative solutions creating warfighter capabilities, solutions best produced by a cognitively diverse workforce.

## Where We Are

Increasing competition for high-tech skills, coupled with internal and external demographic changes, make it difficult to recruit and hire qualified candidates through legacy processes.

With a significant portion of the NRE’s workforce approaching retirement, ONR must reach out to people of excellence in populations previously marginalized or overlooked. As reflected in ONR’s 2015 Human Capital Strategy report, taken as a whole the NRE’s workforce mix is fairly diverse, but within core S&T departments it remains heavily populated by white males.

ONR’s human capital plan needs to recognize changing national and international demographics and work habits, including:

- Women account for 47 percent of the US workforce
- Based in part on immigration trends, Asian and Latino populations constitute the fastest growing segments of the labor force
- Recent immigrants in the prime recruiting age bracket of 25-34 are more than twice as likely as their US-born counterparts to hold master’s or higher-level degrees
- The concept of lifetime employment is largely dead, with the average American worker changing jobs nine times between the ages of 18 and 34.

Homogeneous groups can exhibit cognitive diversity, but increasing the variance of diversity factors greatly improves the chances for gaining diversity of thought. Given the NRE’s aging workforce, if we fail to begin broadening the scope of traditional recruiting paths, we risk failing to support cutting-edge advances.

## Evolving to More Cognitively Diverse Excellence

Going forward, we must address key misperceptions that limit our thinking about diversity, educate leaders to create a common understanding, and generate alignment on actions to mitigate existing barriers (self-imposed or otherwise). We are pursuing the action agenda below, organized around a simple framework of people, organization, and mission.

**People:** View diversity (cognitive and identity) not as a problem to be solved, but as an opportunity to be embraced. It is a consequence of expanding the search for STEM excellence to the broadest extent possible.

- Training: develop and implement training, particularly for leadership, to dispel superficial myths, increase awareness of personal and institutional bias, and establish a common understanding
- Process: review current recruiting and human resource processes to identify constraints that may be limiting the aperture for new talent (i.e., hiring criteria such as education levels, native language, or work experience that may no longer apply to today’s rapidly evolving STEM-proficient applicants)
- Governance: emphasize diversifying criteria in the command hiring board to prioritize positions that would benefit from a wider range of applicants.

**Organization:** Diversity and inclusion go hand in hand—diversity factors are something staff members can track and manage, while inclusion is a function of good leadership. Organizations with an inclusive culture will naturally track toward increased diversity.

- Leadership: hold one-on-one meetings with leaders to review their department’s diversity. Identify where diversity is working well, understand why, and share the lessons learned with all leaders
- Communication: sustain the dialogue by soliciting ideas and providing feedback (information exchanges, articles, lecture series, etc.)

- Teams: ensure the diversity council is a command priority, establish working groups across departments to foster activity, and leverage existing diversity when creating integrated product teams.

**Mission:** Diversity of thought is critical to the innovation process. The kind of innovation that wins wars is technology-based. To maintain our world-class status, we must search worldwide for the best and brightest to join the NRE.

- Research: leverage investments being made in historically black colleges and universities and minority institutions and naval STEM efforts to increase awareness of opportunities to work in the NRE
- ONR Global: leverage knowledge of regional technology hotspots and contacts worldwide to uncover new recruiting sources and different staffing strategies (i.e., international exchanges)
- Barriers: seek new tools for new times; recruit, hire, and fast track qualified visa holders to US citizenship and security clearance, as feasible.

## Conclusion

In the final analysis, widening the aperture begins with recruiting. Our past efforts have made us successful to date, but we must ask ourselves: are we positioned to find STEM excellence wherever it may be going forward? Do we seek talent without boundaries? Is the American dream fully unleashed in the NRE? Are we positioned to attract excellence when we find it, and can talented people see themselves here as an attractive destination?

Recruiting is only the beginning of the quest for excellence. Diversity changes the landscape, while inclusion changes the culture. Once we have found and acquired excellence through the most talented, diversely smart people, are we positioned to inspire, grow and retain them?

Our point is that diversity must be part of an ongoing conversation. When we can answer “yes” to these questions and then take a close look at ourselves, what will we see? We expect to see an inclusive culture reflecting diversity—both cognitive and identity—in a sharp and enduring focus.

\*The NRE consists of the Office of Naval Research, the Naval Research Laboratory, ONR Global, and PMR-51.

### About the authors:

The authors are members of the ONR Diversity Council, all of whom contributed to this article.



## DATELINE 2030

# THE STATE OF THE WORKFORCE

By Alan J. Dean

**T**he year is 2030. The Naval Sea Systems Command's (NAVSEA) warfare centers are poised with diverse teams of seasoned and new multidiscipline scientists, engineers, and technicians to research, develop, test, and evaluate all the latest naval capabilities and perform in-service engineering efforts across all Navy surface and undersea platforms. But how did these teams originate and evolve? What activities did the warfare centers engage in to spark inspiration and develop foundational skills in the science, technology, engineering, and math (STEM) fields?

### How It Started

In 2002, Chief of Naval Research Rear Adm. Jay M. Cohen recognized the need to create an intellectual capital base to develop and deploy the required technologies for the "Navy after Next." He initiated the "Naval Research—Science and Technology for America's Readiness" (N-STAR) program. He funded the warfare centers to create and implement an integrated continuum of programs with the goal of sustaining a pipeline of at least 500 scientist and engineering candidates per year. These integrated activities were based on a National Science Foundation research study that determined "experience to date has shown that students can be attracted to and retained in engineering programs if they are exposed to the joys of creation through design discovery, through research and invention through hands-on experimentation." As a result, the naval STEM strategy released in 2011 focused on three areas: "inspire," to plant the seeds of interest in science and engineering in middle and high school students and faculty; "engage," to nurture that interest through engagement with students and faculty; and "educate," to produce the STEM workforce that is critical to the Navy's success through undergraduate and graduate research.

Integrating the hands-on strategy across everything from K-12 to university activities had the potential to yield a robust and diverse STEM pipeline for the Navy and offered new opportunities to partner with academia and industry. In 2007, the National Academies released a report, "Rising above the Gathering Storm: Energizing and Employing America for a Brighter Future," that underscored the need to emphasize STEM programs across the United States—similar to Cohen's vision for the Navy. Today, the warfare centers—composed of the Naval Surface Warfare Center (NSWC) and Naval Undersea Warfare Center (NUWC)—execute a robust STEM program to inspire, engage, and educate the future workforce.

## NAVSEA's WARFARE CENTERS

The NAVSEA warfare centers are composed of the Naval Surface Warfare Center (NSWC) and Naval Undersea Warfare Center (NUWC) and represent about 30 percent of the Navy's engineering and scientific expertise. NSWC is comprised of eight echelon-four divisions: Carderock, Corona, Crane, Dahlgren, Indian Head Explosive Ordnance Disposal Technology, Panama City, Philadelphia, and Port Hueneme, as well as one echelon-five command, Combat Direction Systems Activity (part of Dahlgren). NUWC is comprised of two echelon-four divisions, Newport and Keyport, as well as one echelon-five command, Naval Sea Logistics Center (part of Keyport). With more than 100 years of history, the warfare centers provide full-spectrum technical advice and solutions to our partners in support of naval platforms and systems.

### Inspire

Inspiring the future workforce starts at an early age. This requires robust STEM programs for elementary and middle school students. The flagship program for naval K-12 outreach is SeaPerch, which provides students with the opportunity to learn about robotics, engineering, science, and mathematics while building an underwater remotely operated vehicle as part of a science and engineering technology curriculum. Throughout the project, students learn engineering concepts, problem solving, teamwork, and technical applications.

NSWC Panama City Division's "Science Brothers" is a unique outreach program aimed at getting elementary school students interested in STEM activities. The program centers on the dynamics of two "brothers" who specialize in chemistry and physics—and their argument over which is "cooler." The result is a fun and wacky hour-long experience as the brothers perform an interactive demonstration that involves chemistry, physics, and electricity, light, sound, and energy.

Several warfare center divisions host or participate in other STEM events such as the greater Philadelphia STEM center summer camps, supported by NSWC Philadelphia Division. This is a two-week residential camp designed to increase awareness of STEM and Navy careers. The first two-week program is geared toward middle school girls, in partnership with the Girl Scouts of eastern Pennsylvania. The second two-week camp involves middle school boys and girls. Hosted primarily at university partner locations, the students experience a college campus environment.

In FY 2014, more than 3,300 NAVSEA scientists and engineers participated in student outreach programs, reaching more than 1,800 schools, 1,700 teachers, and 45,000 students. In FY 2015, NAVSEA scientists and engineers engaged 58,650 students and 2,813 teachers.

### Engage

The warfare centers participate in a range of local, regional, and national STEM activities—from division tours to local science fairs to the USA Science and Engineering Festival, held in Washington, DC, every two years.

Scientists and engineers mentor high school interns through the Science and Engineering Apprenticeship Program and university students through the Naval



Naval Surface Warfare Center Panama City Division's Dan Flisek (left) and Bill Porter (right), also known as The Science Brothers, conduct a science show featuring "The Barking Dog" demonstration during an annual Take Our Daughters and Sons to Work Day. (Photo by Dan Broadstreet)

Research Enterprise Internship Program. The eight-week, hands-on experience provides the students exposure to real-world naval technical challenges.

High school and college students put their STEM skills to the test at the International Human-Powered Submarine Races held at NSWC Carderock Division (NSWCCD). The races are a biennial capstone event that provides students from around the world with the opportunity to think outside of the box, build one- or two-person submarines that are either propeller or nonpropeller driven, and test their designs in the spirit of friendly competition in the historic David Taylor Model Basin. In 2015, 24 teams competed. Since the inaugural race in 1989, the races have been sponsored by the Foundation for Underwater Research and Education, a nonprofit organization that operates with the support from corporate sponsors, government, and academic officials and a host of private individuals. The races are hosted by NSWCCD, along with the Office of Naval Research and Program Executive Office Submarines. Navy divers from NSWC Indian Head Explosive Ordnance Disposal Technology Division provide water safety and underwater support.

NAVSEA sponsors and the warfare centers administer the Navy STEM Scholarship Program, a partnership between NAVSEA and strategic systems programs designed to reach out to the next generation of scientists and engineers in historically black colleges and universities (HBCU), Hispanic-serving institutions, and universities serving Native American students. As tuition, cost of living, and other related college expenses continue to rise, the Navy STEM Scholarship Program helps students focus on academics instead of mounting financial debt. The scholarship consists of two parts: a one-time \$10,000 scholarship awarded the freshman year of college, and a student employment internship opportunity to provide valuable technical work experience and continued tuition assistance. Since its inception in 2009, the program supports the annual enrollment of approximately 50 diverse warfare center STEM student employees.

The warfare centers administer the master of science in systems engineers program, sponsored by NAVSEA, which targets diversity and underrepresented undergraduate students. This is a workforce acquisition and development program designed to increase the number of entry-level employees, particularly from underrepresented groups, with naval systems engineering knowledge, skills and abilities.

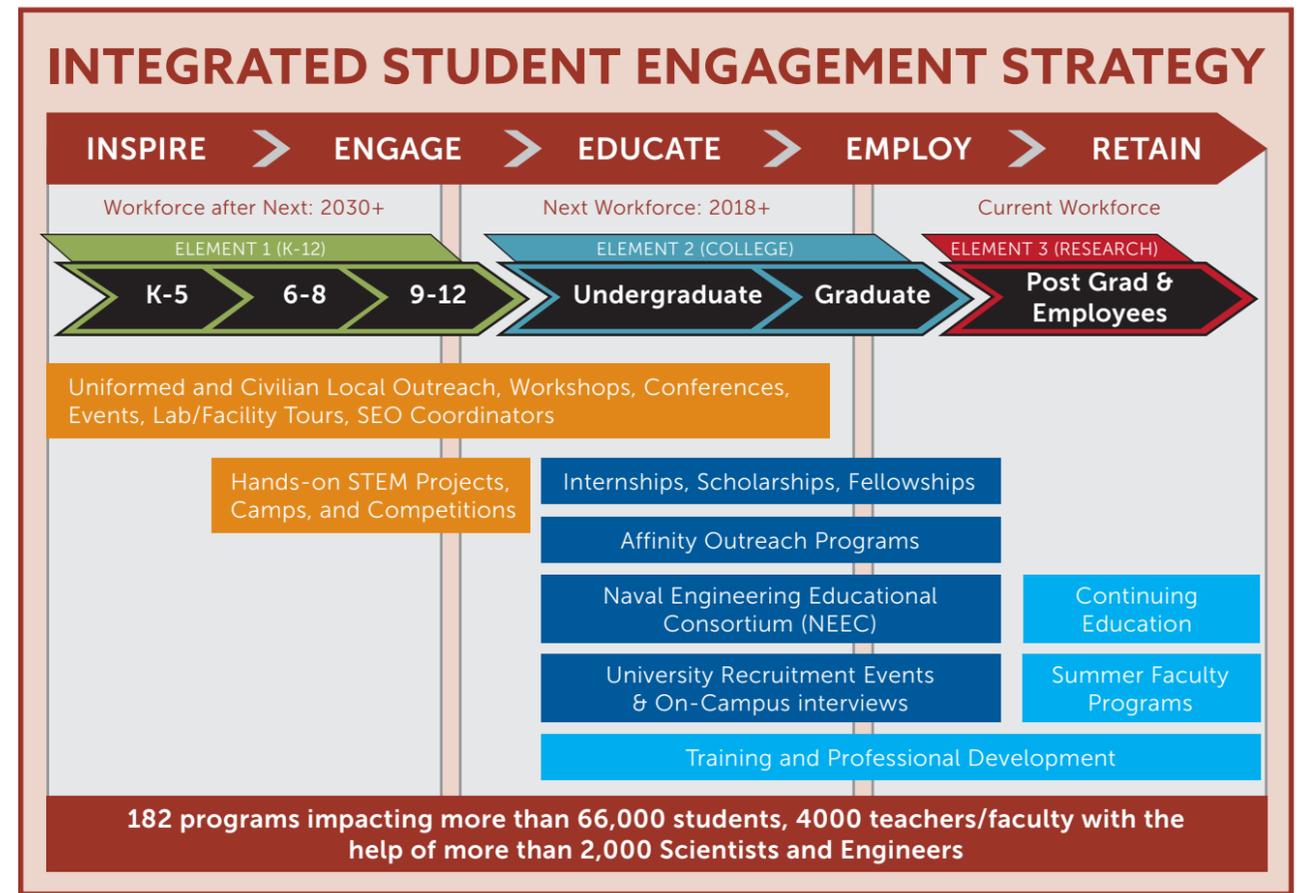
Eligible candidates are hired as full-time employees by the warfare centers and participate in a 12-month intensive academic degree training program at an HBCU, where they receive a multidisciplinary program focused on the engineering of technically complex systems. Since its inception in 2010, NAVSEA and the warfare centers have retained more than 90 percent of the graduates. In 2016, the program—partnering NAVSEA, Space and Naval Warfare Command, and Strategic Systems Programs—is migrating to Morgan State University with a cybersecurity focus.

**THIS INCREASING DEMAND FOR STEM SKILLSETS IN A BROADER RANGE OF OCCUPATIONS UNDERSCORES THE NEED TO CONTINUE TO INSPIRE, ENGAGE, AND EDUCATE AN ENTIRE STEM-FLUENT WORKFORCE**

**Educate**

The warfare centers partner with colleges and universities in undergraduate and graduate research through a range of vehicles including memoranda of understanding, nondisclosure agreements, educational partnership agreements, and cooperative research and development agreements. Although STEM outreach is not the primary purpose of these vehicles, the warfare centers are leveraging them to specifically target STEM students and faculty and provide opportunities to help solve naval challenges.

In 2010, the warfare centers launched the Naval Engineering Education Consortium (NEEC) to accelerate the development of the next generation of naval scientists and engineers through project-based education research. Past examples of NEEC projects include the areas of



maritime communications, acoustics, noise and thermal management of systems, assessing corrosion, analysis of lithium ion batteries, remote magnetometry, testing and operation of a reduced-scale railgun, submarine high-energy lasers, and the use of unmanned vehicles.

**The Challenge**

The 2014 National Science Board report, "Revisiting the STEM Workforce," states that "a decade's worth of data demonstrates the growing pervasiveness of science and technology in the American Workplace." STEM skills have migrated to many more occupations than those traditionally thought of as science and engineering. This increasing demand for STEM skillsets in a broader range of occupations underscores the need to continue to inspire, engage, and educate an entire STEM-fluent workforce, regardless of the job being performed. As the largest federal employer of scientists and engineers, the Department of Defense and the Naval Research and Development Establishment directly and indirectly

influence economic growth in all sectors of the economy. As the demand for a highly skilled STEM workforce continues to grow, sustaining future Department of Defense operations will increasingly rely on a diverse STEM talent pool. The Naval Sea Systems Command warfare centers will continue their efforts to encourage and inspire students to consider careers in the STEM fields to replenish the talent and intellectual capital that helps keep the US Navy and Marine Corps the number one team in the world.

**About the author:**

**Alan Dean** is the Naval Sea Systems Command warfare centers' head of the talent/workforce directorate and has been employed at Naval Surface Warfare Center Dahlgren Division since 1974.

# "FULL ACCESS": Interning at the Naval Research Laboratory

By Dr. Sophoria Westmoreland



Former NRL intern John Purtilo.

The Office of Naval Research supports two internship programs that offer incredible value to the Navy, Marine Corps, and participating students: the Naval Research Enterprise Internship Program (NREIP) and the Science and Engineering Apprenticeship Program (SEAP).

NREIP is a 10-week undergraduate and graduate summer research internship opportunity at a naval laboratory or warfare center. Selected applicants work under the guidance of a mentor conducting naval-relevant research at one of nearly 30 sites across the country. A model mentor engages the interns in real-world experiences, makes time for the interns, fosters the interns' professional growth, and provides balanced feedback and encouragement.

SEAP is an eight-week competitive research opportunity for more than 300 high school students each year. Students get to participate in ongoing naval research at more than 25 naval laboratories and warfare centers. Laboratory personnel mentor the students and encourage them to pursue careers in science, technology, engineering, and mathematics (STEM). Interns will gain real-world, hands-on experience and research skills while being introduced to the Navy and Marine Corps science and technology environment.

NREIP summer intern John Purtilo talks of his engagement with his mentors at the Naval Research Laboratory (NRL) and the meaningful experience this was for him. A recent graduate of the University of Maryland at College Park with a bachelor's degree in computer science, Purtilo interned at NRL in Washington, DC, working in the Physical Acoustics Branch.

**Q:** How did you become interested in STEM?

**A:** I became interested in STEM at a young age through my interest in building things. I went through the phase of playing with LEGOs and construction trucks, and the next natural progression was to do so at a larger scale via STEM. When I learned how to program, I finally had an outlet for these passions. After that, it was just natural to go to computer science at the University of Maryland.

**Q:** What was the best part of your internship at NRL?

**A:** The best part of my internship at NRL was having the opportunity to work with seasoned, expert researchers on a daily basis. On my first day in acoustics, the branch head said that he didn't want me to just learn how to make coffee; he wanted me to learn useful material that would advance me in my chosen field. The only way that could happen is if I was given full access to the scientists in the branch. If I had a question, I was encouraged just to knock on their door and ask. The reception I got from the scientists was wonderful. Not only did they encourage questions, but they also asked my opinion/feedback on what they were doing as well. Instead of a summer intern, I was treated more along the lines of a visiting scholar.

**Q:** What's your current position?

**A:** I am currently working as a project manager at FedCentric Technologies. This is a small, veteran-owned company specializing in big data solutions in bioscience, tax fraud detection, and cyber-security using nontraditional hardware/software approaches (such as graph and in-memory databases). My responsibilities include task assignment, writing project plans, testing/validating software, and monitoring the progress of my teams. It's a great deal of work, but also gives me the chance to be a part of several exciting projects at once.

**Q:** How did the Naval Research Enterprise Internship Program (NREIP) prepare you for a future STEM career?

**A:** NREIP prepared me for a future in STEM by forcing me to learn and study concepts outside of my comfort zone. In acoustics, I spent a great deal of time working on visualizations for traumatic brain injuries. This is hardly the bread and butter of a normal computer science major. I was forced to learn the applied math involved as well as the neurological terms involved while writing the software needed for the visualizations. While neurobiology is hardly something I regularly use in my present job, that ability to acquire new knowledge has done me in good stead. In fact, it is one of the reasons that FedCentric took me on in the first place.

**Q:** Who was instrumental in your successful summer at NRL and why?

**A:** Dr. William Szymczak undoubtedly played a crucial role in my summer at NRL. He took his job of mentoring very seriously. I saw all the aspects of how research is done. This included the meetings, research at the library, developing prototypes, testing our theories, writing the results, and more. More than that, he advised me on how to continue my career in STEM—including which courses I should try for as an undergraduate—and helped me along the way towards those goals.

However, in the course of this internship I also worked with many people in the Navy's extended family who helped and influenced me, so I would be woefully remiss if I didn't acknowledge Dr. Brian Houston, Dr. Tony Romano, Kevin Russo, and, especially, Dr. Larry Schuette.

**Q:** What advice do you have for students interested in STEM but apprehensive about how hard it may be?

**A:** If you're apprehensive of STEM, start small. Find some concept, field, or niche that really excites you and then learn one or two concepts in it. Make sure that those concepts are concrete enough that you can articulate to another person what you've learned. After that, reevaluate if you're still interested or not. If so, repeat the process described above but now learn some more details based off what you just learned. Continue as necessary. Don't doubt for a minute that STEM can be hard. But every day, you're using the fruits of someone who went through the same process as you did. It can be done.

**Q:** What activities did you participate in at NRL outside of your regular day-to-day tasks?

**A:** In addition to my normal work at NRL, I also took part in the weekly lunch meetings set up for the fellow interns. This was a great opportunity for me to interact with others in the program, network, and learn about the happenings at NRL. I also took full advantage of the tours of the other laboratories on site. However, my favorite "extracurricular" activity was the fair set up on the mall with the ice cream, live music, and socializing.

**Q:** What future do you envision for yourself?

**A:** Like any software architect, I will always be working hard to maintain and expand my technical skill set. At the same time, I also want to continue to hone my administrative skills through eventually going for an MBA. One of the most important lessons I've learned through my NREIP experience is that knowing the nuts and bolts of STEM is only part of the challenge. Knowing how to take those ideas, present them, manage the administrative details, and deploy them at the finish is just as—if not more—critical. It's safe to say that I wouldn't be where I am now without this knowledge, acquired from my summer at NRL.

**Dr. Westmoreland is a support contractor in the Directorate of Research at the Office of Naval Research.**

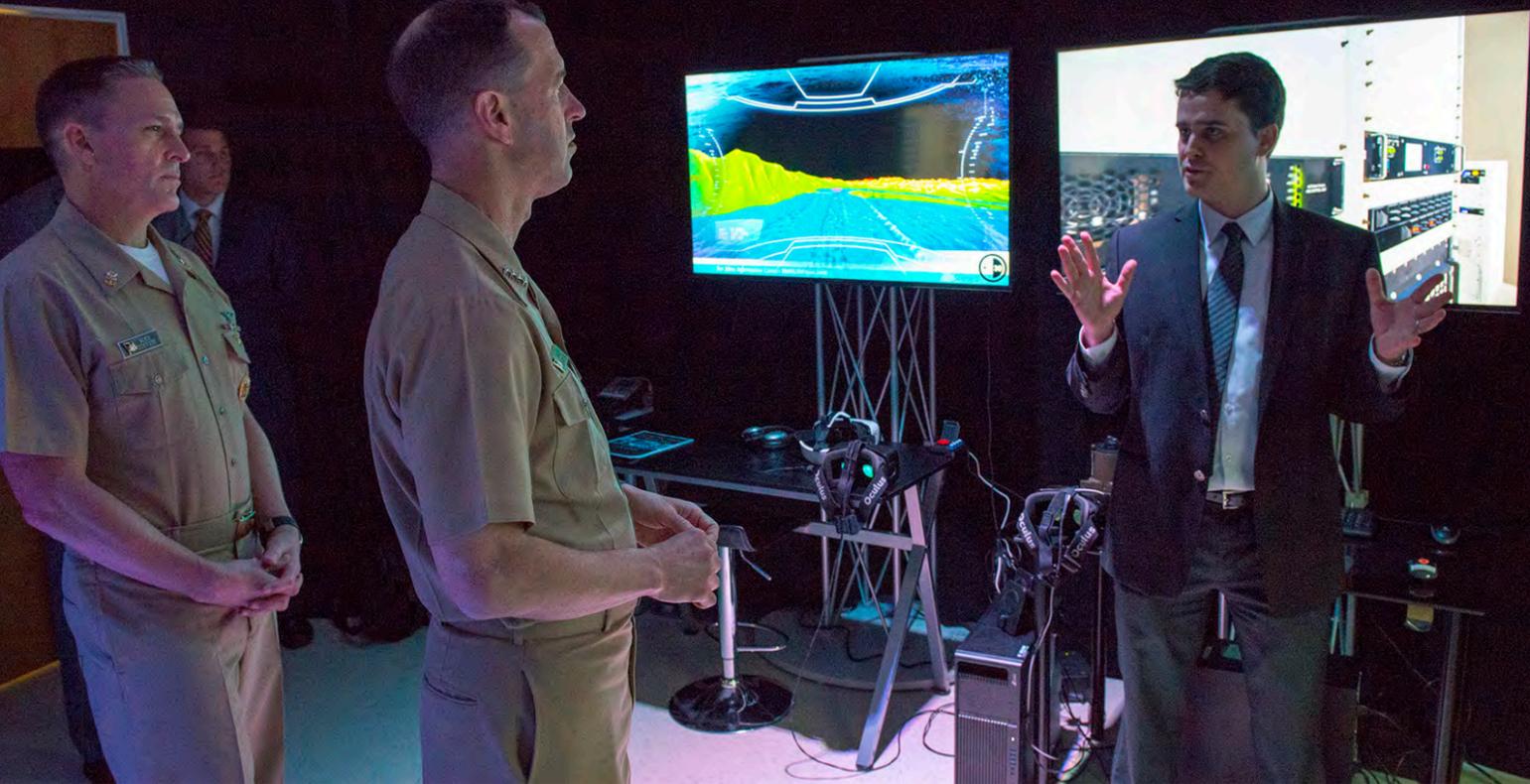


Photo by SSC Pacific

Opposite, Dr. Mark Bilinski (right), a mathematician at Space and Naval Warfare Systems Center Pacific, discusses his work with Chief of Naval Operations Adm. John Richardson.

# It's Time to Take a TECHNOLOGY SCOUT TOUR

By Katherine Connor

**SPACE AND NAVAL WARFARE SYSTEMS CENTER PACIFIC IS SENDING NAVY SCIENTISTS AND ENGINEERS TO LEADING FIRMS IN INDUSTRY TO SEEK OUT THE BEST NEW IDEAS IN THE PRIVATE SECTOR.**

Secretary of Defense Ashton Carter is pushing hard for increased collaboration between private industry and the military as part of the Department of Defense's (DoD) Third Offset Strategy, which focuses heavily on technological superiority.

In August 2015, Carter opened the Defense Innovation Unit Experimental in Silicon Valley, which is meant to serve as a conduit for technology matching and information flow between the two communities, and pledged to establish a Defense Digital Service that would bring top

talent from private firms into the DoD for a temporary stint to increase efficiency and agility. In February 2016, Carter established the Innovation Advisory Board, headed by 12 industry executives, to advise department leaders on organizational and technical challenges.

Carmela Keeney, executive director of Space and Naval Warfare Systems Center (SSC) Pacific, is taking the call for collaboration a step further. In addition to bringing smart people into the DoD to solve these problems, why not also send the laboratory's smart people out to industry

to gain insight into rapidly evolving technology areas, to identify defense uses for that technological capability and pinpoint research gaps on which neither DoD nor industry are concentrating?

The first cohort of the groundbreaking SSC Pacific "technology scout tour" kicked off in February 2016. Three researchers focusing on autonomy, trusted computing, and quantum information received funding for two months of part-time work over four months to go to the physical hub of their research area; develop partnerships with companies, universities, and organizations conducting cutting-edge research; and bring that knowledge back to SSC Pacific to match industry solutions with defense needs.

The technology scout tour is open to civilian personnel and allows employees to continue working on their current projects while scouting for beneficial advances. The tour differs from the Secretary of Defense Executive Fellows Program, which is only for active-duty service members and is for two years, requiring personnel to disengage from their organization.

"I think private industry has smart technologies that will close some of the research gaps we have—they are ahead of us in creating novel technologies in certain areas," said Olinda Rodas, a scientist in the User-Centered Design and Engineering Division at SSC Pacific. SSC Pacific selected Rodas as a technology scout for autonomy, and she has a particular interest in locating key autonomy algorithms.

"For instance, the Google self-driven car project is using multiple autonomy algorithms that could benefit many different projects at SSC Pacific," Rodas said. "The trick is to think out of the box."

One project in particular is the Intelligent Multi-Unmanned Vehicle Planner with Adaptive Collaborative/Control Technologies, which is developing autonomous system capabilities to allow one human to supervise multiple teams of unmanned vehicles at the same time. The project is being conducted along with the Army, Air Force, and Naval Research Laboratory. The team, which includes Rodas, has hit a sticking point; they need algorithms that can prioritize and allocate tasks for the autonomous systems, and determine which tasks should be completed by the system and which would best be done by a human.

Rodas said some of these algorithms almost certainly

exist in the private sector, and many are likely even open source, but there's no one dedicated to finding them and no existing partnerships to leverage.

"It's a matter of having someone assigned to that position of searching for new technologies, determining possible matches for current projects and establishing new collaborations and partnerships with industry and other government labs," Rodas said.

In the case of David Lee, who is scouting for the latest advances in trusted computing (specifically in data integrity, data transfer, cloud computing, and cryptographic encryption), he isn't looking for any specific capability. Instead, he is focused on working with the Defense Innovation Unit Experimental and In-Q-Tel—an independent, nonprofit venture capital organization bridging the gap between the US intelligence community and commercial firms—to leverage their connections to develop partnerships with private companies and find ways of making this information flow mutually beneficial.

"One of the challenges is how do we create a win-win environment for them as well as for us," Lee said. "That's part of SSC Pacific's outreach effort. When we meet with the Googles of the world, we can't just knock on the door of these companies and say, 'Hey open your door, give us your good ideas, the latest and greatest you're working on'—that's not going to work. We need to partner with them."

Rodas agreed that getting a foot in the door will be a big part of what this first group of scouts is tasked with, but she said some of the specific technologies she's interested in have a saving grace: the Defense Advanced Research Projects Agency (DARPA).

"Google has funding from DARPA," she said. "Most of the projects I'm looking at are funded by DARPA, so they're DoD properties. We can go talk to the program managers and say, 'We're interested in this.'"

The same goes for Dr. Joanna Ptasinski, an SSC Pacific electronics engineer in the Advanced Photonics Technologies Branch and the technology scout investigating quantum computing. The Massachusetts Institute of Technology Lincoln Laboratory is involved in the Intelligence Advanced Research Projects Activity's (IARPA) Quantum Enhanced Optimization (QEO) program and built a test bed to examine QEO products. Ptasinski said lab personnel also have an in-depth knowledge of

Photo by SSC Pacific



Dr. Joanna Ptasinski is a Space and Naval Warfare Systems Center Pacific electronics engineer in the Advanced Photonics Technologies Branch and the technology scout investigating quantum computing.

these partnerships, the goal is to become experts on the cutting-edge technologies and tools available in their field and bring that knowledge and their connections back to SSC Pacific.

“Through the technology scout program, we are investing in developing subject matter expertise in both the scout and the center in a new and rapidly evolving commercial technology,” said Doug Evans, deputy for program development for the Enterprise Communications and Networks Division at SSC Pacific and the chair of the midcareer professional program, which is bootstrapping the technology scout program. “We want the scout to become a catalyst for their assigned technology, sharing the knowledge with coworkers and sponsors when they return full time to the center. They’ll have a handle on how this technology can be used in naval and DoD applications, and help develop a strategy for starting new SSC Pacific business initiatives based on what they’ve learned.”

“Maybe they start a new group or business area,” Evans said. “These scouts should take ownership of that technology and work with others to grow new business here at SSC Pacific.”

Lee said his idea of success would be to facilitate technology matching between capabilities from industry and projects at SSC Pacific that could benefit from those technologies. Rodas added that even identifying where industry does not have solutions is useful.

“When you find a gap in a particular research domain, you can use that for generating research proposals,” Rodas said. “So the benefit for us is win-win. You can come up with proposals for innovative research, or solutions for the problems that we have here.”

The program is so new that many details are still being worked out, but Evans said interest has been hot, and he expects the number of technology scout opportunities to expand in future years for those employees who have the required five years of employment at SSC Pacific.

“We want to create a bridge between [the Office of Naval Research] and places like Silicon Valley,” Lee said. “Maybe we can be that conduit.”

how quantum systems work, are involved in the fabrication of quantum devices, and are versed in quantum algorithms.

Since IARPA is involved in the project, Ptasinski and SSC Pacific will have easier access to some of the government deliverables associated with QEO.

Ptasinski also plans to collaborate with the NASA Ames Research Center, which partnered with Google to purchase a quantum computer, and leases out time on the machine to third parties. These quantum computers are ideal for solving optimization problems such as planning the locations of multiple unmanned aerial vehicles in relation to one another, and position, time, and navigation challenges in a defense setting.

Once the scouts make these connections and develop

## Breadth over Depth

While the technology scout tour is the latest way the center is supporting the Secretary of Defense’s Force of the Future mission, it’s not the only one. SSC Pacific has a variety of opportunities meant to broaden and deepen the STEM knowledge of the existing workforce.

The midcareer professionals program (MCP) offers 25 SSC Pacific technologists each year the chance to spend three months expanding their knowledge of the system engineering lifecycle by working in a different division within the center, and then bringing that knowledge back to their own codes to improve processes and products.

“You become better at making products successful in the fleet because you understand how the wiring of product development goes,” said Evans, noting that the MCP is open to technologists with at least 10 years of technical experience, though not all of that experience must be at SSC Pacific. “You know the technology, you have that expertise— what’s the next step? How do you understand how everything gets into the warfighter’s hands from a system-of-systems perspective?”

One MCP tour places employees at the Space and Naval Warfare Systems Command Program Executive Office of Science and Technology where they gain an understanding of how technology is transitioned to the fleet or to a program of record. For three months, the researcher puts his or hers work on hold to focus on either getting a certain project to a program of record, or on a related goal, such as determining a better way to facilitate SSC Pacific’s technology transition efforts, such as working on Office of Naval Research transition proposals, or developing interagency agreements.

Another opportunity that has received keen interest is the Joint Maritime Tactics Course (JMTC) offered at US 3rd Fleet for military officers who served on shore duty for a time and are preparing to head back to sea. The course provides a refresher on warfare tactics and maritime dominance strategies. Thanks to the center’s close working relationship with 3rd Fleet, any extra seats in the course are opened to SSC Pacific personnel, who gain a deeper understanding of where their technologies go, how they will be used, and what warfighters experience on deployment.

JMTC was first offered in the fourth quarter of 2015 to six SSC Pacific personnel. The goal is to fund 18 center employees to take the two-week course each year.

## From the Bottom up

These top-down approaches work well because executive leaders approve and support these efforts, but the flow of information and ideas goes both ways. The scientists and engineers who develop the technology are creating many grassroots educational efforts as well.

Take the Machine Learning Workforce Development initiative, for instance. Dr. Mark Bilinski, a mathematician at SSC Pacific and member of its machine learning community, said the roughly 15-person group saw the strong interest in machine learning and its relevance to codes across the center. The group applied for Navy Innovative Science and Engineering (NISE) program workforce development funds to craft a three-part training program for center personnel wanting to incorporate machine learning concepts into their projects and research.

“We knew we had a very small group of people who would be Ph.D. level, who went to school for machine learning, who knew what this is and were ready to do projects,” said Bilinski. “Then we had a lot of people who felt, ‘This is important, we need to know more about it, we’re technically savvy, but we didn’t go to school for machine learning. We need to know enough to be able to do our day job and bring some of these tools in and start leveraging that capability.’”

Through the NISE funding, Bilinski and his colleagues compiled data and algorithm repositories on the center’s wiki site and high performance computer for use during a two-day workshop they developed. The workshop, which was held in SSC Pacific’s new Collaborative Innovation Lab, initially had 20 slots, but demand was so high it was opened to 33 engineers and scientists from among SSC Pacific’s codes. A seminar component was also provided for experts in machine learning to add new skills to their repertoire.

A Deep Learning Workforce Development initiative is now under way, with participants going through a structured online class together.

### About the author:

**Katherine Connor** is a staff writer with Space and Naval Warfare Systems Center Pacific.



Photo by John F. Williams

Opposite, students, faculty members, and distinguished visitors participated in the Cybersecurity/Information Assurance program inauguration ceremony at the University of the District of Columbia in February 2016.

# SHAPING THE FUTURE CYBER WORKFORCE

By Kathleen Gately, Shanda Johnson, Kelly Thompson, Nick Kamin, Monica Umeda, and Maurice Civers

## ONE OF THE BEST PLACES TO FIND FUTURE NAVAL RESEARCHERS IS TO LOOK RIGHT IN THE NAVY'S BACKYARD.

According to the Bureau of Labor Statistics, there will be 1.4 million computer science-related jobs by 2020, but there will be only 400,000 people with the skills to fill those roles. How will the Naval Research Enterprise ensure there will be a sufficient talent pool capable of completing cyber, information technology, and engineering tasks vital to national security and naval technological superiority? It starts with outreach.

Space and Naval Warfare Systems Center (SSC) Pacific and SSC Atlantic are conducting an array of science, technology, engineering, and mathematics (STEM) outreach programs to encourage an interest in these career fields in students from elementary school and beyond. Here are a few of the ways the systems centers work to inspire a love of STEM in tomorrow's scientists and engineers, thereby building the next generation of the workforce.

- **Cybersecurity partnerships:** SSC Pacific's Hawaii team has begun raising awareness about cybersecurity careers by interacting with island partner schools through the presentation of a cybersecurity lecture and hands-on

activity at the high school level. The team also has been working with middle and elementary school teachers to develop age-appropriate curricula and activities to introduce cybersecurity concepts to younger students. Next year, the team will expand its presence and introduce mentoring to several partner schools in support of the national CyberPatriot competition.

- **Cybersecurity/Information Assurance program:** SSC Pacific's Philadelphia Cybersecurity/Information Assurance program is funded by the Department of the Navy and is designed to be its premier cyber outreach effort to the best and brightest undergraduate and graduate computer engineering students attending historically black colleges and universities and minority-serving institutions. Participating students have an opportunity to participate in cyber lectures to establish a technical foundation, work on an academic research project for practical application, and apply for a chance to work as paid interns alongside SSC Pacific experts to receive real-world training in mission-critical, cyber-related projects during a six- to seven-month program.

- **Palmetto Cybersecurity Summer Camp:** SSC Atlantic's 2015 annual Cybersecurity Summer Camp was hosted in collaboration with the Charleston County School District and the Lowcountry Technical Academy. SSC Atlantic provides middle and high school students with a week of hands-on training to educate them on new skills and encourage their interest in STEM careers. Campers choose from tracks including cybersecurity, programming, robotics, and computer network defense. SSC Atlantic professionals teach the classes, which have campers deconstructing computers, writing HTML code, and building robots. The camp added a new curriculum for the middle school campers that included snap circuits, scratch programming, and internet security.



Two students work during a "Cyber Espionage" session at the annual Cyber Security Summer Camp, which was held at the Lowcountry Technical Academy in Charleston, South Carolina, in June 2015. (Photo by Joseph Bullinger)

- **Palmetto Cyberdefense Competition:** In its fifth year, SSC Atlantic's Palmetto Cyberdefense Challenge hosts a day for college students, a day for high school students, and a third day where two college students are imbedded within each team. Students are responsible for operating a small business network and are required to reconfigure a misconfigured network while defending against a red team of volunteers who are attempting to disrupt and penetrate their network.
- **Palmetto Digital Forensics Competition:** SSC Atlantic sponsored the Digital Forensics Competition, which in 2015 included students in grades 9 through 12 for the first time. Competitors were required to solve several rounds of exercises at various levels of difficulty by examining provided artifacts, answering questions, and describing the solution methodology. The competition

had 20 teams from 14 different schools, both public and private, made up of 51 students from various counties in South Carolina and with forensic experts from the SSC Atlantic cyberforensics program.

- **Girls Day Out:** In 2015 SSC Atlantic, in collaboration with local colleges and businesses, sponsored the largest Girl's Day Out (GDO) to date in Charleston and Hampton Roads, Virginia. GDO is an informative STEM event for eighth and ninth grade girls, and is designed to inspire the next generation of women to pursue STEM careers. The program is structured to educate girls and their parents about how to make appropriate curriculum choices in high school that will prepare them for STEM degrees, and provide them with college and university requirements for degree programs. GDO focuses on fun and educational activities to introduce girls to various STEM topics such as cybersecurity and robotics. The girls are taught important life skills such as how to dress appropriately and conduct themselves in interviews. The event also features a keynote speaker who is a successful woman in a STEM field, a business and college expo, and a panel of female STEM professionals who give the girls an opportunity to ask questions and listen to personal testimonies. GDO has been a labor of love for SSC Atlantic and we are proud to inspire the next generation of young women scientists and engineers.

These programs create a pathway to employment through the various opportunities to meet Space and Naval Warfare Systems Command personnel and learn what the command does, and gives the command the opportunity to have a say in shaping the workforce of the upcoming decades.

### About the authors:

**Kathleen Gately** is the Space and Naval Warfare Systems Command's STEM outreach lead.

**Shanda Johnson** and **Kelly Thompson** work in Space and Naval Warfare Systems Center Atlantic's K-12 outreach program.

**Nick Kamin** and **Monica Umeda** work in Space and Naval Warfare Systems Center Pacific's Hawaii outreach program.

**Maurice Civers** is Space and Naval Warfare Systems Center's Philadelphia STEM outreach manager.



Photo by MCMCS D. Kevin Elliott

Opposite, Naval Surface Warfare Center Dahlgren Division scientist Dr. Kevin Boulais uses liquid nitrogen in a molecular beam epitaxy system to create photo capacitors for light guide film applications.

# Understanding the Ins and Outs of HIRING AUTHORITIES

By Jennifer Hartman

**GETTING THE RIGHT PEOPLE FOR THE JOB FOR NAVAL SCIENCE AND TECHNOLOGY JOBS DOESN'T HAVE TO INVOLVE A LONG, DRAWN-OUT PROCESS. THERE ARE A NUMBER OF HIRING PROCEDURES THAT CAN FILL THE TOUGH POSITIONS WITH THE BEST TALENT.**

The Science and technology reinvention laboratories (STRLs) conduct basic and applied research and development in support of defense and naval missions. Scientific inquiry is key to supporting warfighters, and currently five Department of the Navy laboratories and centers are among the 17 Department of Defense STRLs, which are authorized to conduct personnel management demonstration projects. These projects are human resources management systems that are alternative to the traditional GS system and allow flexibilities in policy, procedure, and related personnel management matters.

To ensure they are recruiting the best people to perform and administratively support this important research and development, STRLs can exercise many personnel-related flexibilities in their demonstration projects by waiving existing federal human resources management laws and regulations.

STRLs also have special hiring authorities that are particularly useful for quickly appointing top-quality candidates into short-handed or critical positions. Direct-hire authorities, for example, waive certain provisions of law, which allow candidates to be appointed without

applying to a vacancy; the hiring process is much quicker than normal recruitments in which applicants are ranked and a certificate is issued. Available authorities include those covering scientific and technical candidates with bachelor's or advanced degrees; veterans hired into science, technology, engineering, and mathematics (STEM) positions; and degreed candidates with at least a 3.5 GPA:

- The Distinguished Scholastic Achievement Appointment Authority (DSAA) allows appointment of candidates—those who have a 3.5 or better GPA while earning bachelor's or higher degrees, or who are within the top 10 percent of a university's school of graduate studies—to positions with a positive education requirement, up to GS-12 equivalent. Using the DSAA, candidates for these positions qualify on education, not experience, and are appointed to the position and grade level commensurate with the degree, regardless of work experience. The DSAA is a unique demonstration project authority with no expiration date.
- Direct Hire Authority for Candidates with Advanced Degrees for Scientific and Engineering Positions may be used to hire a candidate who possesses a master's degree or higher. Professional scientific and engineering positions are eligible under this authority. Positions in the following disciplines are include: social science, psychology, biology and natural resources, engineering and architecture, physical science, and math and computer sciences. The candidate's advanced degree must be directly related to the duties of the position. The number of appointments is limited to 5 percent of the science and engineering positions encumbered at a specific STRL at the end of the previous fiscal year. This authority was made permanent by legislation in fiscal year 2012.
- Direct Hire Authority for Candidates with Bachelor's Degrees for Scientific and Engineering Positions may be used to appoint a candidate with a baccalaureate to the same professional scientific and engineering positions listed above, and the number of appointments may not exceed 6 percent of the positions encumbered at a specific STRL at the end of the previous fiscal year. This authority was granted by legislation in fiscal year 2014 and expires on 31 December 2019 unless extended by future legislation.
- Direct Hire Authority for Veteran Candidates to STEM Positions may be used to appoint veteran candidates

to the professional science and engineering positions noted above as well as to STEM-related technical or technician positions in those occupational groups. These appointments may not exceed 3 percent of the number of STEM and technician positions encumbered at a specific STRL at the end of the previous fiscal year. This authority was granted by legislation in fiscal year 2014 and expires on 31 December 2019, unless extended by future legislation.

- The Expedited Hiring Authority for Select Acquisition Workforce Positions is available DoD-wide and applies to positions designated as Defense Acquisition Workforce Improvement Act (DAWIA) and classified as severe shortage or critical hiring need. Multiple career fields are covered: auditing; business-cost estimating; business-financial management; contracting; facilities engineering; information technology; life cycle logistics; production, quality, and manufacturing; program management; science and technology management; engineering; test and evaluation; and small business. There are two methods of filling a position: filled from a certificate issued by an Office of Civilian Human Resources Operating Service Center, or a direct hire a candidate. For direct hires, an announcement must have been posted, though the candidate of interest need not apply to the announcement. This authority was granted by legislation in fiscal year 2013 and expires on 30 September 2017 unless extended by future legislation.

The benefits of these authorities are seen in the shortened hiring timeframes. At the Naval Research Laboratory (NRL) in fiscal year 2015, those hired under the direct hire authority for advanced degrees, bachelor's degrees, and veterans received, on average, tentative offers within two days and final offers within 15 days. As a result, NRL has used these authorities for much of its hiring. In fiscal year 2015, 51 percent of hires at NRL were made using the direct hire authority for candidates with advanced degrees, and 23 percent of hires were made using the direct hire authority for bachelor's degrees. Direct hire for veterans enabled NRL to fill 57 percent of its technician vacancies. Use of these three direct hire authorities accounted for 73 percent of total hires in fiscal year 2015.

The chart below summarizes these hiring authorities and provides information about the eligible positions and candidate qualifications. For all positions covered under these authorities, candidates must meet Office

of Personnel Management (or Department of Defense) qualification standards appropriate for the series.

An added authority will be available to STRLs soon. Legislation in 2015 authorized a new direct hire for science and engineering students, which is currently pending implementation and will allow further flexibilities in recruiting the future STRL workforce. In addition, STRLs may use government-wide direct hire authorities; information may be found on the Office of Personnel

Management’s website at <https://www.opm.gov/policy-data-oversight/hiring-authorities/direct-hire-authority/>.

Finding the right people to do the important work of the Navy’s research community is exciting for all involved in the hiring process. Using direct hires and other flexibilities can be extremely valuable to hiring managers who have identified high-quality professionals and seek to bring them on board quickly, without the normal and often lengthy advertising and certificate processes. To

make the most of recruiting efforts and to reach the best candidates, hiring managers and selecting officials should discuss hiring options and flexibilities with their command’s human resources office.

**About the author:**

**Jennifer Hartman** is a human resources specialist in the Naval Research Laboratory’s human resources office.

	DISTINGUISHED SCHOLASTIC ACHIEVEMENT APPOINTMENT	DIRECT HIRE AUTHORITY SCIENCE AND ENGINEERING WITH ADVANCED DEGREES	DIRECT HIRE AUTHORITY SCIENCE AND ENGINEERING WITH BACHELOR’S DEGREES	DIRECT HIRE AUTHORITY STEM VET CANDIDATES	EXPEDITED HIRING AUTHORITY DAWIA POSITIONS
<b>LEGAL AUTHORITY</b>	Must be included in STRL Federal Register notice or by adoption from another STRL.	NDAAs FY 2009, sec 1108	NDAAs FY 2014, sec 1107(a)(1)	NDAAs FY 2014, sec 1107(a)(2)	NDAAs FY 2009, sec 833
<b>REFERENCE</b>		Federal Register Notice vol. 79, No. 144, dtd. 28 July 2014	Federal Register Notice vol. 79, No. 144, dtd. 28 July 2014	Federal Register Notice vol. 79, No. 144, dtd. 28 July 2014	USD memo Extension of Expedited Hiring Authority for Select Defense Acquisition Workforce Positions of 18 Dec 15
<b>CAP ON POSITIONS FILLED</b>	No limitation	5 percent	6 percent	3 percent	No limitation
<b>CANDIDATE QUALIFICATIONS</b>	GPA 3.5 in field of study or Top 10 percent of a university’s major school of grad studies for professional occupations	Possess Master’s or higher	Possess Bachelor’s Degree	Meet the definition of Veteran Candidate and meet OPM qualifications	May require ACWA examination or USA Hire assessment and must meet OPM or DoD qualifications
<b>ELIGIBLE POSITIONS</b>	Professional positions with a positive education requirement.	Professional positions with a positive education requirement in the S&E occupational groups: 100, 400, 800, 1300, 1500	Professional positions with a positive education requirement in the S&E occupational groups: 100, 400, 800, 1300, 1500	Positions in the S&E occupational groups: 100, 400, 800, 1300, 1500. Note: Technician positions must be STEM-related.	DAWIA positions in career fields AUD, BCE, BFM, CON, FE, IT, LCL, PQM, PM, S&T, ENGR, T&E, SB
<b>ELIGIBLE LEVELS</b>	Up to GS-12 equivalent	any	any	any	GS-5 through 15 equivalent

# FEELING THE STING OF STEM: THE ROBOBEES



By Robert Thacker-Dey

## WITH THEIR ROBOT "WAR-HOG," THIS FIRST TEAM PUTS SCIENCE AND ENGINEERING LEARNING INTO PRACTICE.

FIRST Robotics Team 836—more popularly known as the RoboBees—is located deep in St Mary's County, Maryland. It is a hive of students that forms a FIRST (For Inspiration and Recognition in Science and Technology) Robotics team with a tremendous reputation.

The RoboBees are mentored by several engineers in the Naval Air Systems Command workforce, along with other local companies. The focus always is on inspiring the students to pursue careers in science, technology, engineering, and mathematics (STEM)-related fields. The team is composed of mostly high school students from St. Mary's County. Their mission is to inspire the community

to celebrate STEM by teaching life skills in an invigorating environment that provides an opportunity to apply this knowledge. They hold outreach events throughout the year to inspire younger students to pursue STEM fields and thoroughly embrace their learning.

FIRST is an organization founded by inventor and engineer Dean Kamen in 1989 that grew into a worldwide phenomenon, composed of four levels of competition encompassing all age groups from elementary to high school. The FIRST Robotics Competition is the focus of the RoboBees, where they are one of 2,904 teams from 19 countries (as of 2015).

Photo by Christy Sloop



Photo by FIRST Robotics

The RoboBees pause to take a team picture after winning the 2016 Chesapeake District Championship.

The RoboBees are well known throughout the international FIRST community for their success and outreach. To date they have won 19 awards, which include four Regional Chairman's Awards, the most prestigious award that FIRST gives to a team. They are well on their way to winning the National Chairman's Award, which would place them in the FIRST Hall of Fame with a permanent invitation to the world championship. The competition itself is held in various districts, district championships, and one world championship event in St. Louis, Missouri. The RoboBees have made it to championship events for the past five years and have won a championship award for their robot design.

At each competition, the RoboBees have students assigned to go around to other teams in the pits to help prepare them for competition if help is needed, which includes tasks such as building bumpers, programming, and mechanical repair of other teams' robots. This team breathes professionalism and effective interpersonal skills, encompassing critical not only to FIRST competitions, according to FIRST distinguished advisor Dr. Woodie Flowers, but to the future as they assist their fellow FIRST colleagues.

Even outside the competition, the team maintains this professionalism in their outreach events and media news releases. They desire not only that their robot is in prime condition during competition, but that their opponents are as well. A FIRST competition game is usually played with three robots against three robots (Red versus Blue Alliance) on a 27-by-54-foot field. Teams manipulate game components by human-operated controls to score points, which are collated within 2 minutes and 30 seconds, including an initial autonomous period

without human control. This year's game is called "Stronghold" and can be viewed at <https://www.youtube.com/watch?v=VqOKzoHJDjA>.

Some students from the team have moved on to work locally at Naval Air Systems Command through internship programs, joining the Navy workforce in critical areas to enhance the future of naval aviation. Zach Stachelczyk, former team member and current mentor, enthusiastically reports that "this program really helped me figure out what I wanted to do in life. I would not be where I am today without it!" All of the students, old and new, have an excellent foundation from their experience on the team that ensures more success—their momentum and professionalism is inspiring. The team would be extremely pleased to have anyone join them at the competition and cheer in the stands.

The RoboBees official site is at <http://www.robobees.org/>.

### About the author:

**Robert Thacker-Dey** has been a mentor for the RoboBees for the past five years and has participated in FIRST since 2003. He is a civilian working for Naval Air Systems Command as a turbine specialist on gas turbine engines.

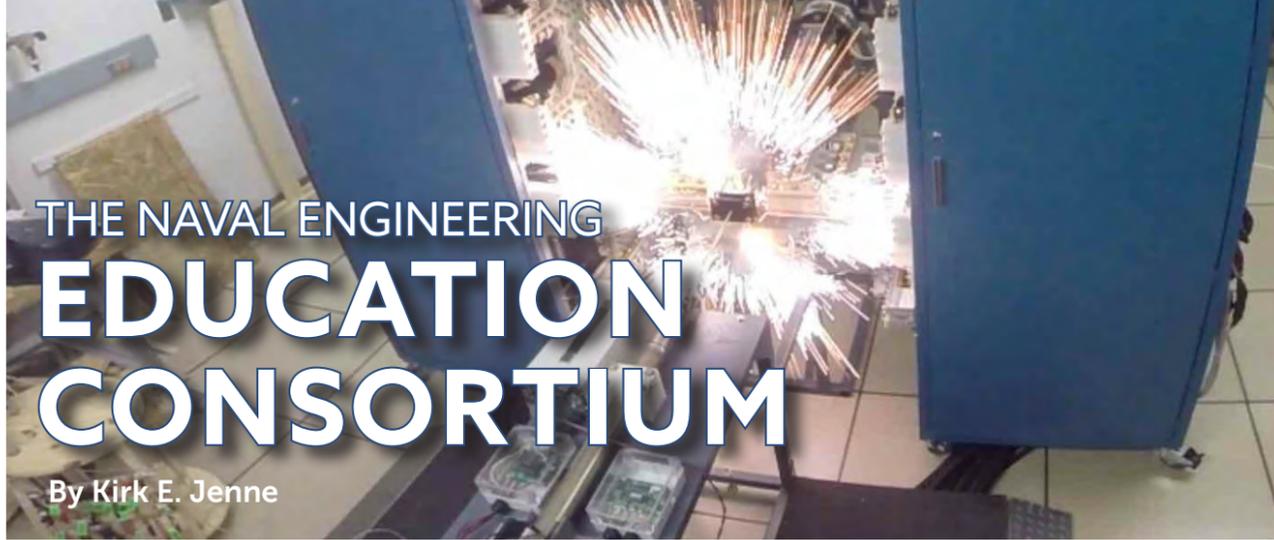


Photo by Hardus Odendaal

# THE NAVAL ENGINEERING EDUCATION CONSORTIUM

By Kirk E. Jenne

## A NEW COLLABORATIVE EFFORT THAT CONNECTS NAVY TECHNICAL EXPERTS WITH ACADEMIA IS HELPING TO CREATE PARTNERSHIPS THAT GENERATE REAL INNOVATION.

A new collaborative effort that connects Navy technical experts with academia is helping to create partnerships that generate real innovation. As a catalyst for developing the Navy's future workforce, professors and students at universities nationwide are conducting research and development on naval-relevant topics at their campus laboratories. The research takes place through the Naval Engineering Education Consortium (NEEC), an initiative that provides multiyear funding for project-based, hands-on research conducted during the academic year.

An arrangement between the divisions at the naval warfare centers and various universities enables professors to hire students who are seeking bachelor's or master's degrees—and for technical experts from the warfare centers to visit campuses and discuss technology and how their projects relate to challenges facing the Navy and Marine Corps. The warfare center experts also are primed to talk with students about employment as a civilian scientist or engineer. And by all accounts thus far, the students thoroughly enjoy the opportunity to speak with them as part of projects that have direct effects on Navy capabilities.

The three primary objectives of the NEEC initiative are:

- Acquire academic research results and products to resolve naval technology challenges
- Hire college graduates with research and development experience into the Naval Sea System Command workforce
- Cultivate exceptional working relationships with naval engineering colleges, universities, professors, and academics.

Universities can join up via a successful bid on a topic listed in the NEEC broad agency announcement directed at colleges and universities. The announcement is published in Federal Business Opportunities ([www.fbo.gov](http://www.fbo.gov)) in the spring (March), time enough for professors to select their student researchers for the next academic year. Once an agreement is reached, the intent is for the Navy to provide funding for multiple years to establish a closer working relationship with the research professor and technical experts at a warfare center. Professors are asked to help Navy civilians identify students with the potential and interest in working at the warfare centers.

### Success Stories

Professor Hardus Odendaal at Virginia Tech is thrilled with the success he has had with undergraduate research students who want the opportunity to participate in working on his "Reduced-Scale Railgun" project. The students have been involved in designing and building parts, setting up industrial control systems, testing phases of development, and operating the railgun in a safe manner.

The students designed the sophisticated system from the ground up. It incorporates more than 100 custom-designed machined parts; more than 100 custom printed circuit boards; five microprocessors; a Labview user interface; a health monitoring system; and intelligent algorithms that monitor and extend lifetime, predict firing solutions, and ensure module physical separation to minimize interference. This is a reduced-scale version of the Navy's, with less energy and smaller components. It comprises 32 pulsed-current modules for a peak-current capacity of one million amps.

Opposite, with help from the Naval Engineering Education Consortium and NSWC Dahlgren Division, students at Virginia Tech created a "Reduced-Scale Railgun."

"The students who may not stand out in the classroom sometimes prove to be superstars working in the laboratory as instructional components of my NEEC project emphasize real-world applications in a real work environment," said Professor Odendaal. "This hands-on work with others requires students to develop technical talents, teamwork skills, and leadership."

Approximately 15 students from the mechanical, electrical, and computer engineering departments compete every semester to work on this project. Professor Odendaal believes the good relationship he has with mentors and experts in the technology fields is key to the success of the students in the laboratory and his project. Summer internships for his students are aligned with Naval Surface Warfare Center (NSWC) Dahlgren Division in Virginia.

Professor David Dowling at the University of Michigan has a NEEC acoustics team composed of six students investigating techniques for noise cancellation, signal recovery, and nondestructive evaluation using array-recordings of airborne and waterborne sound. The overall goals of the project are to identify, develop, implement, and test appropriate acoustic signal processing techniques for determining the characteristics of sound sources in the reverberant environments provided by the laboratory's cylindrical water tank. According to Professor Dowling, "NEEC provides a unique opportunity for students to gain laboratory, software, and presentation skills while working on projects and with technologies that are of interest to the Navy. And, it allows participating students to make informed decisions about civilian careers in NAVSEA."

The work these students are doing includes detecting and locating acoustic sources, characterizing echoes in the acoustic environment, and reducing unwanted influence of noise. Other efforts in the laboratory include complex signal processing such as beamforming, matched filtering and filed processing, adaptive noise cancellation, and blind deconvolution. Work in acoustics contributes directly to work at NSWC Carderock Division and Naval Undersea Warfare Center Newport Division.

NEEC students are linked directly to internship opportunities and hiring managers to help develop a future workforce. One such link is the Naval Research Enterprise Intern Program (NREIP) managed by the Office of Naval Research. NREIP provides strategic benefit because Navy personnel get a look at participating students as they work on site at warfare centers for 10 weeks during the summer.

The experience is tailored to help assess where students could fit in the organization and for hiring managers to assess students that have potential as employees. The Pathways program at the warfare centers also is used to hire interns for the summer. These programs that take on students participating in NEEC projects at their universities are given extra consideration during employment cycles.

The NEEC annual meeting was held at NSWC Carderock in Bethesda, Maryland, this past April. The meeting provided the venue for students, professors, and Navy personnel to highlight content of their projects via poster sessions, discuss the future of the NEEC initiative, and develop their professional networks. As the event keynote speaker, Vice Adm. David Johnson (principal military deputy to the Assistant Secretary of the Navy for Research, Development, and Acquisition) provoked the students to help the Navy confront its future technology challenges. "The Navy offers great opportunities to further your education and be right in the mix of technology and development, seeing where it's going and what our nation needs," said Johnson. "You can work with stuff like railguns, lasers, hypersonics, missiles, unmanned and autonomous vehicles, sonar, radar, electromagnetics, optics, aircraft, ship and submarine design, just to name a few...and this work: it matters."

Other speakers at the meeting included Don McCormack, executive director of the naval surface and undersea warfare centers; Rear Adm. Lorin Selby, Commander, Naval Surface Warfare Center; and Dr. Hardus Odendaal from Virginia Tech.

### The Future

NEEC will be implemented across all 10 major sites when it reaches full maturity as a program in 2017. Don McCormack is giving special attention to the NEEC and is committed to its long-term success. "We are looking forward to seeing progress made in all NEEC research projects with our academic partners," said McCormack, "developing very successful long-term relationships, and seeing a steady stream of motivated NEEC students transitioning to the civilian workforce ready to contribute to the Navy's warfighting effectiveness."

### About the author:

**Kirk Jenne** is currently director of the Naval Engineering Education Consortium.



Photo by MC3 Charles D. Gaddis IV

Opposite, students from Mullenix Ridge Elementary School learn about angles and calculations during a science, technology, engineering, and mathematics fair at the Naval Undersea Museum in Keyport, Washington.

# Fostering a World-class NAVAL STEM WORKFORCE

By Michael Simpson and Lindsey Groark

THE NAVAL STEM COORDINATION OFFICE LEADS A COORDINATED APPROACH WITHIN THE DEPARTMENT OF THE NAVY TO OPTIMIZE RESOURCES AND ACHIEVE GREATER IMPACT.

The Department of the Navy (DoN) operates in a unique environment, with numerous commands and organizations focused on a variety of science and technology challenges. These challenges include areas such as autonomy and unmanned systems, information warfare-cyber, and warfighter performance, among many others. In order to respond to these technical challenges, there is an inherent need to provide opportunities for members of the current workforce to stay sharp with leading-edge knowledge and inspiration, and to introduce students to the opportunities available as members of the next DoN workforce.

One way that the DoN is addressing these needs is by formalizing the naval science, technology, engineering, and mathematics (STEM) community. This community consists of DoN commands and agencies that develop, manage, and execute STEM education, outreach, and workforce initiatives. Because of the varied workforce requirements of each command and facility, the Naval STEM community maintains a relatively decentralized approach to STEM programming and includes grassroots efforts that support each site's specific workforce needs and interests. These efforts are then coordinated across the DoN through engagement in department-wide working groups and the Naval STEM Coordination Office, located at the Office of Naval Research.

The DoN is driven by high-velocity learning, a process wherein the organization and its people maximize nodes and opportunities for learning (e.g., maximize connections and coordination for learning).

This coordination promotes a variety of benefits and efficiencies across the science and technology and education communities by ensuring that organizations with the appropriate skills and experience focus on the challenges and opportunities that they are most suited to address. It also provides the entire organization with the opportunity to learn from each other and to apply lessons learned to unique challenges facing our various components and communities.

Recently, the Secretary of the Navy released his instruction for Naval STEM policy and coordination and Naval STEM strategy, which defines the policy, responsibilities, and strategic direction of STEM efforts. The strategy highlights five strategic priorities that provide a framework for the



Photo by Rick Naystatt

Space and Naval Warfare Systems Command volunteers judge the technical design competition during the For FIRST LEGO league robotics qualifying tournament at Eastlake High School in Chula Vista, California.

geographically dispersed and technically diverse Naval STEM initiatives. Through the inspiration, engagement, education, employment, and development efforts offered within the community for the current and future workforce, we aspire to foster and cultivate a diverse, world-class STEM workforce that will maintain the US Navy and Marine Corps' technological, educational, and inspirational superiority.

## Inspire

Inspiration is the cornerstone of innovation and is an important component of a successful workforce. Outreach efforts have traditionally focused on students and raising awareness of opportunities to get involved in STEM programs but we believe these efforts must continue for members of the current workforce. Providing opportunities for our scientists and engineers to engage in programs, events, and other experiences that excite them is a significant way to reinvigorate the workforce.

Sparking an interest for students often is as simple as introducing how the content and skills they are learning in school applies to the real world. Through traditional outreach and participation in STEM-related events, demonstrations, and career exploration activities, we can raise student awareness of naval-relevancy. Once students have this awareness, we can then help to connect them with programs and opportunities to learn more and get involved in areas of specific interest.

### Engage

One of the DoN's best assets is its current workforce. Partnering current professionals with students and interns as mentors provides value for both the mentors and mentees. Through active participation in naval-relevant STEM opportunities, students and professionals learn from each other and increase confidence in themselves and their abilities.

In addition to working with mentors, there are a number of DoN opportunities available to students, including clubs and camps focused on naval-relevant topics and activities. The Naval High School Science Awards Program encourages students to develop and retain an interest in STEM by sponsoring and supporting high school science fairs. Similarly, the triservice-sponsored National Junior Science and Humanities Symposium encourages the analytical and creative development of the nation's youth in STEM disciplines through research. These efforts partner students with professionals and engage participants in naval-relevant pursuits and research that will further enhance their capacity in areas of naval-relevance.

### Educate

Education programs have long been a fixture in STEM initiatives and aim to prepare students for careers in STEM fields. In addition to specialized certification and degree programs that further prepare current professionals for career opportunities, the Naval STEM community recognizes the value of training scientists and engineers how to lead successful outreach efforts. One such program to support our current professionals is the US Naval Academy's Best Practices for STEM Outreach Workshop. This workshop engages DoN scientists and engineers in various hands-on educational modules and then supports these professionals to start the development of a module focused on their areas of expertise. Participants are then asked to serve as ambassadors in their communities to share what they learned and further expand the pool of scientists and engineers prepared for and confident in STEM outreach.

Trainings and workshops for professionals and teachers also impact students by improving educators' capabilities, knowledge, and curricula. The Naval STEM community has numerous initiatives focused on increasing naval-relevance

in curricula and providing support for students who pursue education in specific STEM areas. Through programs such as the National Defense Science and Engineering Graduate Fellowship to support study and research leading to doctoral degrees in STEM fields and the Science, Mathematics, and Research for Transformation designed to produce the next generation of science and technology leadership for the Department of Defense, the DoN invests in promising students that may be members of our future workforce.

### Attract and Employ

Introducing students and faculty members to naval research laboratories is a great method for introducing potential workforce members to the DoN research environment. Two programs that exist at laboratories across the DoN are the Science and Engineering Apprenticeship Program and the Naval Research Enterprise Internship Program. These programs are paid summer internships at naval laboratories or warfare centers where students are immersed in naval research programs. Working side-by-side with current naval scientists and engineers, students gain a firsthand perspective on what it's like to work for the DoN and the type of work and opportunities available upon graduation.

### Develop and Retain

Expanding DoN's high-velocity learning includes empowering current scientists and engineers to refresh their knowledge and inspiration. We are examining ways to augment current programs for research opportunities for program officers, scientist-to-sea and scientist-to-FOB programs, mentoring, access to professional conferences and publications, and professional training and education, sabbatical leave, and rotations.

We also are exploring ways to augment our programs to develop the capabilities of faculty members outside DoN, to enhance the basic research capabilities in topics with naval importance. These programs are:

- A sabbatical leave program that provides fellowship appointments to science and engineering faculty members from institutions of higher education
- A summer faculty research program provides science and engineering faculty members from institutions of higher education the opportunity to participate in research of mutual interest to faculty member and peers at naval laboratories for a 10-week period.

### Collaborate

Optimally addressing these strategic priorities requires coordination across DoN, the Department of Defense, the federal government, academia/training, and nonprofit entities. This coordination relies greatly on effective initiatives for the future workforce consisting of varied opportunities for students to gain awareness about naval-relevant content, skills, and applications. ONR's STEM grant program funds new and innovative STEM approaches to address the needs of the Navy and Marine Corps to motivate students to pursue a STEM career and to develop the future naval workforce. Through partnership with various DoN commands, this portfolio supports the broad Naval STEM community and aims to further extend the reach of grassroots efforts.

### Get Involved

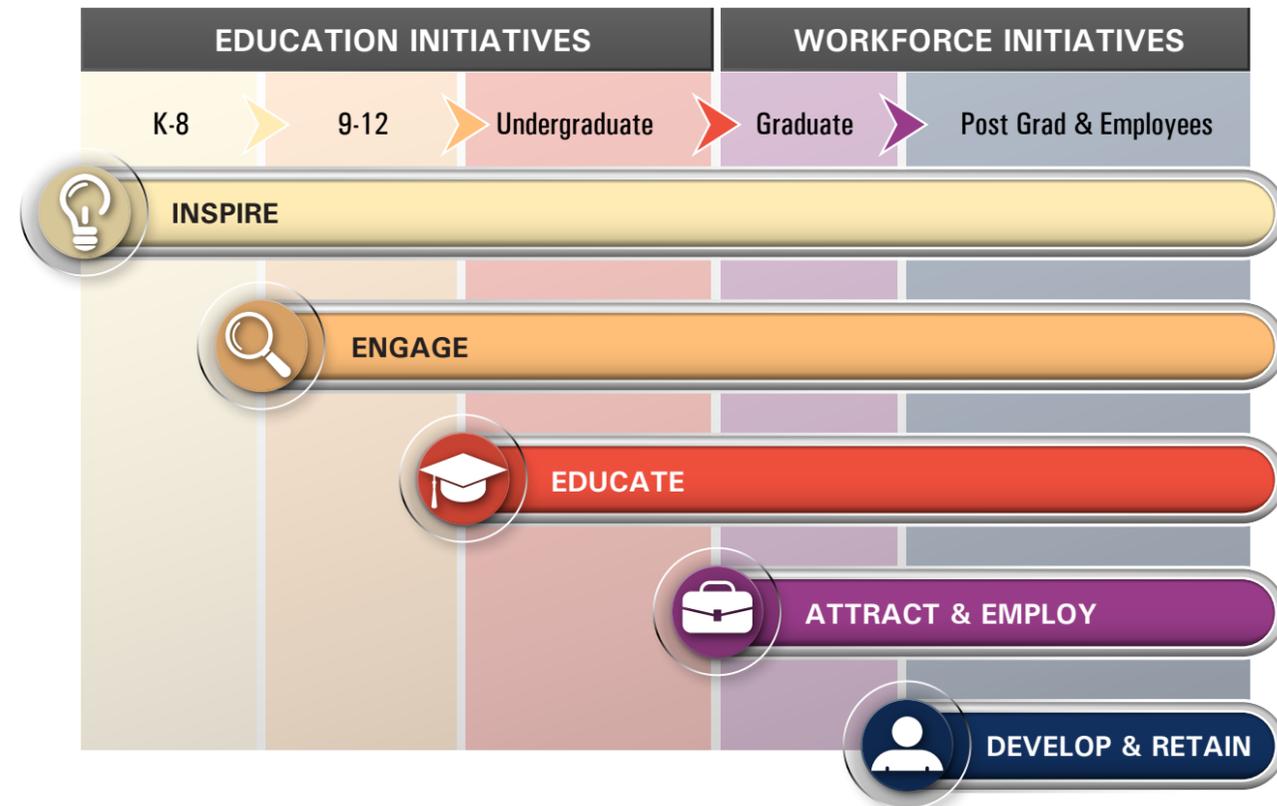
Regardless of your background or affiliation there are ways for you to get involved in the work the Naval STEM community is doing. If you are a student, consider pursuing STEM classes in your school and participate in STEM clubs or extracurricular activities. If you are an educator or current professional, try to incorporate naval-relevant content into your classes and engagement with students. Use your experience and expertise to mentor students in your community and get involved in local Naval STEM efforts. If you are part of the industry, nonprofit, or educational communities, engage with naval commands and facilities in your area to share best practices, assets, workforce, and expertise. Working together as individuals and organizations, we will be better able to anticipate, plan for, and respond to workforce needs for the near and distant future.

For more information on the Naval STEM community and to get involved, visit <http://navalstem.navylive.dodlive.mil> or contact us at [naval\\_STEM@navy.mil](mailto:naval_STEM@navy.mil).

#### About the authors:

**Michael Simpson** is the director of education and workforce at the Office of Naval Research.

**Lindsey Groark** is a support contractor with the Naval STEM Coordination Office.



Naval STEM strategic priorities mapped to individuals at different stages in the workforce pipeline.

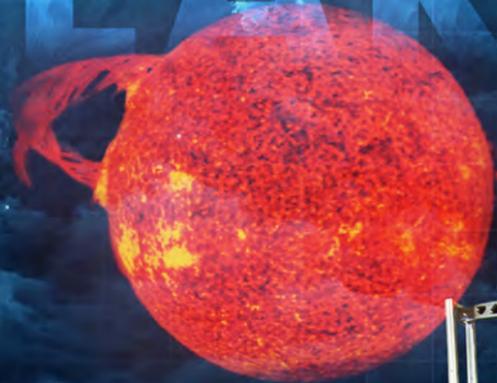
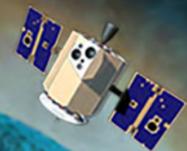
# A LOOK AHEAD

70 YEARS OF  
Naval Research



In 1946, congressional action created the Office of Naval Research (ONR). A product of the lessons of war, ONR was the first US government agency dedicated to funding scientific research during peacetime on a permanent basis. This new organization—and others modeled on it that soon followed—fundamentally changed how science and technology research was conducted, and marked the beginning of a deeper interconnectedness between government, academia, and industry that persists to this day. The next issue of *Future Force* will examine the rich history of this new relationship between the many organizations of the Naval Research and Development Establishment and its partners.

# 70 YEARS



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Cmdr. Robert Getty, with the Office of Naval Research reserve component, helps a visitor explore a ship of the future exhibit during the USA Science and Engineering Festival held at the Walter E. Washington Convention Center in Washington, DC, in April 2016. (Photo by John F. Williams)

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