



NAVAL POSTGRADUATE SCHOOL

IN REVIEW

MAGAZINE

FALL 2019

RESEARCH IN REVIEW

NPSAT-1

LAUNCHED

An orbiting satellite designed and built on the NPS campus is impressive, but it's just the beginning of the impact NPS' Space Systems programs have on American interests in the final frontier.

INSIDE:

Cyber Endeavour Tackles Russian Interference
Faculty Participate in Massive Arctic Study
Course in Great Power Competition Launched

PRESIDENT'S MESSAGE



Dr. Ann Elisabeth Rondeau
Vice Adm., U.S. Navy (Ret.)
President, Naval Postgraduate School

“Space systems graduates are more than just well-educated engineers and scientists; they are innovative leaders of transformation, and creative solvers of tomorrow’s problems.”

What a sight!

Watching SpaceX’s Falcon Heavy majestically lift off from Launch Complex 39A at Kennedy Space Center in Cape Canaveral was truly awe-inspiring, but knowing that this impressive feat of human engineering contained a piece of the Naval Postgraduate School is what I will always remember.

Some of the most prideful milestones our nation has celebrated over the years occurred on this same hallowed ground. Built initially to support the Apollo and Skylab programs, more than a dozen launches of the Saturn V rocket, including the Apollo 11 spaceflight that put an American on the moon, departed from Launch Complex 39A. In addition, an impressive 24 launches of the Space Shuttle have occurred on this same complex, from the first flight, STS-1 in 1981, to the final flight of the program, STS-135, three decades later. I should note that many of these launches also had a piece of NPS with them in the form of one of our 40+ NASA astronaut alumni, more than any graduate program in the world.

Today, with the Falcon Heavy’s third launch, our own feat of impressive human engineering, NPSAT-1, was placed into orbit shortly after the spacecraft’s forceful, yet graceful ascent into the night sky. Designed, engineered and built right here on the university campus, NPSAT-1 will execute a number of experiments for the university, the Naval Research Laboratory and a few others. And as one might expect with a project from NPS, our exceptional students, guided by renowned faculty, were critical to the execution of this ambitious project.

Over the course of the NPSAT-1 evolution, more than 40 student theses were completed on varied aspects of the craft, and countless more students participated via directed study. NPSAT-1 is a remarkable achievement, and yet it is just an introduction to the impact of the university’s Space Systems Academic Group (SSAG). Space systems is a truly interdisciplinary approach to graduate education, where leading academics in a broad range of disciplines join seasoned practitioners like former NASA astronauts and senior military officers to provide a unique education in space systems engineering and space systems operations.

As noted in the SSAG’s purpose statement, “Space systems graduates are more than just well-educated engineers and scientists; they are innovative leaders of transformation, and creative solvers of tomorrow’s problems.”

Now more than ever, graduates from our own hallowed grounds, from this university, are poised to make Herculean contributions to America’s security challenges in the space domain. Just a few weeks ago, on August 29, Air Force Gen. John “Jay” Raymond officially took command of the re-established United States Space Command (USSPACECOM). Raymond and his team have the challenge of re-imagining an organization best positioned to meet those challenges and opportunities.

While USSPACECOM, and the broader DOD, evolve to meet these rapidly-changing security requirements, NPS will continue to provide well-educated leaders throughout the Navy and Marine Corps, and all of the Armed Forces, ready to make their contributions to the greater effort. As that vision is realized, and our milestones are celebrated, knowing that the Naval Postgraduate School has played a critical role to our success is a fact in which we all can take great pride.

A handwritten signature in black ink that reads "Ann E. Rondeau". The signature is fluid and cursive, with a large initial 'A' and 'R'.



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On The Cover

In the early morning of June 25, 2019, a Falcon Heavy blasts into the Florida sky from Cape Canaveral. Onboard are 24 individual satellites with varying mission sets, one of which is a 300-lb, cylindrical craft designed, engineered and built by personnel at the Naval Postgraduate School. It was a landmark achievement, but impressively, not the first satellite launched by the university – the Petite Amateur Navy Satellite, or PANSAT, was launched in late 1998 by legendary astronaut John Glenn from the Space Shuttle Discovery. (Photo courtesy SpaceX)

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Industry Execs Talk Innovation with NPS Students

NPS' Graduate School of Business and Public Policy (GSBPP) brought together two captains of industry for a panel discussion titled "Challenges of Innovation in Defense Acquisition" in Ingersoll Hall, Aug. 13. It was an opportunity for students in the university's acquisition and management programs to hear from seasoned acquisition experts.

Jerry DeMuro, CEO of BAE Systems Inc., and Mitchell Waldman, Executive Vice President of Huntington Ingalls Industry, brought years of experience to the discussion, with NPS' own Director of Cybersecurity Robert Sweeney joining the panel and GSBPP Lecturer Ray Jones serving as moderator. The panel jumped right into the challenging question of how to meet the rapidly evolving needs of the warfighter.

"We often hear that the defense acquisition process needs to move faster and adapt to the speed of relevance," said moderator Jones. "From your perspective, what are some of the key enablers and detractors that formed this view and where should the DOD focus its resources to optimize return on investment (ROI) in the context of defense?"

"We all know what the end objective is ... Superiority, dominance and to be strong enough to where no one will threaten us," said DeMuro.

The DOD is spending money on discovering new and innovative ideas to increase speed of product to the warfighter, he adds, but he is quick to point out the immense regulations governing the industry.

"Do we regulate how Google develops software?" DeMuro asked. "Do we regulate what interfaces they have to have? And what documentation they have to provide, and who is going to provide spare parts?"

Waldman offered an example of effective partnering between the DOD, industry and others in the undersea warfare domain.

"I offer to you that we actually have examples of doing things with the speed of relevance as the CNO says. The SSGN program is one such as example," said Waldman. "We converted Trident missile carrying submarines to submarines that can launch Tomahawk missiles, and we did that very rapidly, with public shipyards, teaming with industry."



Senior industry executives join NPS experts for a panel discussion on the "Challenges of Innovation in Defense Acquisition" in Ingersoll Hall, Aug. 13.

Summit Examines USMC Resilience

The 4th Marine Reserve Division (MARFORRES), headquartered in New Orleans, La., brought together a diverse cross-section of reservists, active duty and retired service members and spouses, and family services representatives from centers around the nation, to take inventory of issues affecting the health and vitality of Marines.

Held on campus at NPS, the three-day Appreciative Inquiry Resilience Summit focused on using an organizational behavior model that emphasizes self-awareness and self-determined change. For the Marine Corps Reserve, leaders see the model, coined Appreciative Inquiry, as a way to develop mental resilience and toughness, and a means to ensuring the total health of the



U.S. Marine Corps Reserve holds Appreciative Inquiry Resilience Summit at NPS.

40,000 Marines within MARFORRES.

Appreciative Inquiry (AI) focuses organizations, and individuals within them, to identify what is working well in the organization and why. The method asks

what gives life to the organization at its best moments by using the power of positive questioning. The AI approach then uses a series of calibrated exercises designed to discover what critical actions need to be taken for a desired change.

The participants, like Marine Reservist Maj. Ryan Shaw, have been empowered by Marine Corps leadership to bring fresh perspectives and new ideas toward change in the Marine Corps.

"This is a specialized problem-framing program where we can get inputs about the problems of suicide, retention, and where we can rethink how to be proactive to improve the force in the future," said Shaw.

"Participants will return to their commands with a renewed vigor on attacking these problems."

NPS Professor Frank Barrett, who coauthored the Appreciative Inquiry method, met with representatives from across the U.S. about establishing methods to cause better health and resiliency within the Marine Corps. Barrett says it's the "power of the question" and how it

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is framed that provides positive and intuitive answers.

“Learning always begins with a moment of inquiry,” said Barrett. “Resilience builds on strong relationships, and on that positive core we can launch actions. The asking of questions already begins to transform and change the capacity of the human system we seek to understand.”

NPS Welcomes Senior Indian Delegation

NPS hosted a delegation of senior leadership from India’s Navy and Defense Research and Development Organization (DRDO), Aug. 5. The visit opened doors for the

possibility of more NPS international students, as well as building relations by showing what NPS has to offer.

Indian Navy Vice Adm. Gurtej Pabby, Chief of Material; Indian Navy Rear Adm. Rajaram Swaminathan, Assistant Chief of Material; Dr. Siddalingappa Guruprasad, Director General of DRDO; and several members of DRDO comprised the delegation that toured several NPS research labs and facilities, as well as spoke with NPS leadership.

“We discussed opportunities for more students from India to come here for a graduate-level education,” said Al Scott, Director of the Inter-

national Graduate Programs Office.

“The timing of their visit was great,” said Dr. Jeff Paduan, NPS Dean of Research. “A group from the Navy International Programs Office



(NIPO) was here recently and they are really reaching out to NPS and working with us to facilitate international collaboration. We’re learning what the next step is and NIPO

is ready to help us get the necessary sharing agreements.”

Working with foreign countries

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Student Board Holds First-Ever Women’s Leadership Forum

The NPS President’s Board for Student Affairs hosted the university’s first Women’s Leadership Forum (WLF) at the Mechanical and Aerospace Engineering Auditorium, May 31. NPS students, faculty and staff took the opportunity to take part in a candid discussion about the opportunities and challenges facing female leaders in the military community.

“Diversity makes us stronger and there aren’t many opportunities to make this type of event happen,” said U.S. Air Force Capt. Jessica Padoemthontaweekij, a student in the Security Studies program and event organizer for the WLF. “I think it’s very important for us, especially for NPS students who are going to lead in their service — whether it’s Air Force, Navy, Army or Marine Corps. Making this opportunity available for students is important not only for the school but for their own self-progress.”

“There are roles for both men and women to support women in leadership positions, especially in society today where we need the support of men in higher leadership to bring us to the table,” contin-

ued Padoemthontaweekij. “Having men and women who are in senior positions see that they have an active role in promoting women and their growth in leadership is one thing I would like everyone to take away from this event.”



Moderating the panel, Padoemthontaweekij introduced the audience to former Senior Advisor to the Secretary of Defense Sally Donnelly, NPS Meteorology and Oceanography Program Officer Cmdr. Paula Travis, AFSOC Special Reconnaissance Superintendent Senior Master Sgt. Alex Eudy, and 314th Training Squadron Commander Lt. Col. Jaclyn DeRoush. NPS President retired Vice Adm. Ann Rondeau provided opening remarks before the forum started.

“I am privileged as the president of this university to be here, because you are all dedicated to the diversity that will lead to innovation, and innovation is what will keep this country’s freedom and democracy safe,” said Rondeau. “Because in the end, it’s about the dignity to the individual and understanding that he or she actually brings to the fight.”

UNIVERSITY NEWS

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is nothing new for NPS. The school has working relationships with over 40 countries with approximately 150 international students every year. Working with India will help further develop ties with a nation that currently does not have any students attending the university, although Indian students have attended NPS in the past.

Summer Interns Share Research with Campus

NPS said farewell to a cadre of its summer science, technology, engineering and mathematics (STEM) interns with a research showcase and certificate presentation ceremony, July 25.

Upon their arrival to campus, incoming summer interns are partnered with volunteer university faculty, and assigned projects that focus on areas of national security. With the summer coming to a close, the results of their research were shared with NPS faculty, staff and students during the showcase by way of posters set up in the courtyard of Glasgow Hall.

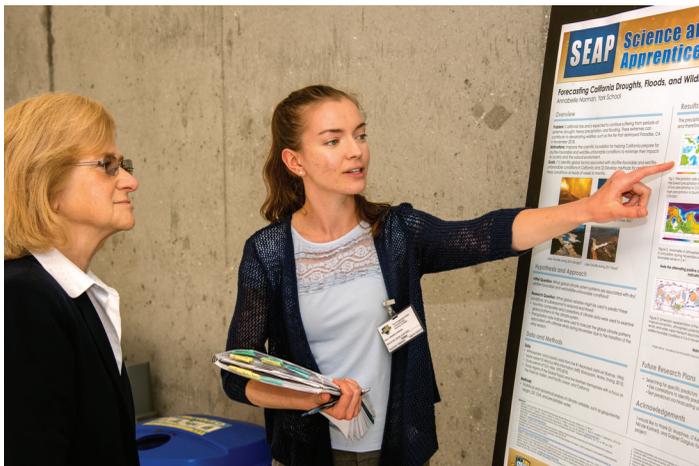
After the catastrophic wildfires that recently ravaged the state of California, Annabell Norman, a Science and Engineering Appren-

ticeship Program (SEAP) intern from York School, investigated global climate system patterns and how they are associated with dry/wildfire-favorable and wet/wildfire-unfavorable conditions.

“I was interested in the meteorological influence on national security,” said Norman, who researched what global variables might be used to predict these conditions at sub-seasonal to seasonal lead times.

“I feel like this internship gave me a great foundation for future research,” she continued.

NPS' STEM internship program partners with the Office of Naval Research to bring high school and college students onto campus for 6-10 weeks over the summer through Naval Research Enterprise Internship Program and SEAP. In addition, the university hosts Midshipmen from the U.S. Naval Academy as well as cadets from the U.S. Military and Air Force academies, and maintains active relationships with California State University Monterey Bay and regional high schools. NPS also has a long-standing partnership with nearby Hartnell Community College providing opportunities for students from the Salinas Valley.



Summer intern Annabell Norman shares the results of her research into the relationship between climate patterns and fire conditions in California to NPS President retired Vice Adm. Ann E. Rondeau.

Enterprise Chairman, Former VCJCS Attribute Navy Values to Innovation

Executive Chairman of Enterprise Holdings, Inc. Andy Taylor, along with Enterprise board member retired Adm. James A. “Sandy” Winnefeld, former Vice Chairman of the Joint Chiefs of Staff, talked about how innovation, leadership and Navy values impacted the company as part of the latest Secretary of the Navy Guest Lecture (SGL) in King Auditorium, July 9.



Executive Chairman of Enterprise Holdings, Inc. Andy Taylor, left, retired Adm. James A. “Sandy” Winnefeld, former Vice Chairman of the Joint Chiefs of Staff, center, and Dr. Uday Apte, NPS Distinguished Professor, take part in a forum on business innovation, July 9.

In a departure from the traditional single speaker format, the SGL consisted of a panel discussion with Taylor and Winnefeld as speakers moderated by NPS Distinguished Professor Uday Apte.

“I first met Andy when I was the commanding officer of the USS Enterprise (CVN 65),” said Winnefeld. “Our aircraft carriers have these beautiful legacy rooms dedicated to the ship’s namesake, and we didn’t have one onboard Enterprise. Somebody said call the CEO of Enterprise Rent-A-Car, so I call and it’s a wonderful organization. Literally within a minute or so I’m talking to Andy Taylor.”

Taylor, a dedicated philanthropist, not only provided some funding for the ship’s legacy room, but embarked on a long-time friendship with Winnefeld who would eventu-

ally become part of Enterprise Holdings’ independent board. During the discussion, Taylor stressed one of the biggest threats a company can have is to be satisfied with “good” when things can be “great” through innovation.

“Today we encourage innovation, for my father would say early on if you got that idea you go out and try it,” said Taylor. “It gets harder as the company gets bigger, but we encourage people to try new things,

and if they fail, and they tried really hard, we still applaud them. We make sure we spend some money every year on trying new things to give opportunities for people to grow the business.”

As the conversation closed, Winnefeld offered advice to the audience that would serve them well throughout their future careers, no matter where those might take them.

“Prepare yourself, because even though you have an interest in lifelong learning, which is why you’re here, try to spend at least a little bit of time reading about how business thinks and how business works,” said Winnefeld. “It’s going to help you while you’re in the service because you’re going to be a more efficient user of taxpayer resources, and you’ll carry that knowledge over after you retire.”

Longtime Operations Research Professor Becomes New GSOIS Dean

Dr. Rob Dell, professor and past chair of the Department of Operations Research, is the new dean of the university's Graduate School of Operational and Information Sciences, officially stepping into the position, Aug. 18. Dell takes over following more than six years of leadership by Dr. Gordon McCormick, who will return to teaching in Defense Analysis department.

"This is an opportunity for myself, and GSOIS in general, to be able to step in and serve my colleagues and help advance our school," said Dell. "The school was well served during [McCormick's] time as dean and we should be very appreciative for everything that he's done."

Dell has been teaching NPS students for nearly 30 years, joining the OR department as an assistant professor in 1990, and served as its department chair from 2009 to 2015. He says one of his top priorities is to continue GSOIS' role in executing the university's strategic plan, in the focal areas where the school's expertise can best contribute.

"My goals are being developed as I have conversations with different faculty members within GSOIS," said Dell. "Cyber is a key element of everything we do at NPS, and I can definitely see the



Dr. Rob Dell

university continuing to move out in that direction. Artificial Intelligence is also one of those areas that certainly resides within GSOIS as well, and that's absolutely going to play as one of the initiatives that we're looking to as part of the school."

Dell earned his Ph.D. from the State University of New York at Buffalo in 1990 and he has done research for every uniformed service on topics such as U.S. Navy capital planning and U.S. Army base realignment and closure. Dell's awards include the Barchi, Koopman, and Rist prizes for military operations research, a Brazilian Navy Tamandaré Merit Medal, two Department of the Army Payne Memorial Awards for Excellence in Analysis, and two Department of the Navy Superior Civilian Service Awards.

The Graduate School of Operational and Information Sciences prepares future senior military leaders to succeed in an uncertain, rapidly changing and information-intensive environment through research and educational programs. It consists of the Departments of Computer Science, Operations Research, Defense Analysis and Information Sciences, as well as the Cyber Academic Group and the Data Science & Analytics Group.

NPS Hosts Ordnance and Ballistics Working Group

NPS, in partnership with the National Armaments Consortium (NAC), hosted the 68th annual Ordnance and Ballistics Technology Working Group allowing researchers and developers from government, academia and industry to exchange information on the latest weapons technology, July 29 - Aug. 1.

The working group serves a unique role, providing partners with an opportunity to discuss ideas at the classified level, and is limited only to personnel from Department of Defense, the Federal Bureau of Investigation, Central Intelligence Agency, Department of Homeland Security, and Department of Energy.



NPS Dept. of Physics Associate Professor Joe Hooper, left, speaks to Vice-Chairmen of the NAC Executive Committee James Miller during the 68th annual Ordnance and Ballistics Technology Working Group Meeting at Glasgow Hall, July 29-Aug. 1.

NPS President retired Vice Adm. Ann Rondeau opened

the working group linking the group's value directly to how NPS students will apply their education in the fleet.

"Our students are here work-

ing on cutting-edge solutions, not just in the technical areas of this field, such as physics, mathematics, engineering and material sciences, but they also do it with the notion of lethality and effect," said Rondeau. "Having conferences like this, that brings industry and government together with our student practitioners, is very important so they can return to the fleet and the field to apply this knowledge with lethal force."

The event was structured over a three-day period, with the approximately 300 participants engaging with a variety of speakers on topics that covered mechan-

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MAE Faculty Advances Research Into 3D Printed Propellants

Naval Postgraduate School (NPS) Professor of Mechanical and Aerospace Engineering Emre Gunduz was recently awarded funding from the Strategic Environmental Research and Development Program (SERDP) for a joint undertaking with researchers at Purdue University and Army Research Laboratory (ARL) to explore the use of a vibration-assisted 3D printing method in the production of gun propellants.

Gunduz's printing method utilizes ultrasonic vibrations, creating a force great enough to pull extremely viscous materials off the surface of printing nozzle walls, and then allow that material to exit the nozzle without increased pressure and the resultant friction and heat that accompany it. In this way, the vibrations allow for the safe printing of extremely viscous materials without the addition of the solvents required to modify the consistency of propellants produced via traditional manufacturing methods.

There are propellant formulations that do not use solvents, but instead use a mixture of an explosive powder mixed with binders. These "insensitive" energetics are attractive for military use as they are capable of providing a higher energetic release necessary to propel a projectile from a gun, but are also insensitive to going off if hit by munitions or shockwaves from nearby explosions.



Dr. Emre Gunduz

These formulations will also benefit from the use of Gunduz's method, as he can successfully add far more solids to the mix — amounts of solids which would render the propellant unable to pass through traditional extruders. The more solids you have, the higher the energy density of the propellant, so this increase allows Gunduz to provide propellant with maximum energy density.

"My process is unique in that we can put more of the solid in there and still be able to process it," Gunduz explained. "That gives a big advantage in terms of performance — you know, somebody can go and make a pellet ... and I can make something half the size with the same amount of energy. The bullets we make would go faster and have a longer range."

Gunduz will serve as a co-PI (principle investigator), working with a team that includes two NPS master's students and one undergraduate intern. Together, the NPS group will work on applying the method to similar — but non-energetic — materials. Working with these inert materials allows the team to concentrate their efforts on developing and testing process conditions for the manufacturing of propellants without the risk of adverse energetic reactions. Simultaneously, Purdue will work with insensitive energetic material formulations, while a collaboration with the ARL rounds out the project.

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ics, warhead technology, explosives and propellants.

"This particular conference is unique because it allows us to collaborate at the classified level," said NPS Dept. of Physics Associate Professor Joe Hooper. "This is one of the few places in the ordnance and ballistics community where you have people from all the various disciplines come and give scientific talks on what they're working on.

"You're getting input from

both DOD sponsors and the people who are executing the work, as well as input from the people providing oversight, such as government scientists and policy makers," he continued. "Having all these people under one roof really helps push the overall field forward."

Alumnus Honors Legacy of Professor Richard Hamming

NPS alumnus Dr. Martin Mandelberg is working on an effort to honor one of the 20th century's greatest minds, esteemed

computer scientist and mentor NPS Distinguished Professor Richard Wesley Hamming. Mandelberg offered an overview of his Hamming Legacy project during a special presentation in Reed Hall on the NPS campus, July 18.

Mandelberg, who was Hamming's only doctoral advisee, reflected on Hamming's teaching career and mentorship,

which spanned 22 years at the university from 1976-1998.

"He developed early on the skills, knowledge and insights to



NPS graduate Dr. Martin Mandelberg details the Hamming Legacy Project during a guest lecture on campus.

mentor people,” said Mandelberg. “He liked being the research mathematician that helped you with your problem. He was a perfect professor to help people with their master’s thesis because he could hop from problem to problem.

Mandelberg reviewed nearly 30,000 total pages of research findings in Hamming’s archive, taking 30 months to complete. He introduced an online archive of Hamming materials featuring digitally remastered videos of NPS classes taught by Hamming, and a preview of previously unavailable research findings, soon-to-be-available through the NPS archive, Calhoun.

“[Hamming] is a great role model to set the standard,” said Lt. Ashton Miller, an NPS electrical engineering student who is looking forward to the great resource that will be available to him and the rest of the student body in the near future.

“Hamming was a good and valued friend,” said Dr. Herschel Loomis, NPS Distinguished Professor and a colleague of Hamming. “One of the great privileges of my career was to be able to work with this intellectual giant on a daily basis.”

Hamming was one of the world’s most distinguished computer scientists, best known for his work in coding and information theory developing innovations known as the Hamming code and the Hamming spectral window. He was director of the Manhattan Project Computing Facility, and later at Bell Labs, he introduced error-correcting codes and performed pioneering work in operating systems and programming languages.

NPS Researchers Honored with Regional Clean Air Award

NPS received Monterey area community recognition recently for its efforts to reduce the Navy’s carbon footprint in developing alternative energy technology.

Lecturer Doug Seivwright of the university’s Mechanical and Aerospace Engineering (MAE) department was presented with an award of individual distinction for Technology/Air Quality Education at the 2019 Clean Air Leaders Awards held by the Monterey Bay Air Resources District (MBARD), May 16, for his groundbreaking work at NPS’ Turbopropulsion and Gas Dynamics Laboratories.

Along with MAE chair, Dr. Garth Hobson, Seivwright is researching a new method of transforming heat from engine exhaust into electricity, which has the power to greatly reduce the Navy’s reliance on fossil fuels.

“The intent is to capture heat in a closed loop carbon dioxide cycle and run the heat through another gas turbine to actually produce electrical power,” Hobson explained. “We’re only talking about 10 percent of the power out, but that would be wasted in any case. If you do it strong enough, you can actually recover quite a bit of heat.”

This free energy could potentially have a huge impact across the Fleet as it strives to reduce energy



Research Associate Doug Seivwright, right, accepts the 2019 Clean Air Leaders Award from Compliance Inspector Bronwyn Nielsen, May 16.

requirements and increase resilience of facilities and operations across the globe.

Since 2013, the Office of Naval Research (ONR) Energy System Technology Evaluation Program (ESTEP) has sought to forge alternative energy technologies and a capable workforce to address one of the greatest costs, and vulnerabilities, of the military – reliance on traditional, external energy sources.

As a federal government agency dedicated to healthy air quality throughout Monterey, San Benito and Santa Cruz counties, MBARD created the Clean Air Leaders Award in 2010 to honor citizens who are making positive contributions in this domain.

The awards specifically identify individuals, organizations and companies for “initiatives in the region that advance the understanding and/or awareness of air quality, promote improvements in air quality through policy, regulation or practice, or improve air quality monitoring,” according to the group’s awards website.

NPS Researchers Share Expertise at Regional UxS Symposium

The rapidly-growing industry of drones and automation has taken to California’s Central Coast. To help drive regional research, development and collaboration, a consortium known as Monterey Bay Drone, Automation and Robotics Technology (DART) held its first symposium this summer, with researchers from NPS participating in the new effort.

According to Josh Metz, the Economic Development Manager at the Ford Ord Reuse Authority and co-creator of Monterey Bay DART, the goal of the symposium was to take advantage of the area’s

proximity to educational institutions, Silicon Valley and environmental organizations to drive collaboration on the interrelated technologies involved with drones.

The DART initiative is intended to align industry, academia and government in the Monterey area toward establishing and operating a world-class drone, automation, robotics technology testing and development cluster, said Metz.

“NPS has always valued the research ecosystem formed when industry, academia and the military services unite to innovate novel socio-technical solutions for today’s warfighters,” said NPS’ Robotics and Unmanned Systems Education and Research (CRUSER) Associate Director Dr. Carl Oros, one of NPS’ symposium speakers. “NPS researchers have more than 200 professionally published papers and theses on autonomous vehicles. The relationships NPS has created through this work uniquely positions us to be at the center of all types of autonomous systems activity as Monterey’s DART initiative emerges.”

“We have a space to do research, development and experimentation at Camp Roberts, and we would also like to do those types of things locally,” added Research Associate Marianna Jones. “We want to not only work with industry and academia, but other non-governmental agencies to continue advancing autonomous systems experimentation.”

As a broad range of applications for drones on the Monterey Peninsula continues to expand, Monterey Bay DART organizers are already planning next year’s symposium to capitalize on the region’s unique advantages. **IR**



Participants of Cyber Endeavour 2019 gather on the steps of the Stanford Research Institute. Cyber Endeavour is an annual Department of Defense-sponsored conference that brings together U.S. and international military and civilian practitioners from across government, industry and academia to address the nexus of cyberspace and national security. (U.S. Navy photo by MC2 Patrick Dionne)

Latest Cyber Endeavour Tackles Russian Interference from Diverse Perspectives

By MC2 Patrick Dionne

More than 200 experts and operators representing organizations across the Department of Defense (DOD), academia, industry and NATO gathered at Stanford Research Institute’s (SRI) International Headquarters in Menlo Park, Calif. to tackle issues surrounding Russian aggression in the cyber domain, June 18-20.

Originating in 2011, the annual conference sponsored by the DOD Information Operations Center for Research (IOCR), located at the Naval Postgraduate School (NPS), and the U.S. Army Reserve’s 335th Signal Command, seeks to provide an interactive, working level event to discuss the most critical

challenges in the information environment facing our nation and to identify potential solutions.

“This year’s topic is so critical because it is right in our face, we’re seeing it happen every single day. It’s in our news, it pervades every aspect of our lives right now, so it’s critical that we all come together to identify potential solutions in a collaborative way.”

Austin Branch
Executive Director, Information Strategies and Programs
COLSA Corporation

“The idea is to bring experts, practitioners and policy people together so at the end of the conference they have a better idea of the threats posed by Russia and what we can do about it,” said IOCR Director Dr. Hy Rothstein.

“There are a lot of conferences on cyber, but most of them are actually too large. We keep it small because we want to have an exchange of ideas, if thousands of people are in an auditorium, or if you’re in a separate room piped in by

a screen, people can't stand up and say something when it's Q-and-A time after a panel."

Throughout the conference, participants had the opportunity to engage with a plethora of influential speakers, experts in the information warfare domain including The Honorable Chris Inglis, former deputy director of the National Security Agency; retired Army Col. Bryan Sparling of Army Cyber Command; Dartmouth College Department of Government Chairman, Dr. Russell Muirhead; and, Timothy Thomas of the MITRE Corporation.

In addition, military commanders from the cyber domain also served as presenters during the conference, including Army Brig. Gen. Tina Boyd of the 335th Signal Command; and, Army Maj. Gen. Stephen Hager, deputy commander operations, U.S. Cyber Command. Senior international leaders were also represented, including National Mission Force and Assistant to the Minister of Defense of Ukraine Col. Viktoria Kushnir.

"One of the biggest problems with cyber is getting all these heads in the same room to try and develop better ideas about the best policy to counter the threats facing the U.S. and our western and eastern partners," said Assistant Professor Ryan Maness from NPS' Defense Analysis department, who served as a panel moderator during the event. "People take these ideas back to their respective commanders, to their respective research institutes, and to their respective bosses to maybe facilitate some of the agreed upon ideas.

"That being said we're still learning a lot," he continued. "Conferences like these can help us ask the questions we need answered but change doesn't happen overnight. I think advising the best policy forward where escalation and possibly armed conflict does not happen as a result of conflict in the cyber domain is the main goal."

A cornerstone of the event included a series of moderated panels between key figures representing all facets of cyber. Each panel facilitated dialogue between the panelists and the audience on important issues ranging from Russian attempts to undermine NATO, advancing U.S. interests, ensuring the integrity of democratic elections and overcoming barriers on the way ahead.

"This year's topic is so critical because it is right in our face, we're seeing it happen every single day. It's in our news, it pervades every aspect of our lives right now, so it's critical that we all come together to identify potential solutions in a collaborative way," said panel moderator Austin Branch. As president of the Information Professionals Association, and executive director for information strategies and programs for the COLSA Corporation, Branch has a compelling perspective.

"The networking aspect of these events is critical. From a corporate standpoint these networks are helpful because we can find ways to contribute to larger efforts where we might be able to bring our skills in a more definitive and helpful way," said Branch. "On the Information

Professionals Association side these venues are critical for our members that we stay engaged and that we're informed enough so we can advocate on their behalf."

This year's Cyber Endeavour offered a new fresh perspective with the inclusion of U.S. international partners including representatives from NATO, the United Kingdom and the Armed Forces of the Ukraine.

"On a daily basis we try to protect Ukrainian society from Russian disinformation ... In such a conference we have the ability to share our thoughts, to speak with practitioners, to speak with people with great personal experience in the field of information operations," said Armed Forces of Ukraine Col. Andri Dyda, Ukraine Chief of Defense, STRATCOM Assistant. "Informational security plays a very important role in Ukraine's efforts against Russian aggression as the non-kinetic part of the war is more significant."

Over its eight-year run, Cyber Endeavour has been hosted by a variety of research universities around the country. This year, organizers saw the value of staying a bit closer to home.

"SRI has been around for 75 years now, and part of the decision to bring this conference to SRI was to show that we are not only part of the defense re-



CYBER ENDEAVOUR 2019

search community and further evolve our relationship with NPS," said Moyer. "We also have interns now that are from NPS working up here and conferences like these do a great deal to developing a formal relationship and evolve future projects."

In addition to his role as a lab director for SRI, Moyer also attended the conference as a representative for his reserve unit, which he serves as the 151st Theatre Information Operation Group Commander, in order to bring a valuable uniform perspective to the biggest challenges in the information domain.

"Even just a couple of years ago, you were not seeing this much of a demand for information operations within the military," said Moyer. "Since the 2016 elections, the demand signal for information operations has grown absolutely exponentially, and it's unsustainable for the current position that we are in."

Silicon Valley can provide critical partnerships, Moyer said, as tech companies have become increasingly savvy in gleaning information from big data.

"We are now living in an era where all high-value targets, from Presidents to oligarchs to major commands, all have substantial media footprints," said Moyer. "We have begun to leverage those footprints ... and that's what makes conferences like these so valuable. In the future, we can leverage this data with machine learning and artificial intelligence and that is something that SRI has been working on." ■



Thrusters fire on the Falcon Heavy as it launches from Kennedy Space Center Launch Complex 39A in Cape Canaveral, Fla., carrying 24 satellites including the university's own NPSAT-1. The spacecraft, designed and built on campus by Space Systems Academic Group faculty, engineers and students, will conduct several experiments over its mission in space, and serve as a node on NPS' Mobile CubeSat network. (Photo courtesy SpaceX)

NPSAT-1 Launches Onboard SpaceX Falcon Heavy

By NPS Public Affairs

The long wait finally came to an end for faculty and researchers in the Naval Postgraduate School's (NPS) Space Systems Academic Group (SSAG). Following several external delays to a launch that was originally scheduled for September 2016, the university's own NPSAT-1 was launched and deployed into a 720 km orbit by SpaceX's Falcon Heavy at 2:30 a.m. on Tuesday, June 25, from Kennedy Space Center Launch Complex 39A in Cape Canaveral, Fla.

The mission was slated to be the "most difficult" undertaking by the Falcon Heavy to date, according to SpaceX CEO Elon Musk during an interview prior to Tuesday's spectacular night-time launch. The mission called for the release of 24 satellites during three individual deployment stages ... Each stage separated by a burn of the Heavy's thruster.

Overall, the mission proved to be largely successful, especially for the NPS team who watched NPSAT-1 successfully release from the SpaceX craft and enter into its orbit within seconds of its planned deployment.

"It's the end of an era," noted Professor Emeritus Rudy Panholzer, former SSAG chair and a pioneer of the university's space education and research programs, on hand to witness the launch first-hand.

Like much of the research at NPS, the satellite is ultimately about student experimentation and study. Over the course of the craft's development, NPSAT-1 supported well over 40 student theses, noted SSAG engineer Dan Sakoda, with countless more students contributing via directed study.

"We are not here to build satellites, but the satellite is a nice byproduct of the educational process ... We designed it, built it and [tested] it in house. We also developed the lab around it, and developed the curriculum that led to its completion," said Panholzer.

"We are educating students, so why not choose an educational vehicle?" added Sakoda. And while Sakoda and Panholzer could have contracted out the building of the satellite, they and their colleagues chose to build it themselves in NPS' Small Satellite Lab.



“It is very important that students realize that engineering is not just about Power Point [documents] and white boards,” said Panholzer. “That stuff may work in the classroom, but it does not necessarily work in the real world.”

According to Sakoda, the success of the programs is largely a product of a systems approach to engineering that has incorporated many disciplines toward the success of the NPSAT1 project.

“It’s all about space systems engineering, students can see how all of these components work together ... That’s why a systems approach is necessary,” he said.

“That’s why we aren’t a department, but an academic group. We’re a hub that draws from disciplines all across the campus,” added Panholzer.

NPSAT1 was launched in conjunction with the Department of Defense’s Space Test Program (STP), which maintains a list of experiments to be launched into space. Researchers can apply to have their experiments incorporated into future launches in keeping with the STP charter, which calls for the organization to get as many experiments into space as possible.

And while the development and launch of NPSAT1 is quite an accomplishment, it is the first NPS-developed satellite launched into orbit. According to Panholzer, former astronaut Senator John Glenn launched NPS’ first satellite, the Petite Amateur Navy Satellite (PANSAT), from the Space Shuttle Discovery in 1998.

“It was a non-attitude controlled, tumbling satellite. [But] the NPSAT1 is attitude controlled, using the earth’s magnetic field to align itself in space,” explained Panholzer.

Graduate students from across the services and from varied backgrounds have contributed to NPSAT-1 over the years. Like all SSAG students, the experience and critical thinking skills developed during their studies are invaluable as these graduates provide leadership to America’s future in the space domain. **IR**

Watch the Falcon Heavy launch from Cape Canaveral carrying NPSAT-1.



NPSAT-1 Experimentation in Review

The space environment is extraordinarily harsh on electronics with extreme hot and cold temperatures, ionizing radiation, and the vacuum of space. With this consideration in mind, spacecraft designers often prefer proven technology over newer technology that promises greater functionality. But how, then, does new technology, or even current, low-cost technology, find its way into space if it hasn’t proven itself to be reliable.

NPSAT-1 attempts to address this “Catch 22” by providing spaceflight demonstrations of technology for future and near-term spacecraft applications, with an eye on reducing the cost of technology. The experimental technologies are the building blocks generally used in almost all spacecraft, such as solar cells, batteries, computers, solid state memory and sensors.

Complementing experimentation with power conversion from the sun, energy storage using an NPS-designed lithium-ion battery is another NPSAT-1 experiment. The lithium-ion battery is the main battery for the spacecraft but utilizes commercial-off-the-shelf lithium-ion cells in a 7S-7P configuration — seven cells in a series connected in seven parallel strings for a total of 49 cells. No cell-by-cell charge control is used for a much simpler design. Careful cell selection along with safety design features in the assembly and housing ensure the battery meets space flight safety requirements.

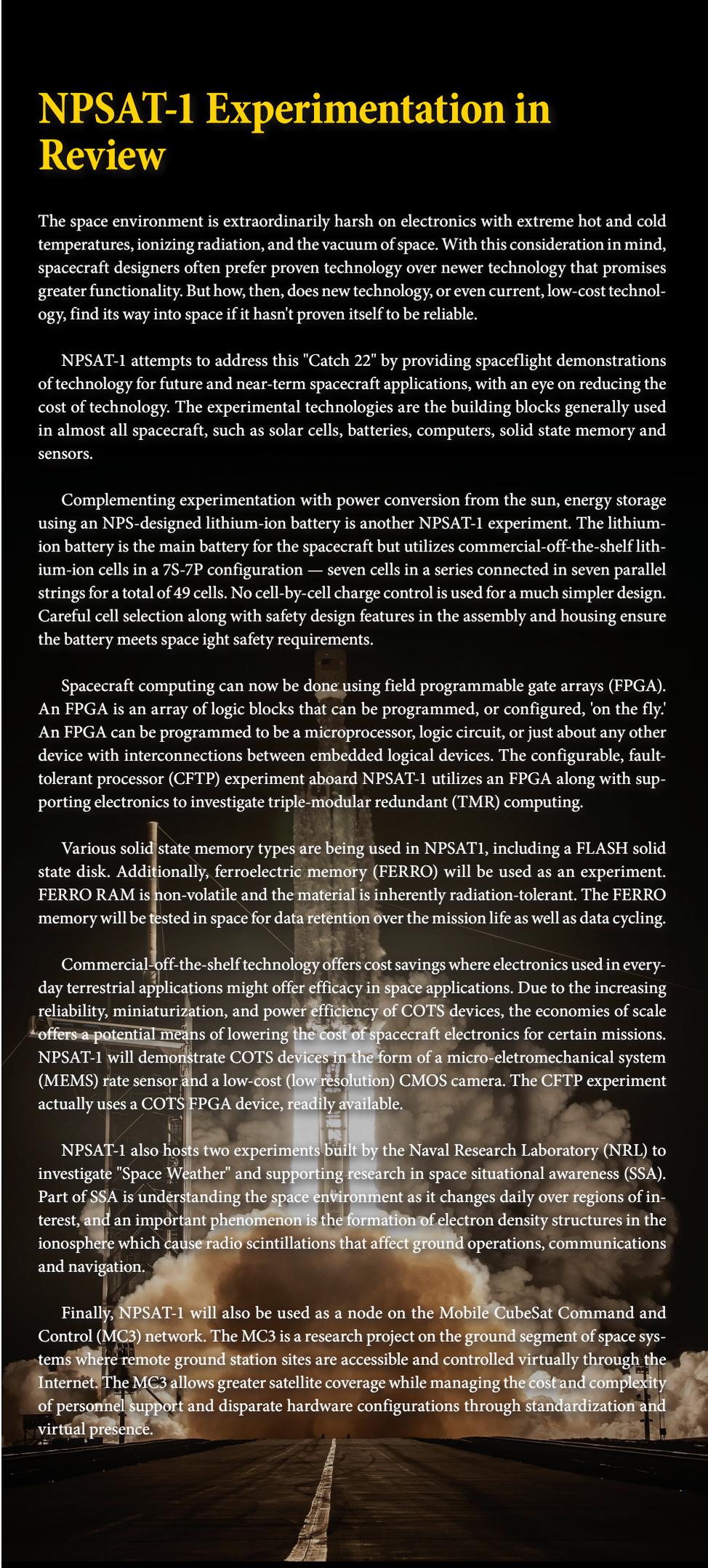
Spacecraft computing can now be done using field programmable gate arrays (FPGA). An FPGA is an array of logic blocks that can be programmed, or configured, ‘on the fly.’ An FPGA can be programmed to be a microprocessor, logic circuit, or just about any other device with interconnections between embedded logical devices. The configurable, fault-tolerant processor (CFTP) experiment aboard NPSAT-1 utilizes an FPGA along with supporting electronics to investigate triple-modular redundant (TMR) computing.

Various solid state memory types are being used in NPSAT1, including a FLASH solid state disk. Additionally, ferroelectric memory (FERRO) will be used as an experiment. FERRO RAM is non-volatile and the material is inherently radiation-tolerant. The FERRO memory will be tested in space for data retention over the mission life as well as data cycling.

Commercial-off-the-shelf technology offers cost savings where electronics used in everyday terrestrial applications might offer efficacy in space applications. Due to the increasing reliability, miniaturization, and power efficiency of COTS devices, the economies of scale offers a potential means of lowering the cost of spacecraft electronics for certain missions. NPSAT-1 will demonstrate COTS devices in the form of a micro-electromechanical system (MEMS) rate sensor and a low-cost (low resolution) CMOS camera. The CFTP experiment actually uses a COTS FPGA device, readily available.

NPSAT-1 also hosts two experiments built by the Naval Research Laboratory (NRL) to investigate “Space Weather” and supporting research in space situational awareness (SSA). Part of SSA is understanding the space environment as it changes daily over regions of interest, and an important phenomenon is the formation of electron density structures in the ionosphere which cause radio scintillations that affect ground operations, communications and navigation.

Finally, NPSAT-1 will also be used as a node on the Mobile CubeSat Command and Control (MC3) network. The MC3 is a research project on the ground segment of space systems where remote ground station sites are accessible and controlled virtually through the Internet. The MC3 allows greater satellite coverage while managing the cost and complexity of personnel support and disparate hardware configurations through standardization and virtual presence.



SSAG Education, Research Prepares Grads, and DOD, for America's Interests in Space

The launch of a functioning satellite — conceived, engineered and built by the intellect and talent of the university's faculty, students and staff — is a remarkable accomplishment. But it merely scratches the surface of how NPS graduates contribute to America's mission in space.

By Dr. Jessica Neasbitt

With the successful launch of SpaceX's Falcon Heavy in the early morning hours of June 25, the thesis work and directed studies of more than 40 students and countless faculty and staff at the Naval Postgraduate School (NPS) entered orbit in the form of NPSAT-1. The satellite, first envisioned almost two decades ago by former Space Systems Academic Group (SSAG) Chair Rudy Panholzer, now Professor Emeritus, launched through the Department of Defense (DOD) Space Test Program's STP-2 mission, houses a number of experiments built by NPS along with two built by the Naval Research Laboratory (NRL), which will be carried out over the satellite's 18-month mission.

The NPS students, faculty and staff behind NPSAT-1 hail from the university's SSAG, an interdisciplinary academic group whose mission is to "provide direction and guidance for students in the Space Systems Engineering and Space Systems Operations curricula." The SSAG guides the graduate education of those NPS students who will become the military's future space professionals by coupling NPS space research efforts with the education of these officers in ways that range from relevant course work to work in small satellite laboratories to helping determine mutually-beneficial topics for thesis research.

With the promise of 18 months of data from onboard experiments, NPSAT-1 has much to offer in the way of future support of SSAG students — but it is far from the only source of research and data available to NPS students working in the realm of space sciences and operations. A close look at current work happening in the SSAG reveals myriad other ground-breaking projects underway, many specifically designed to address potential challenges posed by the changing uses—and increasing militarization — of space.

The shift toward militarization is worldwide, as exemplified over the past year by events such as a demonstration in which India shot down its own satellite and the release of a Defense Intelligence Agency (DIA) report detailing China's strengthening of its military space capabilities. The president has answered these growing threats with a recent call to stand up a Space Command headed by Air Force Gen. Jay Raymond.

"Space is vital to our national security, and our adversaries know this," Raymond said. "We need to compete, deter and win." NPS is well-established in this critical area, ready to address emerging military challenges with cutting-edge academics, research and well-educated graduates.

Students and professors in the SSAG are engaged in research on multiple fronts when it comes to the use of space for military purposes. As such, the group is uniquely positioned in such a way as to connect students developing forward-thinking technologies with researchers and professional staff who have the knowledge and skill sets to guide these projects from idea to prototype, through testing to eventual development.

The work of three recent NPS graduates — Marine Corps Maj. Jason Kozak, Capt. Dillon Pierce, and Maj. John Pross — offers excellent insight into how the SSAG fosters research with real-world applications at the forefront of modern military concerns. The thesis research these three Marines conducted encompassed multiple theatres of operation — terrestrial, near-space, and space — and offered practical designs for solving issues they identified using acumen gained over the course of their military careers.

From the Earth to the Sky and Beyond — Extending the Theatre of Operations

The questions at the heart of these Marines’ research have varied origins, but all have at least one thing in common: they took inspiration and built necessary skills for their projects in a course focused on payload design. As SSAG students, they took part in a payload design sequence which provides a practical, hands-on approach to teaching spacecraft design. Students design and test payloads that will be housed on buses provided as part of the course. Faculty Research Associate Dr. Giovanni Minelli describes these buses as “the stuff that makes the satellite (or, in this case, payload) work, such as solar panels, batteries, radios, etc.,” while the payload is “the thing that’s doing the experiment and/or getting the mission done.”

In the payload design sequence, students test their payloads via launch and flight on high-altitude balloons (HABs). These large latex weather balloons can carry student payloads to a desired altitude, including even to near-space — the area from roughly 20km-99km above sea level — where the payloads are then tested, perform experiments and gather data before (hopefully) being successfully returned to Earth for student collection, inspection, and possible repair and/or re-use.

It’s a unique and challenging sequence, as confirmed by Senior Lecturer in Space Systems Dr. Wenschel Lan.

“It’s not done very often in other curricula or in other schools because it is hard to build a spacecraft payload in an academic quarter, which is only three months. But I think that’s where NPS has a really unique set of students that are capable of doing that,” explained Lan. “They’re more mature, they’re better at managing their time, and we have engineers that support hands-on projects like these in our Space Systems curricula. And having that mindset for accelerated learning — because they have fleet experience — means that they’re capable of putting something together, usually in a short amount of time.”

The experience helped shape Maj. John Pross’ payload research, which focused on providing communications in a contested environment. Armed with the knowledge that SATCOM’s (the system of satellite communications responsible for most electronic and radio communications) underlying architecture is vulnerable to multiple lines of attack and interference, including jamming and the use of directed energy weapons, Pross set about addressing the fallout of such a situation.

In the face of this growing probability of interference with SATCOM, Pross designed a payload with the power to provide service as a short-duration radio relay — essentially reestablishing communication between units for long enough to issue crucial orders and coordinate response efforts. Using mostly commercial, off-the-shelf (COTS) technology, Pross’ payload consists of a single board computer (in this case a Raspberry Pi 3B+, or rPi 3B+), a software defined radio (SDR), a low pass filter (LPF), and two ½ wave dipole antenna.

The use of SDRs has proved popular among SSAG researchers. SDRs offer radio communications via a system wherein components traditionally implemented in hardware — such as filters, amplifiers, mixers, modulators, etc — are instead actualized by means of software (this can be accomplished either in an embedded system or on a personal computer [PC]).

The replacement of hardware with software gives SDR a major advantage, as it allows for over-the-air or remote reprogramming, as well as for bug fixes that can be conducted while the radio is in service. This is especially valuable when it comes to space and satellite operations, as problems can be addressed while systems are in orbit (a previously difficult, if not impossible, feat).

In Pross’ payload, the SDR works similarly to a traditional transponder: As it begins its post-deployment descent, it receives VHF transmissions from one user (uplink), then simultaneously retransmits that signal over a UHF frequency to another user (downlink). The presence of the LPF protects the SDR circuitry while also reducing noise in the receive signal by limiting the energy detected by the uplink antenna.

While the SDR is integral to the overall mission, it requires a computer, the rPi 3B+, in order to execute commands, run configuration software and provide the necessary power for signal processing. About the size of a credit card and retailing for around \$35, their narrow size and cost footprint make these single board computers popular in the SSAG’s small satellite laboratory, and they have been integrated into many CubeSats and other payloads.

Fully assembled and deployed, the entire payload weighs in at less than 1.8 kilograms and has the power to provide beyond line of sight (BLOS) communications for personnel separated by distances as far as 600 miles. In order to attain these communications, however, the payload must reach altitudes that would require precious time if deployed via HAB. In an effort to shave down the estimated 1.5 hours necessary for a HAB to reach the appropriate altitude, Pross turned to the work of fellow Marine Capt. Dillon Pierce.

Getting a Boost — Sometimes It Is Rocket Science

As it turns out, both Pierce and Pross had identified an operational need, a possible solution and an existing ability within the Marine Corps to carry out the proposed solution with minimal additional training. A high-powered rocket could deliver the payload to operational altitudes within minutes,



I am convinced that in the future, if we get into a conflict ... We are going to have to fight for space superiority.

— U.S. Air Force Gen. John “Jay” Raymond, Commander, U.S. Space Command

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and while the Marine Corps does not traditionally train personnel to operate satellites, they do have what Pross describes as “an abundance of qualified explosives handlers and operators who can launch a rocket.”

Seeing the utility of a high-powered rocket program for both NPS and the Marine Corps, Pierce consulted SSAG Chair Dr. James Newman, who agreed to advise Pierce through a sequence of directed studies. Over the course of only two quarters, these studies led Pierce through the process of not only building and modifying a series of ever more complex and powerful rockets, but also through the civilian certification necessary to launch, and thus test, these rockets.

In just one year, Pierce achieved his level one, two and three certification by the Tripoli Rocketry Association (TRA), as well as the required Explosive Handler requirements necessitated by the propellants used at this level. Level three is not your childhood rocket kit: at this level, motors used range in total impulse from 5,120.01 – 40,960.00 Newton-Seconds, using Goex 4F black powder for the ejection charge and potentially providing for sub-orbital delivery of payloads like Pross’ to altitudes of 150,000-200,000 feet.

SSAG member Associate Professor Dr. Chris Brophy, who works in NPS’ Rocket Propulsion Laboratory (RPL), was present for one of Pierce’s launches and confirms both the degree of difficulty and the accelerated pace of Pierce’s progression to level three certification.

“He was doing this on his own, and got his level three certification within a year — he was pretty quick ... he’s a go-getter.” said Brophy. “He was launching motors that will generate 800, 1,000 pounds of thrust. Once you hit that level of thrust, that’s the size motors that we (at the RPL) work with...He’s doing real rocket science — and he makes great rockets.”

But how does a “great rocket” pass level three certification? To do that, Pierce was required to fly a rocket “substantially” built by himself, with the

design and construction of that rocket documented (again by Pierce). The rocket must also employ a recovery technique that utilizes electronics to deploy a parachute and facilitate recovery of the rocket, which is then subjected to a post-flight inspection for any disqualifying “flight induced damage.”

Pierce’s design was equipped with two independent, redundant ejection systems and used a dual-deployment technique (a more complex recovery technique that requires electronic sensors with the ability to detect a rocket’s altitude and deploy the appropriate parachute). Also included were a custom-built sensor package and flight software similar to that built and used to capture accelerometer and gyroscope data during Pierce’s previous certification launches — data used to characterize the rocket’s flight.

Like Pross, Pierce used a Raspberry Pi for his main computer, although his data processing and storage needs were better met by the Zero W model. In addition to the rPi, the custom-built sensor package contained an analog accelerometer able to measure large g scale forces, an analog-to-digital converter, a gyroscope (to determine how the rocket was twisting and turning), a battery pack, and a linear regulator to step down the voltage provided by the battery pack to a voltage acceptable for the rPi.

For his level three certification rocket, Pierce added a barometric sensor, camera and GPS module to the custom sensor package, and configured the rPi for the establishment of an ad-hoc wireless network, allowing for wireless SSH (Secure Shell) communications with the rPi — both during development and once it was placed inside the rocket. With help from the SSAG’s machine shop, a custom-made electronics bay was designed and 3D printed for the rocket’s assembly.

All told, Pierce built five rockets and completed six launches during his time at NPS, tirelessly studying the data from each and utilizing it to make improvements to his creations, and to redesign and build new ones when appropriate. Despite the unplanned, rapid disassembly of the rocket carrying Pross’ payload at Mach 1.5 during a test flight (it is rocket



Recent Space Systems graduates U.S. Marine Corps Capt. Dillon Pierce, Maj. John Pross, and Maj. Jason Kozak, from left to right, each pursued a unique, self-identified thesis topic addressing operational capability in multiple theatres of the space domain — terrestrial, near-space, and space.



science, after all), he and Pross both graduated having successfully completed a “proof of concept” of their respective projects, and Pierce’s final launch successfully reached 40,000 feet. Additionally, the two leave NPS with a burgeoning high-powered rocket program that they hope will continue to grow as a way to augment the delivery of crucial communications payloads to near-space altitudes.

Getting a Closer Look (Even in the Dark of Space)

While Pierce sought out new ways to propel payloads like Pross’ into near-space, another Marine in the small satellite lab was working on a payload destined for orbit. Working in tandem with researchers tasked with designing and developing a bus at the Air Force Institute of Technology (AFIT), Maj. Jason Kozak joined Dr. Wenschel Lan and Associate Professor of Physics Dr. Fabio Alves in developing a payload specializing in terahertz (THz) imaging.

For this portion of their research, the group’s focus is specifically on imaging within the terahertz band, which exists between the infrared and microwave bands in the electromagnetic spectrum (one terahertz is 10¹² hertz, or 1000 gigahertz). In order to accomplish this, the research team of the Sensor Research Laboratory has developed a terahertz imaging camera by modifying a COTS long wave infrared camera in such a way as to image the 0.3 THz to 10 THz portion of the band.

Electromagnetic energy enters the camera via a specifically manufactured lens, which in turn filters out what Kozak describes as “almost all energy except energy within the terahertz band.” The camera creates an image of this energy via the use of a silicon nitride material on the focal plane array, which possesses limited sensitivity to terahertz radiation. This limited sensitivity is sufficient to absorb enough energy to complete the imaging process.

This imaging should provide researchers with new information on the upper levels of the atmosphere in the terahertz band, allowing them to learn more about those levels while simultaneously offering a view of colder objects (on the order of about 60-80 Kelvin), both manmade and otherwise, that have been heretofore invisible to other cameras or out of the sun’s illumination.

This information has incredible value for space operations and exploration, as it will provide what Kozak terms “better situational awareness in the space domain.” Aside from the location of debris (which can be dangerous to orbiting satellites, space stations and vehicles), terahertz imaging could also be useful in conducting satellite inspections, using information related to temperature to provide data regarding the health and function of orbiting satellites.

Kozak, working with Lan, was tasked with integrating the imager into a small satellite that will be compatible with AFIT’s bus and its primary payload and mission (the NPS team’s payload will be a hosted, secondary payload). This integration included the hardware necessary for a connection with the camera that would allow for the successful transfer of power, data and images; it is also one place where Kozak sees room for the next student to work on the project to cut costs and boost efficiency by finding ways to reduce the size, weight and required power of the payload.

Passing the Baton

Taking a project to the next step and setting up the next person for success is standard operating procedure for those who study in the SSAG. Each officer credits those who came before for their work, and — like Kozak — each professes their hopes for where their own successors might take the research that they are handing off as they graduate. For Pierce, this means the transition away from solid propellant to the use of liquid engines for future HPR work conducted at NPS. For Pross, this means a higher-altitude demonstration of his payload, and the possibility of eventually modifying the system to accommodate data transfers, Wi-Fi, or even cell phone communications.

As Kozak describes, “In the SSAG, we hand the ball off to the next individual. It’s a run game, you know — it’s not a Hail Mary to the end zone; you grind away at the problem, you hand your progress to the next student, and they continue the effort inch by inch.”

The work of these three recent Space Systems Operations graduates showcases this rigor even as it highlights both the innovative research happening at NPS and how the SSAG is uniquely constituted to foster and support that innovation. As the world once again turns its attention to space, with increased exploration and research sponsored by both governments and private interests from countries around the world, the militarization of space has moved from distinct possibility to accepted reality.

In the SSAG, NPS finds itself singularly positioned to meet the challenges these new directions will pose, and to provide officers educated in space systems operations and engineering and well-versed in how the solutions to these challenges will be accomplished, as well as how the next phase of this country’s engagements of space will need to unfold. The research coming out of the SSAG offers proof positive that NPS graduates are taking this engagement seriously and conducting research that tackles the many facets of how it will play out moving forward.

On the operations side, considerations abound—not the least of which regards the prioritization of information transfer once the payloads are orbiting and collecting data. Kozak is quick to point out that the SSAG provides a wide variety of resources for students looking to meet these challenges, including access to highly qualified, expert faculty, a first-rate machine shop with skilled technicians to assist with the computer-aided design and the fabrication of additional metal pieces to complete student payloads, and a core group of four engineers employed by the SSAG who have amassed decades of personal, professional and institutional knowledge.

Perhaps Associate Dean of Engineering and Applied Sciences Col. Tim Sands sums it up best: “What is different about us is, we’re the ‘do it’ school- you can’t leave here with our pedigree unless you did it. You built it. It worked. You’ve got to do it.”

As these three Marines move on to their next assignments, they take with them the expertise gained from this doing, while also leaving documentation of their contributions behind so that the next officers to inhabit the SSAG’s labs can take their hard-earned knowledge to the next level of research, development and applications. **IR**



NPS students and faculty discuss one of several wargaming scenarios executed during the latest iteration of 'Wargaming Week,' the culmination of an 11-week course in wargaming applications. Drawing on extensive research, sponsor interaction, and military experience, the students designed, developed and executed eight different wargames directly related to sponsor issues.

Student-led Wargaming Offers Insights, Analyses into Future Conflict

By Matthew Schehl

The U.S. stands at the brink of war with a peer adversary, and Navy and Marine Corps leaders need to figure out how to best position our forces and interoperate with our allies in the Australian Defense Force (ADF) to answer the call.

Nearby, another team of military officers examines a future conventional conflict scenario with a focus on better understanding how the skills and capabilities of Marine Raiders can best be applied to the objective.

These are just two of several future scenarios, and to be sure, each comes with a host of questions to be answered. But that's exactly the point of the Naval Postgraduate School's (NPS) 'Wargaming Week,' and these are the sorts of critical issues NPS students work through in rigorous detail during the annual activity organized by the NPS Wargaming Activity Hub.

Held twice a year in June and December, Wargaming Week is the

culmination of an 11-week course in wargaming applications. Drawing on extensive research, sponsor interaction, and their own considerable military experience, the students designed, developed and executed eight different wargames in this latest iteration — classified and unclassified — to dive deep into a range of technical and conceptual aspects of these scenarios.

"That's fundamentally the most important thing we're doing. We're teaching students their business, and their business is warfare," noted legendary naval strategist Dean Emeritus Wayne Hughes, a retired Navy captain who literally wrote the book on naval tactics and operations - his seminal work "Fleet Tactics" is widely considered the go-to resource for Navy officers on battle planning and tactical thinking.

"NPS is unique in its ability to teach the technology, the tactics, the operations, the logistics, the policy and the strategy of Navy and Marine Corps operations," Hughes added.

Although the eight wargame scenarios differed, they all took place in the INDO-PACOM AOR. In the Navy's Small Combatant Flotilla wargame, Hughes himself took the helm as the blue forces commander tasked with delivering supplies from Guam to the area of operations.

"The scenario represented our response to a near-peer threat to prevent us from logistically sustaining the forces and Marine advanced bases that were in the first island chain," he recalled. "[Marine Corps] Maj. Josh Faucett, who led the wargame's organization and referee team, was superb in everything he did; it was a very useful exercise."

The takeaway? The adversary's commander performed with an effectiveness that was "a significant concern" to Hughes. But that's the point: unlike automated computer simulations which might describe optimal performance, analytic wargames like these force participants to engage in a very human activity — decision-making — in the context of a complex and structured environment. Moreover, they allow players to make critical mistakes and learn from them.

"Wargaming is one of the most effective means available to offer senior leaders a glimpse of future conflict, however incomplete," then-Deputy Secretary of Defense Bob Work and Gen. Paul Selva explained in a 2015 War on the Rocks article.

Wargames, they said, present an opportunity to test new ideas and explore the art of the possible. They help us imagine alternative ways of operating and envision new capabilities that may prove decisive on future battlefields.

NPS has excelled at bringing this capability to the Department of Defense (DOD) for over three decades.

"NPS is one of the very few institutions that has a robust wargaming education program to bring wargaming to the forefront and produce experienced wargaming practitioners that senior leadership can leverage," said Dr. Jeff Appleget, Wargaming Activity Hub director and senior lecturer in the OR department.

"The great benefit of the wargaming course is it matches student teams with a DOD or defense partner sponsor who has a real-world problem," he continued. "Their problems aren't articulated in terms of 'use this tool to solve this problem,' but rather, 'I have a difficult problem and help me understand how to solve it.'"

This year's iteration includes sponsors from the Marine Corps Warfighting Lab, the ADF, Marine Corps Forces-Pacific, Marine Corps Special Operations Command, and U.S. Army Pacific.

In the second week of the course, student teams are formed and matched with the sponsors who pose a question or issue they need answered, and it's off to the races. For the next five weeks, the students learn about wargaming as they get hands-on experience designing the

foundations of their sponsor's wargame. After week six, the teams intensely focus on designing, playtesting, and redesigning their sponsor's wargame to ensure it addresses the sponsor's problem.

"The idea is that up until their fifth quarter, students have learned a lot of high-level techniques like mathematical programming and advanced statistics, but when they graduate they're going to have to apply these tools in a military context," Appleget explained. "The wargaming sponsors pose very fuzzy problems that are not clearly defined, and understanding and refining those problems is something students typically don't practice when they're learning to apply a specific tool such as linear programming."

The process is win-win ... Sponsors receive critical input to inform key decision-making. And the students gain invaluable experience melding their military backgrounds and skill sets obtained at NPS into a specific challenge before returning to the operational world, where they will apply this knowledge as OR analysts.

For ADF Lt. Col. Andrew Middleton, Australian liaison officer to the U.S. Marine Corps and sponsor of the ADF-USMC interoperability wargame, the ability of Marines and Australians to work side-by-side is a paramount concern. The American and Australian militaries have a long history of working together, but the nuts and bolts of keeping this a practical reality down the line can be daunting ... Their different

gear, weapons platforms and training are matched by differing cultures, even language in some context.

“That’s fundamentally the most important thing we’re doing. We’re teaching students their business, and their business is warfare.”

Dean Emeritus Wayne Hughes
retired Navy captain

"We looked at one of our four primary focal areas in our bilateral service interoperability plan, our digital fires system, and I engaged with the students for a number of months," he said.

"This enabled us to pull in the required subject matter experts from Australia and the Marine Corps to really tease out the interoperability problems and have robust discussions to identify capability gaps and risks that we can take back to our respective services and ensure that we can rectify those through future acquisitions, training and exchange programs," Middleton continued. "[The wargame] was very well executed and achieved the outcomes that we desired."

Middleton is not alone in this assessment. Since the Wargaming Activity Hub was stood up in 2014 to meet a surge of interest in wargaming across the military, feedback from sponsors has been unequivocally "tremendous," according to Appleget, with sponsors frequently requesting follow-on wargames with future classes.

"The sponsors are impressed with the quality of the wargames because they rival wargames that their commands have paid money for from other folks," he said. "They're typically amazed by the amount of information they get out of a game; that NPS students can come up with such a great quality product." ■



For more than 20 years, the Naval Postgraduate School's home-grown, innovative Autonomous Ocean Flux Buoy has braved some of the Earth's harshest environments in support of student research and scientific discovery.

A Legacy Under the Ice

For more than 20 years, the Naval Postgraduate School's home-grown, innovative Autonomous Ocean Flux Buoy has braved some of the Earth's harshest environments in support of student research and scientific discovery.

By Dr. Jessica Neasbitt

In September of 2019, NPS Emeritus Research Professor of Oceanography Tim Stanton will travel to the Arctic as part of the largest expedition in human history to study drastic changes in sea ice throughout the region. While there, Stanton and his NPS colleague Bill Shaw will deploy four autonomous ocean flux buoys (AOFBs), joining more than 600 participants from 17 countries in the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) in “the first year-round expedition into the central Arctic exploring the Arctic climate system.”

While a mission like MOSAiC would be considered a once in a lifetime opportunity for any scientist or researcher, the journey is not the first of its kind for Stanton, who has been conducting scientific expeditions and research in the region for over three decades. In fact, the trip will bring his work back to the Arctic ice he dangled a prototype instrument pack through 22 years prior — a prototype that would evolve, over the next two decades, into the current design of the AOFBs that will be deployed as part of MOSAiC.

At its heart, Stanton's AOFBs are the quintessential NPS story — a story of innovation, research and development occurring in answer to real-world necessity. It is a story of the continuous improvement and evolution of specially-designed tools, and the experimentation and knowledge those tools enabled, the student fieldwork and research they created and contributed to, the data they provided, and the myriad scientific and academic projects they supported. To track the AOFB through its many incarnations and uses is to see science in the making, and NPS functioning in accordance with its highest purposes and directives.

Read the complete history of Stanton's innovative Autonomous Ocean Flux Buoy, its evolution in the face of discovery, and the impactful research it has supported online. **IR**



NPS Researchers Play Leading Roles in Massive Arctic Study

By Dr. Jessica Neasbitt

The largest Arctic expedition in human history — the Multidisciplinary drifting Observatory for the Study of Arctic Climate (MOSAiC) — is scheduled to depart Norway on September 19 with two NPS professors serving in key roles in the planning and execution of the year-long undertaking.

NPS Department of Oceanography Research Professor Emeritus Tim Stanton and Research Professor Wieslaw Maslowski join more than 600 participants from 17 countries in this historic expedition to explore, better understand and model the Arctic climate system, with Stanton set to sail on the first leg of the expedition.

Maslowski, who helped to shape the project's science and implementation plans, also sits on its executive committee board as a co-lead for the modeling component of MOSAiC. Improved climate modeling and prediction is a focal point of the expedition, and, as Maslowski explains, "a majority of the effort within MOSAiC's observational component is a contribution to advanced understanding and more realistic model simulation of Arctic climate for the past, present and prediction of the future."

MOSAiC has been carefully designed to make this contribution by collecting continuous year-long data, courtesy of an icebreaker — the Research Vessel (RV) Polarstern — as well as an assortment of observational sites established on the Arctic ice within 50 km of the vessel. The Polarstern will enter the Siberian side of the Arctic in late September of 2019, freeze into a floe of multi-year ice, and then drift with the pack ice towards the Atlantic over the course of the year.

Gathering 12 months of continuous Arctic data will help scientists address one of the biggest challenges to improving polar climate models: the lack of sufficient, year-long observational data capable of illustrating how particular ocean and atmospheric processes and exchanges are contributing to the earth's rapidly changing Arctic and global climate. Maslowski stresses the uniqueness and importance of this data in determining the effects of changes in the Arctic on the rest of the globe.

"An improved representation of the Arctic region in [the] global climate system will lead to a better understanding and prediction of how [the] Arctic interacts with and affects the rest of the global weather and climate," he said.

One of the vessels that will assist the Polarstern during MOSAiC is the Akademik Federov, a deployment icebreaker set to accompany the Polarstern on the first leg of its journey (from Tromsø, Norway into the Arctic). Over the course of the 45-day journey, Stanton — one of the primary investigators (PIs) participating in MOSAiC's overall efforts — will be onboard the Federov, teaching oceanography to 20 competitively selected early career scientists as part of MOSAiC's exclusive educational component.

In addition to oceanography, Stanton will also be instructing the school's participants in the preparation and deployment of the four autonomous ocean flux buoys (AOFBs) that will be deployed in support of the expedition. These AOFBs, designed and built by Stanton at NPS, will collect data that researchers will use in order to discern how changes within the upper ocean affect the sea ice. They will also measure energy from the

ocean escaping through cracks in the sea ice and offer insight into how this might affect the regional atmosphere, including warming that atmosphere at an accelerated rate.

This data is key to the completion of MOSAiC's overall mission, as Maslowski explains.

"From the beginning, this program has been designed for making observations for the very particular purpose of improving [coupled ocean-ice-atmosphere] models," he said. "If you read the science plan, if you read the implementation plan, the whole science objective is based on what improvements in climate models are needed, and what measurements and what knowledge is missing that is necessary to improving those models."

MOSAiC is set to offer these improvements with a complete characterization of physical and biogeochemical interactions over the seasonal cycle, including the important "shoulder seasons" — the transitions between the melt and freeze-up seasons — for which observations are even more limited. By filling in the gaps of previously seldom measured and poorly understood Arctic processes, MOSAiC will be poised to offer a once in a lifetime opportunity to dramatically advance Arctic modeling capability. Such advancements will include both improvements of existing model representation of the operation of the Arctic climate system (by offering unique and comprehensive observational data for model evaluation and testing of more realistic parameterizations) and the development of new, more accurate models, in which the knowledge of processes and exchanges advanced by MOSAiC's data will be explicitly resolved.

The data gathered during MOSAiC holds the key to future process studies in a diverse array of scientific fields, and will benefit scholars working in disciplines both within and outside of climate studies. As the nation and the Department of Defense continue to assess and plan for a wide range of impacts and risks of climate change, Maslowski and Stanton's work with the project puts NPS, and its students and faculty, at the forefront of this effort. **IR**



NPS Department of Oceanography faculty Drs. Wieslaw Maslowski, left, and Tim Stanton, right, are integral contributors to a landmark study poised to be the largest Central Arctic climate study ever.



Lt. Sephora Fortune, a 2019 graduate of NPS' financial management program, shows a proposal of the Rose L. Fortune Faith Outreach Ministry she looks to rebuild in Mt. Charette, Haiti. Fortune's mother led a mission and orphanage in the same location until 2016, when Hurricane Matthew destroyed the modest facility.

NPS Alumna to Use Education, Career Intermission for Higher Calling

By MC2 Patrick Dionne

Lt. Sephora Fortune served as a Nuclear Officer aboard the USS George Washington (CVN 73) when it responded to Haiti in the aftermath of Hurricane Matthew. She shared a much more personal connection to the tragedy than the majority of her shipmates.

"I am originally from Atlanta, but both my parents are from Haiti," said Fortune. "My mom ran a ministry in the area where she grew up that includes a school and an orphanage."

Fortune feared the widespread damage likely impacted the school and orphanage her mother led ... Indeed, her fears were realized. Her mother was able to rebuild a simple structure that would at least keep the children out of the elements, but Fortune was compelled to do more, and found herself in a struggle pulled between her call to serve in the Navy, and a desire to help her family's native Haiti.

"All that had happened in Haiti rejuvenated my passion to help," she said. "Originally, my initial goal was to do my first term in the Navy

and then get out and return to Haiti to serve. Over time, though, I recognized my calling was to continue to serve in the military ... I decided to stay in and save enough money up to send it back to help rebuild.”

A year after the hurricane, Fortune’s mother suffered a stroke making it difficult for her to manage the rebuilding effort, which by then was just the temporary structure to house basic services for the displaced orphans.

Due to her mother’s struggles, Fortune recalled her time on the George Washington where she first learned of the Career Intermission Program (CIP). The program allows active duty service members the ability to take up to a three-year sabbatical and transfer into the Individual Ready Reserve to address personal challenges or opportunities Sailors may experience in work and life.

“While at NPS, I applied for the program and was approved,” said Fortune, who graduated from the university’s Graduate School of Business and Public Policy in early 2019. “I can now devote full time to my mother’s ministry work in Haiti.”

During her sabbatical, Fortune will begin fundraising, and oversee the design and construction of a new development center in Mt. Charette, Haiti that will include a school, an orphanage, and a medical center where her mother’s former ministry once stood.

“This is a multimillion-dollar project that is more of a sustainable grade, and it is much bigger than I could have ever imagined,” said Fortune. “With my newfound business and financial knowledge and skills I acquired here at NPS, I can help shape my understanding of this project into not just a goal, but reality.” **IR**

Learn more about Lt. Sephora Fortune’s story on the NPS YouTube channel



NPS Launches Campus-wide Course in Great Power Competition

By Javier Chagoya

The Naval Postgraduate School’s (NPS) Department of National Security Affairs (NSA) has launched an initiative to help students from every curriculum better understand the history and nuances behind Great Power Competition (GPC).

NS4000 held its first open lecture on the first day of the Summer quarter, July 8, to a packed auditorium on hand for the seminar-style, one unit course intended to provide a broader understanding of the challenges facing the U.S. in the 21st century by peer adversaries.

NSA Department Chair Clay Moltz took lead on developing the course, providing leadership with a proposal outlining the essential elements. It was reviewed by NPS’ academic council and given the green light to be organized as a one-credit course.

NSA Professor Daniel Moran opened the inaugural lecture with his brief overview of the underlying dynamics of GPC historically, its Cold War manifestations in the bipolar arms race, and what has changed in the new century. Moran’s expertise includes modern international and military history, strategic theory and he’s an authority on the works of Carl von Clausewitz.

Moran is one of 14 NSA expert lecturers who will examine the political, economic and military drivers that have contributed to this current security environment. Over the next three months, lectures will discuss Chinese and Russian efforts to extend their influence into critical regions of the world, as well as the challenges this behavior poses to U.S. interests. The course will later focus on GPC dynamics in several key functional areas, such as economics, cyber, space and energy. Finally, the course concludes with a discussion of possible future outcomes in the context of varied U.S. and allied responses.

On hand to introduce the new course, Moltz explained the importance of understanding American adversaries’ race for influence and superiority around the globe.

“Just within the last five years, Chinese revisionism and Russian revanchism have posed a series of threats to the U.S. and to our allies,” said Moltz.

He pointed to the recent decision in China to remove its constitutional two-term limit for the presidency, clearing the way for Xi Jinping to rule beyond 2023, a move which came as a surprise to the world, Moltz noted. He also discussed similar aggressive actions and policy changes in Russia that could provide Vladimir Putin with an opportunity to serve a fourth term, setting the stage for the discussions to follow.

NPS Professor Daniel Moran holds the first of 20 lectures, July 8, for an all-new course seeking to advance the NPS student community’s understanding of the history and nuance of Great Power Competition (GPC). Responding to a direct leadership request to integrate more GPC studies into its curriculum, the university launched the course open to all interested students, faculty and staff.





U.S. Marine Corps Lt. Gen. Michael Dana, center, observes one of several presentations during Joint Interagency Field Experimentation 19-4. Dana observed several experimentation programs during his visit to the NPS Field Laboratory, and offered some words of advice to several Marine students participating in the program.

Academia, Industry Partnerships Advance Capabilities at Latest JIFX

By MC2 Nathan K. Serpico

Exercising its strong partnerships with military, academia and the private sector, the Naval Postgraduate School (NPS) hosted more than 230 leading technology experts to test and evaluate solutions to 21st century challenges during its Joint Interagency Field Experimentation 19-4 (JIFX) event, Aug. 5-9.

Experts from private industry, government agencies and top universities converged at the NPS Field Laboratory, located at the California National Guard's Camp Roberts, to explore new ways to adapt rapidly changing technologies to a host of DOD-relevant domains, including autonomy/machine learning, autonomous systems, intelligence, surveillance and reconnaissance (ISR), and command and control systems.

Over the week-long event, the participants conducted various field experiments to research ways both emerging and existing technologies might be adapted to meet military requirements. For example, teams using unmanned aerial systems (UAS) were able to experiment with those systems completing 67 total sorties unencumbered by FAA regulatory frameworks.

According to Dr. Ray Buettner, JIFX director and NPS associate professor of Information Sciences, JIFX is a unique partnership event in the sense that it is not about immediate acquisition. Instead, it's about learning fast, he says, helping to identify commercial and laboratory capabilities that may be transitioned to military applications.

"JIFX creates a multi-institutional, semi-structured learning environment for collaboration across the different communities – academic, military and commercial," said Buettner. "The hope is that we help industry connect to a better starting point into the acquisition process, while at the same time we build up our understanding of where the cutting-edge capabilities are so we can rapidly respond to the technology requirement of the force."

The important benefits of JIFX manifest in multitudes of ways, Buettner says, such as opening doors for new technologies that have a direct impact on the warfighter. In Nov. 2015 at JIFX 16-1, for example, a private sector company introduced a small personal reconnaissance system that sparked interest among DOD stakeholders. Less than four

years later, the system is in operation providing enhanced situational awareness for warfighters.

“Through JIFX, we get greater exposure to our government customer community and deep, open feedback from government stakeholders,” noted Dave Merrill, Co-Founder and CEO of Elroy Air, a small Silicon Valley-based UAS/autonomous logistics startup currently in a Cooperative Research and Development Agreement with NPS. “The continuous experimentation and on-site work happening throughout [the event] makes for a productive way to get to know gov-

ernment stakeholders without time pressure and without being ‘on the record’ in the way that a phone call or a more formal meeting would entail.”

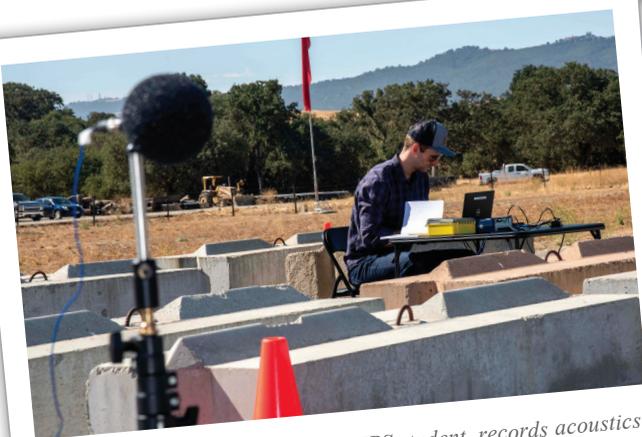
The experimentation, innovation and collaboration with industry that occurs at JIFX are just a few of the many examples of how NPS is answering the call of Secretary of the Navy Richard V. Spencer to leverage partnerships across government, industry and educational institutions, as well as contributing to emerging fields critical to national defense. **IR**



A member of the Elroy Air team moves their experimental aircraft back to the hanger after inspections. Through a Cooperative Research and Development Agreement with Elroy, an NPS student in logistics management is getting a first-hand look at the company's development of an unmanned cargo aircraft successfully flown at JIFX.



Members of the Special Technologies Lab team perform preflight inspections on their Sandstorm fixed-wing aircraft during Joint Interagency Field Experimentation 19-4 at the NPS Field Laboratory, located at the California National Guard's Camp Roberts, Aug. 8.



U.S. Navy Lt. Austin Fleming, an NPS student, records acoustics on the McMillian Airfield runway during Joint Interagency Field Experimentation 19-4 at the NPS Field Laboratory at the California National Guard's Camp Roberts.



Members of the Special Technologies Lab team monitor computers during Joint Interagency Field Experimentation 19-4 at the NPS Field Laboratory at Camp Roberts. The FX program exists to provide an opportunity for NPS faculty, students, private companies, and academia to demonstrate and evaluate new technologies related to the Department of the Navy and the Department of Defense research in an operational field environment.



Marine Corps students from the Naval Postgraduate School who presented research at the latest Big Ideas Exchange (BIX) gather outside the campus' Mechanical and Aerospace Engineering Auditorium, May 16. The BIX brings forward new and potentially game-changing thinking developed by NPS faculty and students to address grand challenges in American national security.

Big Ideas Exchange Seeks Tactical Edge to Address Marine Corps Challenges

By MC2 Patrick Dionne

The U.S. Marine Corps at the Naval Postgraduate School (NPS) hosted the university's latest Big Idea Exchange (BIX) presenting and discussing their cutting-edge research and ideas with a greater Navy and Marine Corps audience, May 16.

"The Big Ideas Exchange is the forum to connect our research to the decision makers," said Col. Todd Lyons, then NPS Senior Marine Corps Representative and Associate Dean of Research. "This forum really allows our students to tailor the hundreds of pages of work they're doing down to a digestible format in which they can communicate effectively. It's critical that our ideas don't just stay inside the halls here at Monterey, but rather head out to the fleet where they can impact the greater Navy and Marine Corps."

The central theme for the Marine Corps-centric BIX was "Empowering commanders at the tactical edge." Brig. Gen. William J. Bowers, President of Marine Corps University, and NPS President retired Vice Adm. Ann Rondeau attended the students' presentations and engaged with the participants on their ideas.

Students presented research that examined several diverse areas including how the weight of a combat load impacts the survivability of the warfighter, the use of block chain to improve logistics, and the use of a rocket delivered communications relay.

Marine Corps Capt. Brittany Snelgrove, a student from the NPS Department of Computer Science, looked at utilizing blockchain technology to speed up and improve logistical systems operations.

"I am a logistics officer by trade, and throughout my career I've been curious how we can improve connecting and authenticating logistical systems users to better distribute our supplies," said Snelgrove.

Also presenting was Capt. Sean Noll, a student from the Defense Analysis department, whose presentation, entitled "Gospel, Opinions and Data," focused on leveraging data to make better decisions regarding training and equipping Marines.

"We live in a day and age where we can collect and use more amounts of data than previous generations," said Noll. "Using that data in our decision-making process on how we train, man and equip our force can now provide a better foundation than the foundation that used to be based on just opinions or observations."

Noll expressed that not only was the presentation a good idea to explore concepts, but it was also essential to sharpening his thesis research, as it helped him challenge his current viewpoints and refine his arguments.

According to Lyons, students who fielded questions about their projects provided an invaluable opportunity to help solidify and test their ideas.

“The incredibly positive reception from the audience and the insightful questions they asked really extended the knowledge of the presentation to the next step and question of ‘how do I do more?’” said Lyons. “This collaboration elicits passion for both the chance at future work, but also the opportunity from General Bowers and from President Rondeau

to do something about it now, and that’s really where the rubber meets the road.” **IR**

Watch all five Marine Corps students’ complete Big Ideas presentations on the NPS YouTube channel.



Senior Leaders in Acquisition, Logistics Highlight Summer SGLs

By NPS Public Affairs

Two of the Department of Defense’s leading experts on equipping the force, and projecting that power worldwide, shared their views on the future of acquisition in the DOD in the face of Great Power Competition during separate offerings of the Secretary of the Navy Guest Lecture series this quarter.

U.S. Army Gen. Stephen R. Lyons, Commander, U.S. Transportation Command (USTRANSCOM), a Naval Postgraduate School (NPS) alumnus, discussed his views on logistics and power projection to university students, faculty and staff, July 23.

Beginning his remarks, Lyons recalled the value his NPS experience has provided throughout his career since graduating in 1993 with a master’s degree in logistics management.

“To this day, the tools I received at that particular time of my career are what I still keep in my toolbox today,” said Lyons. “I still think about complex problems using the set of tools that I walked out of here with 26 years ago.”

Since taking command of USTRANSCOM, Lyons underscored changes in the national security environment due to nations like China and Russia creating separate regional challenges that when combined affect logistics globally.

“In the past, [USTRANSCOM] had the luxury to operate and plan with impunity,” said Lyons. “Now there are discussions about contested environments to understand how the adversary looks at this strategic comparative advantage called power projection.”

Ultimately, Lyons surmised, thinking logistically is about maintaining strategic advantages.

“The fundamental purpose of logistics in our armed forces reflects our ability to project sustaining combat power globally at our time and place of choosing,” said Lyons. “The level of synchronization and level of complexity increases as the demands increase, and our allies and partners are key in expanding those logistics networks.

“Whether coming from the air, land or sea, thinking about where nodes and the ramps connect can give you that strategic flexibility to posi-

tion forces that provide us an advantage over our adversary physically and psychologically,” Lyons concluded.

A few weeks later, the Honorable James F. Geurts, Assistant Secretary of the Navy (Research, Development and Acquisition), told the NPS community that emphasizing output versus process is the key to agile acquisition in the Navy moving forward during his SGL, Aug. 20.

“We’ve started focusing on process compliance as a measure of a good system, not output,” Geurts noted, pointing to his 30 years of experience in the profession. “The process might help you get there, but if you’re not delivering for your customer, you’re irrelevant.”

One of the greatest impediments to this actually comes from within Navy bureaucracy itself, with government red tape slowly growing amass over time, gradually impeding speed and efficiency. The point is not speed for speed’s sake, Geurts emphasized, but about enabling agility at levels which increase efficiency of output over the long term. And one of the primary means to achieve this greater speed and efficiency, he said, is to put more responsibility and power in the hands of Sailors and Marines.

NPS’ longstanding SGL program provides a series of professional lectures by senior leaders throughout defense, government, industry and academia designed to help the university’s students and faculty link their studies, teaching and research efforts to the defense needs of the nation. **IR**



U.S. Army Gen. Stephen R. Lyons, Commander, U.S. Transportation Command.



Elliot Branch, Deputy Assistant Secretary of the Navy for Acquisition and Procurement, offers the keynote address during day two of the annual Acquisition Research Symposium, May 9. Branch discussed the modern era of rapid technological change, and its impact on the acquisition community.

Annual Symposium Puts Technology at the Forefront of Acquisition

By Matthew Schehl

Seaside, Calif. - For two days in May, hundreds of acquisition professionals from government, academia and industry across the nation gathered in this arcadian city on California's central coast to make the sinews of America's military might become more leaner, tougher and agile.

Hosted by the Naval Postgraduate School (NPS) and sponsored by the Department of Defense, the 16th annual Acquisition Research Symposium: Creating Synergy for Informed Change at the Embassy Suites, May 8-9th, explored the latest innovation and research in the field across a range of panel discussions, including cybersecurity, autonomous systems, data analytics and international defense.

The symposium comes at a precipitous and crucial moment, noted NPS President retired Vice Adm. Ann Rondeau as she welcomed the participants.

“Our research program continues to be a major component of the critical thinking skills in the current and future acquisition workforce.”

Rear Adm. James Greene, USN (ret.)
NPS Acquisition Chair

“In the Information Age, we are at the point where we can bring data analytics towards saving money and making cost avoidance so that we can put more

of the nation's treasure towards the end effect that would have this nation safer and more secure all the time,” she said.

“In my view, you who are in this room today is one important way we can deliver lethality and win the fight,” Rondeau added. “If not us in this

room, then who will make those important leadership passages forward in understanding how to acquire better and therefore deliver better?”

Driving the event was NPS’ Acquisition Research Program (ARP), which since 2003 has served as the locus for innovation, creative problem-solving and on-going dialogue in the acquisition world. Nestled within the NPS Graduate School of Business and Public Policy, ARP produces over 80 acquisition products each year and maintains a repository of more than 2,100 unclassified publications, stimulating research into acquisition management, workforce development and policy research.

“Our research program continues to be a major component of the critical thinking skills in the current and future acquisition workforce,” remarked Acquisition Chair retired Rear Adm. James Greene. “What is not fully understood is that almost all of [our students] end up in the acquisition world, not just business school people but people in engineering or science.”

“They all have payback tours when they leave here,” Greene continued. “And where are these tours? They’re in the acquisition business, so NPS is probably the biggest source of manpower for the acquisition workforce.”

As Rondeau observed, these acquisition professionals are now at the cusp of a new era which will place new kinds of demands on the field.

Understanding this context is key to navigating these new waters, and the presentations and sidebar conversations at the symposium demonstrated that the assembly of participants is well underway, according to keynote speaker Elliot Branch, Deputy Assistant Secretary of the Navy for Acquisition and Procurement.

“Most of us in this room — especially those who have more gray hair than we do darker — are trained to fight wars based in physics, computer science and advanced signal processing ... the physics of radar and sonar, the miniaturization of computing components, the exponential growth of computing power, precision munitions, communications networks and GPS,” he said. “We kind of pat ourselves on the back because we won that war, and that informs how we do business today.”

Those same technologies, however, have crept into the commercial sector, and as trade has exponentially increased throughout the world, they are now accessible to both friend and foe alike, and these have

broadened their potential applications.

“Tomorrow’s war will have things like ‘stochastic terrorism,’ where we use social media to potentially demonize a person or a group of people, which triggers an unknown person at an unknown time to commit an act of terror like we saw with the San Bernardino shooting,” Branch warned. “The next war will include terms like ‘computational propaganda,’ where we use big data so that a granular profile of who you are, what you do, how you think and who you associate with can be used to fine tune a message to you personally.”

“What we’re really talking about is how those of us in this room who were very, very successful in fighting that physicists’ and computer scientists’ war have to think about how we turn our system to fight the war that those who study the history of sociology and history have yet to name,” he said.

The U.S. Navy, according to Branch, has already begun to adjust course for this sea change.

Under the aegis of the nation’s 76th Secretary of the Navy, the Honorable Richard V. Spencer, a renewed emphasis has been placed on the people, processes and capabilities which can make this happen. Spencer and Chief of Naval Operations Adm. John Richardson have laid down the marching orders for this in a string of published initiatives, including A Design for Maintaining Maritime Superiority 2.0 and Education for Seapower.

“We understand that no weapons system is effective in any way, shape or form without the Sailors and Marines that deploy it and think critically about what effect that system has, that in order to get them to think critically about this environment, we need the right processes and we need to bring capabilities to the fight,” Branch said. “We realize that by leveraging the power of our people, processes and capabilities, we are increasing the fielding capability and the lethality of our Navy.”

“That’s the job the Secretary of the Navy has given to research, development and acquisitions to do,” he concluded. “That translates to delivering and sustaining lethal capability and capacity, increasing agility, acquire and modernize, provide affordability into every single deal and contract we make and building a workforce to compete with.”

The acquisitions community — and NPS — have the wheel well in hand. **IR**

SAVE THE DATE: May 13-14, 2020

NPS’ 17th Annual Acquisition Research Symposium, Monterey, CA
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Associate Professor Vladimir Dobrokhodov, director of NPS' Center for Autonomous Vehicle Research, teaches satellite autonomy as part of the Center for Multi-INT Studies' inaugural 'SmallSat University' course offering to the U.S. intelligence community.

NPS Launches “SmallSat University” for Intel Community

By Javier Chagoya and Matthew Schehl

When the United States intelligence community recently recognized a critical need, the Naval Postgraduate School (NPS) assembled a team of multidisciplinary experts from across campus to rapidly address and meet this need.

This spring, NPS' Center for Multi-INT Studies (CMIS) launched an inaugural course providing expert, hands-on knowledge of small satellite systems to intelligence professionals in the nation's capital. Dubbed “SmallSat University,” the five-week course delved deep into every facet of the science, engineering, deployment and operation of small satellites.

“The course of instruction we delivered was a resounding success,” noted Dr. Jim Scrofani, CMIS director. “We were able to take a complex set of educational requirements, create relevant courseware and laboratory experiments and deliver mission-impactful instructional outcomes.”

The initial group of students, who make acquisition decisions for overhead reconnaissance systems within the U.S. intelligence community, will directly apply the knowledge and skills gained in the course to satellite constellation design and spacecraft deployment.

“We have a longstanding Space Systems Engineering curriculum, as well as significant experience in designing, developing and operating small satellites for the Department of Defense,” Scrofani said. “NPS uniquely combines experienced professors, facilities, and knowledge of the sponsor's technologies in order to deliver tailored courses for government professionals.”

The course launched in Washington, D.C. with a one-week familiarization with the enabling technologies of small satellites, as well as an introduction to the System Tool Kit, a standard space mission design and visualization software package.

The students then traveled across the nation to Monterey, California,

where they undertook an intense three-week study of small satellite design and development fundamentals with NPS' Space Systems Academic Group (SSAG), including a week-long exploration of remote sensing techniques and small satellite autonomy.

Now armed with intimate understanding of these technologies, the students then returned to NCR for a final week of creating their own small satellite design program as a team, which they presented as a capstone project to management at their parent agency.

According to Scrofani, the sponsor's reaction was astounding.

Scrofani noted, the sponsor — who requested anonymity due to security concerns — expressed gratitude for NPS' work in creating SmallSat University.

“The briefing that was given today by the students far exceeded my expectations of a capstone presentation,” the sponsor said. “The briefing was superb and provided insight to the level of understanding that had been imparted to the students.”

“Following the presentation, my management pulled me aside and stated to me their overwhelming approval of the course and the work that you put into it,” the sponsor continued. “They were incredibly impressed and look forward to seeing how we suggest altering this course for future offerings.”

Given the success of SmallSat University's initial offering, Scrofani is already lining up the next round.

“The course is planned to be offered up to four times per year, as required by the education pipeline in the intelligence community,” he noted. ■

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The Management of Defense



Why does NPS have a business school?

Curiously, this is a question asked from time to time by new visitors to the university, although it seems a query that should be easily answered. After all, the Department of Defense is one of the largest logistics, acquisition, manpower, etc., organizations in the world.

Supplying this massive organization with leaders requires an advanced, defense-focused education in the critical disciplines required to efficiently and effectively manage the business of defense. In other words, a management degree from NPS is no ordinary MBA.

And NPS students are no ordinary graduate students, either. It is commonplace for our alumni to be flying helicopters one day, and responsible for a multimillion-dollar acquisition effort the next. NPS students are required to be expert practitioners in their profession of arms, and equally expert practitioners in management.

This image of 2010 financial management graduate from years back, then U.S. Navy Cmdr. Kevin "Sugarbear" Carey, is one of our favorites, as it visually reflects the duality of the challenge placed on these leaders ... Be warfighters, be executives.

In October 2019, in order to better align its moniker with its mission, NPS' Graduate School of Business and Public Policy will officially become the **Graduate School of Defense Management**, or GSDM.

"We are officially changing our name to the Graduate School of Defense Management to better signal to all of our stakeholders our unique defense-focused identity and mission," said Dr. Keith Snider, GSDM Dean.

"At GSDM, we strive for intellectual leadership in the business of defense in critically-relevant disciplines like financial management and budgeting, logistics and operations management, acquisition management, and manpower management and policy," he added. "We prepare our graduates to think strategically and critically so that they can effectively lead and manage the complex organizations and critical processes that contribute to the nation's defense."

So, to the original question, NPS doesn't have just a business school ... It has a respected school of management that, much like our peers around the nation, is preparing our future leaders for success.

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