Naval Academy Midshipmen Venture into Corrosion Science Research

Top Scholars Excel Through Discipline and Single-Minded Focus
By Cynthia Greenwood

Nobody ever said the road to becoming a Navy ensign or Marine Corps second lieutenant would be easy. Tourists who walk the picturesque grounds of the United States Naval Academy, taking in breathtaking views of the Chesapeake and the stately Beaux-Arts interior of Bancroft Hall, are not privy to the structured world of the resident midshipmen.

Putting aside the exhausting demands of Plebe Summer for the roughly 1,200 who entered as midshipmen 4th class (freshman-level) during fall 2013, the weekday schedule for all classes of midshipmen might resemble life at MIT, combined with four years of basic training for the newly enlisted.

A uniformed midshipman’s weekday is highly regimented. Reveille comes at 6:30 a.m. Six class periods and impromptu inspections get squeezed into standard mealtimes, routine pre-meal march formations, company training time, and late afternoon athletics and extra-curricular activities. Evening study time runs from 8 to 11 p.m., followed by taps for all midshipmen at midnight.

But for some, the lights don’t go out just yet.

“I get most of my studying done during the designated evening period, although I usually have to extend my study time to approximately 12 to 2 a.m.,” said Midshipman 1st Class Sabrina Reyes, who is in her senior year. MIDN Reyes is an aerospace engineering major who has set her sights on joining the submarine community after she receives her commission and completes a master’s degree.

Many who aspire to attend the Naval Academy are careful to weigh other options before applying. It was MIDN Reyes’s first choice, however, over four other schools that accepted her, including MIT, Princeton, Harvard, and UT Austin. “It seemed much more disciplined than any other place,” she said.

For Jennifer Jones, a May 2013 graduate and newly commissioned ensign, the decision to attend the Naval Academy meant taking “a leap of faith,” in spite of the practical insights provided by her father, a 1976 graduate. “The tight schedule forces you to make decisions quickly and sharply focus on each activity that you are doing at any given moment,” she said.

Opportunities for Independent Research

Emerging engineers like Reyes and Jones, who can choose from eight available engineering majors, balance their 15- to 21-hour academic course loads with annual summer training stints “inside the Fleet,” within operational units of the Navy and Marine Corps. For example, when MIDN Reyes took a 10-day submarine cruise on the U.S.S. Rhode Island in July 2011 as part of her professional training block, she shadowed a “running mate” petty officer who worked in the sonar room to learn how he and other enlisted men performed their duties.

Berides their exposure to rigorous physical training, summer fleet experiences, and professional mentoring opportunities, Jones, Reyes, and many others have taken advantage of the Naval Academy’s robust curriculum and research opportunities that are funded by naval and DoD service divisions. “Our midshipmen are heavily involved in our research programs,” said Patrick Moran, senior professor in the Division of Engineering and Weapons and a professor of mechanical engineering.

Jones, who served as brigade commander at the academy during Spring 2013, pursued opportunities for independent research in materials science through two competitive research programs. After she passed the nuclear service entrance interview for midshipmen 2nd class seeking an initial service assignment in the Naval Nuclear Propulsion Program, she was appointed as a Bowman Scholar during her senior year, which included a summer internship at the Naval Research Lab (NRL) Washington, D.C. and one semester of research in corrosion science.

Afterward Jones was selected to be one of 13 Trident Scholars during 2012-2013, allowing her to undertake a yearlong course of study equivalent to graduate-level research under Associate Professors Michelle Koul and Joel Schubbe, who are materials science experts. Jones’s thesis, “An Evaluation of the Corrosion and Mechanical Performance of Interstitially Surface-Hardened Stainless Steel,” set out to characterize, validate, and quantify the long-term performance of surface-hardened stainless steel using various corrosion and mechanical tests. According to her abstract, the tests focused on measuring mechanical properties important for marine applications.

Jones’s interest in materials science started during her sophomore (“youngster”) year while she took Koul’s Strength of Materials course. “I like the unknown factors that present themselves when you
analyze how something breaks and why,” she explained. “Working in corrosion science allows me to do a little detective work.”

During her fleet and internship experiences at the Naval Academy, she quickly saw the practical applications of her chosen subspecialty. “It’s really nice to see aspects of what I learned in class directly applied to the naval platforms where I’ll serve in my naval career.” After graduate school, Jones is slated to do a two-year tour of duty as a nuclear surface warfare officer on a conventional Navy destroyer or cruiser. Then she will attend nuclear power school and nuclear prototype training for a year before being assigned to a nuclear-powered aircraft carrier.

During 2013-2014 MIDN Reyes and 19 other engineering students were appointed to conduct independent research under the Bowman Scholar program. This semester, MIDN Reyes and MIDN Scott Bolstad have been studying the effects of salt water on corrosion fatigue in four different aerospace and naval alloys—7075, 6061, 5083, and 7050 aluminum.

“This project involves applying composite patches, initially boron-epoxy, to see how long we can extend the metal’s fatigue life,” MIDN Reyes said. “What is new about this project in comparison to other research is our study of the effects of corrosion on the boron patch.” Reyes and Bolstad work in the Structures Test Lab under Associate Professor Schubbe, an expert in fatigue and fracture and environmentally assisted cracking.

MIDN Reyes’s and MIDN Bolstad’s corrosion-related research, while enhancing their academic experience and providing support to faculty research, also affords them a chance to attend graduate school before starting their five-year service commitment. About three-quarters of Bowman Scholars will be chosen to pursue a master’s degree at the Naval Post-Graduate School in Monterey, California.

Jones’s record of achievement through the Bowman and Trident Scholar programs, among other academic and leadership accomplishments, helped her gain acceptance into The University of Virginia’s two-year graduate program in materials science and engineering. As an ensign attending UVA, she is engaged in coursework while doing her thesis research on stress corrosion cracking in aluminum. Specifically, she is exploring the effect of water vapor pressure on the fatigue crack propagation of aerospace aluminum alloys 7075-T651 and 2199-T86.

Midshipmen Benefit From Funding for Capstone Design Projects

Approximately 40 percent of Naval Academy midshipmen—about 400 per class—major in engineering. Moreover, non-engineering majors must take six engineering core courses. At least one of these core requirements introduces the students to the science of materials and includes one or two lectures on corrosion. In addition, some of the 1st class (senior-level) engineering majors who embark on a team-based Capstone Design project opt to focus on corrosion and/or electrochemistry. Among other capstone projects, NRL has funded a team to work on a corrosion-hunting robot, Moran noted.

The academy’s robust Capstone Design Program offers many different ways for midshipmen 1st class to work with an advisor on an independent project funded directly by a service lab or division such as NRL, NAVSEA (Naval Sea Systems Command), or DARPA (Defense Advanced Research Projects Agency). During a recent meeting with mechanical engineering faculty, officials from the Pentagon-based Corrosion Policy and Oversight Office expressed interest in sponsoring a capstone design project in the area of materials sustainment.

MIDN Jones, MIDN Reyes, and engineering majors in general, are benefitting from their faculty’s myriad research collaborations with DoD labs, military program offices, and the Technical Corrosion Collaboration comprising eleven universities, sponsored by the DoD Corrosion Office. When midshipmen exercise their option to take part in summer internships before their senior year, the sponsoring entity provides opportunities for them to study and travel.

While NRL is one of many internship sponsors for engineering majors, over the past several years the laboratory has been the main sponsor of corrosion-related internships. Jones’s Trident Scholar research benefitted from materials provided by NRL. The Naval Surface Warfare Center’s Carderock Division also performed hardness testing for Jones and Kou during the project.

Mechanical Engineering Professor Stephen Graham, along with NRL’s Erik Knudsen and The University of Akron’s Xiaosheng Gao, is immersed in various projects that explore the influence of ductile damage on stress corrosion cracking of commercially pure titanium. Moreover, Graham and Kou are pursuing a technology transfer initiative supported by The Office of Naval Research (ONR) in order to help NAVAIR (Naval Aviation Systems Command) better understand how test procedure can influence measured hydrogen-assisted cracking behavior.

“The midshipmen are definitely involved in these and other projects,” said Graham. “We have them working in the lab, learning about stress corrosion cracking, and running tests so they’re informed in a sophisticated way about corrosion as naval officers.”

Scholarship recipients such as Jones and MIDN Reyes, along with midshipmen 1st class pursuing capstone design projects, are encouraged to submit their projects for national and international competitions. Jones entered her Trident Scholar project in NACE International’s 2013 Student Poster Session Contest at its annual conference in March, a competition open to graduate and undergraduate students internationally. 
“Ms. Jones won the [top project] award within the undergraduate division of the NACE poster contest,” Koul said. When Koul was unable to attend the NACE conference because of government travel restrictions, Jones stepped in for her. “She gave my research-in-progress talk while she attended CORROSION 2013, and she did very well!” Koul recalled.