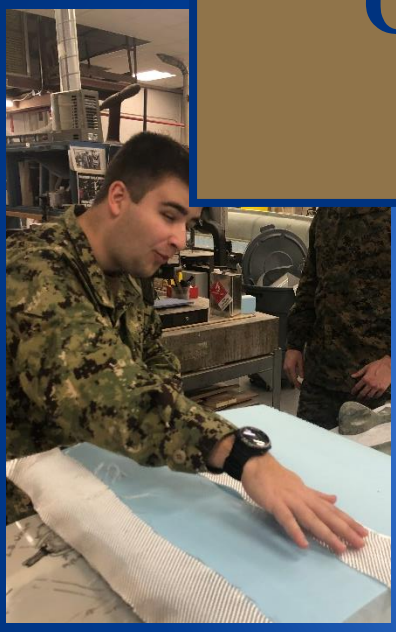
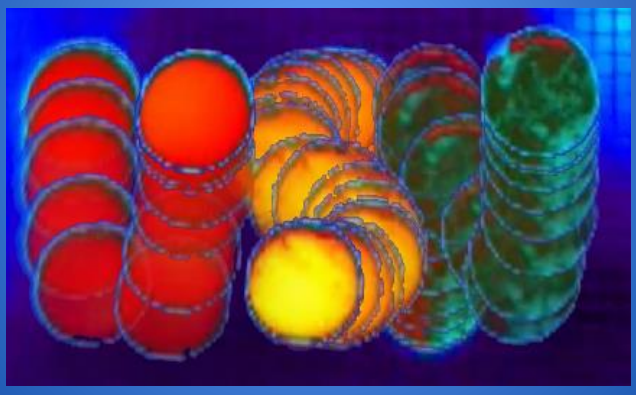
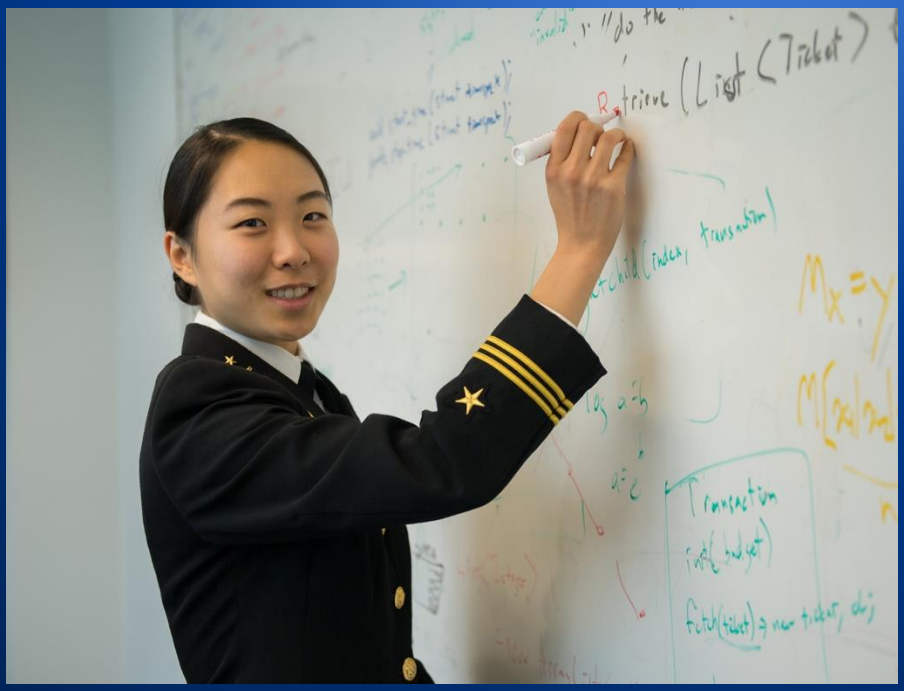
United States Naval Academy

Capstone Projects

2020







Message from the Academic Dean and Provost

Dr. Andrew T. Phillips

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Academic Major Codes

Engineering and Weapons (E&W)

EAS	Aeronautical Engineering
EASA	Astronautical Engineering
ECE	Computer Engineering
EEE	Electrical Engineering
EGE	General Engineering
EME	Mechanical Engineering
ENR	Nuclear Engineering
ENM*	Naval Arch. & Marine Eng.
EOE*	Ocean Engineering
ERC*	Robotics and Control Eng.
ESE*	Systems Engineering

Mathematics and Science (M&S)

SCB	Biochemistry
SCH	Chemistry
SCS	Computer Science
SIT	Information Technology
SCY	Cyber Operations
SGS	General Science
SMA*	Mathematics
SME	Math. with Economics
SMO*	Operations Research
SMP*	Applied Mathematics
SOC*	Oceanography
SPA	Applied Physics
SPAA*	Astrophysics
SPH*	Physics

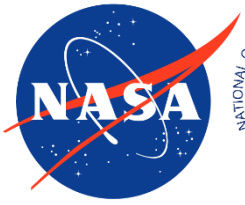
Humanities and Social Sciences (HUM/SS)

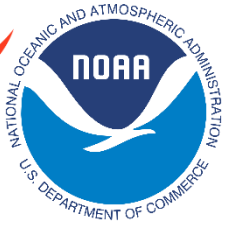
HEG*	English
HHS*	History
FLA	Arabic
FLC	Chinese
FPS*	Political Science
FQE*	Economics

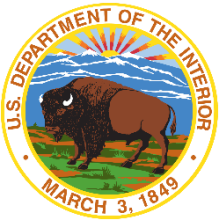
* Denotes honors program available. Honors students are indicated with an "H" following their major code.

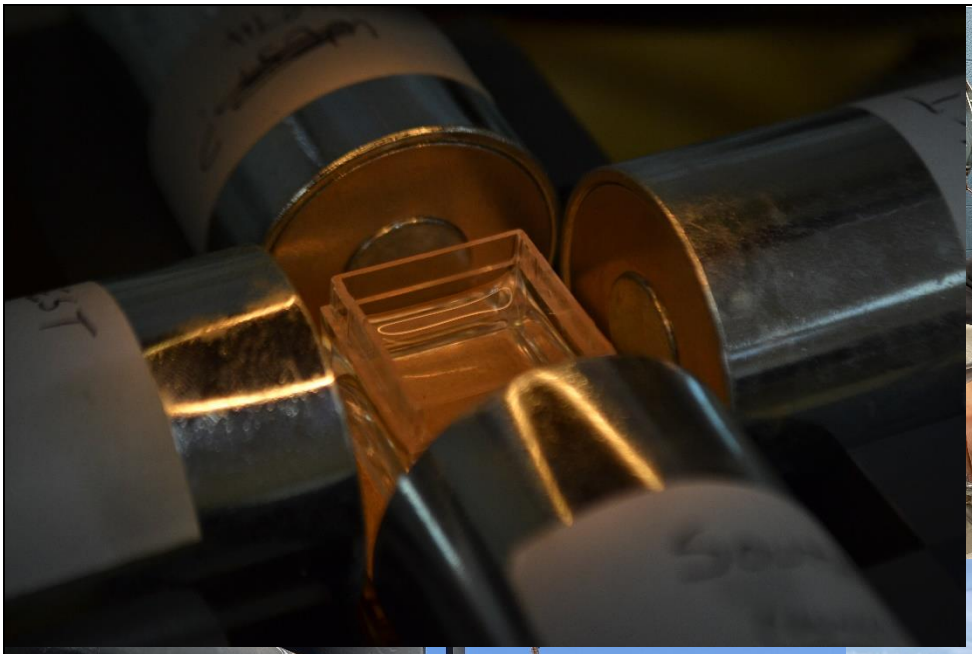
Independent Research and Capstone Project Sponsors

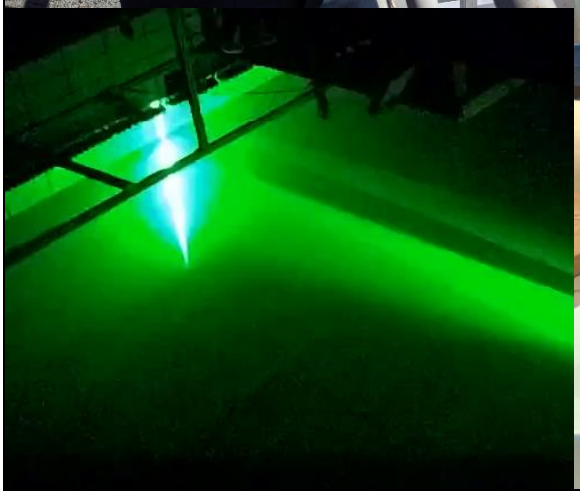
Independent Research and Capstone Projects were sponsored by:











Trident Scholar Research

The United States Naval Academy instituted the Trident Scholar Program in 1963 to provide an opportunity for a limited number of exceptionally capable students to engage in independent study and research during their senior year.

Optimizing the Regression Rate of Aluminum-Rich Paraffin-Based Hybrid Rocket Fuel

Kaden Dohm (EASA)

Contemporary hybrid rockets are severely limited in their applications due to the low regression rate of the fuel. The addition of aluminum powder to paraffin-based hybrid rocket motors offers the potential to increase the regression rate of these fuels. The goal of this project is to find the highest regression rate of these fuels possible, and, furthermore, ensure the structural rigidity of fuel grain can support the loads placed upon it during a launch.

Advancing the Synthesis of Polyionic Biocomposite Materials by the Natural Fiber Welding Process

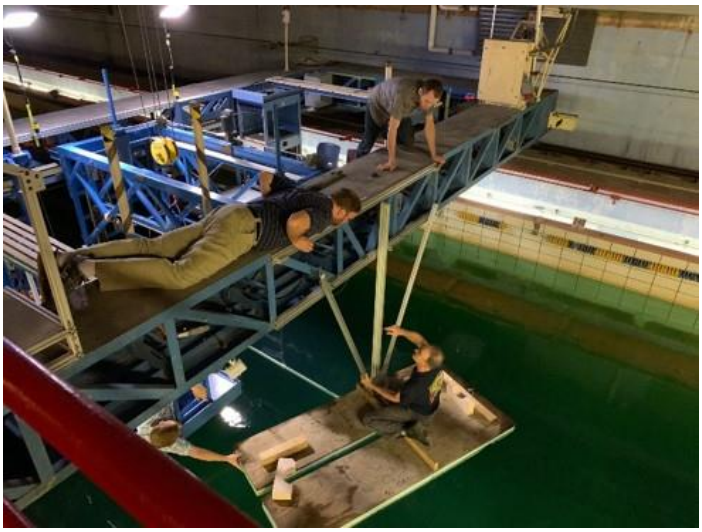
Christian Hoffman (SCH)

Polymerizable Ionic Liquids were evaluated for their ability to polymerize and dissolve biopolymer materials. This report highlights advancements made in synthesis, ex-situ polymerization, treating cotton substrates with novel Poly-ILs, and preparing polyionic biocomposites via Natural Fiber Welding.

Oblivious k-Nearest Neighbors for Secure Map Applications

Jamie Lee (SCS)

In order to implement security in map applications, we have developed a novel network data structure network, the ORAM-backed Hilbert B-tree. This data structure combines existing features to support oblivious 2D k-NN search queries using O(log^2(n)) bandwidth, a function that has not yet been conceived for such applications. This provides a significant security improvement without compromising performance, preventing sensitive information such as the user's physical location from being leaked.



Improving the Security of Unlock Patterns with New Iterations of the Android Pattern Lock Interface

Timothy Forman (SCS)

Android mobile devices use a unique method of authentication in the form of a single-stroke graphical pattern on a 3x3 grid. In this research project we are going to explore improved iterations of this Android Pattern Lock in the pursuit of guiding users towards creating more secure patterns. While many alternative authentication methods have progressed within the last five years, the standard authentication interface for Android devices remains similar in comparison to its initial model.

Proofs of Retrievability with Low Server Storage

Mike Hanling (SCS)

We propose a Proof of Retrievability (PoR) protocol which allows a client to audit a Cloud server storing its data. We trade increased server computation and bandwidth for minimal persistent storage overhead. We demonstrate its efficiency in practice by deploying on Google Cloud Platform, parallelizing with MPI. Auditing 1TB takes 16 minutes at a monetary cost of $0.23 USD, proving to be more cost effective than other PoRs that require minimal computation but have even 2x server storage cost.

Decision Problems in Computational Group Theory

Aidan Sabety-Mass (SMAH)

This research project is focused on the study of decision problems in computational group theory. Specifically, we are investigating computer-run algorithms for solving word problems for certain classes of groups and implementing them in Python. We have been focusing our project on the applications these algorithms have to finding a counterexample to Kaplansky's Direct Finiteness Conjecture and group-based cryptography.

The Effects of Acceleration on Film Cooling in Gas Turbine Engines

Clayton Pelzer (EME)

Gas turbine engine blades contain film cooling holes that direct cool air over the surface of the blades, protecting them from high temperatures. Acceleration of flow over the surface of the blades affects film cooling, but its effects are not fully understood. A test section was constructed to model the flow over a gas turbine blade. The results of this project should give blade designers a better idea of the heat transfer and flow associated with film cooling of a turbine blade.

Characterization of the Far-Wake of a 6:1 Prolate Spheroid

Jonathan Peck (EME)

The study of flow around prolate spheroids has been a rich source of insight, informing our understanding of fundamental hydrodynamics. Prolate spheroids have been used to study the complex interactions associated with 3D flows. Experimental prolate spheroid data are also used to validate Reynolds-Averaged Navier-Stokes (RANS) Computational Fluid Dynamics (CFD) codes. More practically, understanding the flow around prolate spheroids can improve the design of air- and waterborne vehicles.

A Machine Learning Model for Prediction of Optical Turbulence is Near-Maritime Environments

Christopher Jellen (EME, SMAH)

The current study uses one year of optical turbulence field measurements collected along a scintillometer link over water, as well as corresponding measurements of environmental parameters. A fully data-driven model was trained and tested to enhance optical turbulence prediction accuracy and better understand the underlying physical relationships which affect optical turbulence in the near-maritime environment.

Engineering and Weapons

Antenna Deployment Team for CubeSats

AJ Aldrian (EASA), Brendan Philbin (EASA), Cian Singleton-McConnell (EASA), Anthony Polo (EASA), Sam Perez (EASA), David Wiseman (EASA)

The Antenna Deployment Team for CubeSats has created a re-settable and testable Antenna Deployment Mechanism. The ADM is comprised of 3-D printed parts, kapton tape, nitinol wire, and a low speed motor that deploys an omnidirectional array of antennas; comprised of S-band, UHF, and VHF. The ADM was designed to minimize volume to allow maximum payload and to be modularly fitted to the top of any CubeSat—effectively serving as a solution to the challenge of antenna deployment.

Flight Testing a 1966 Beechcraft Baron

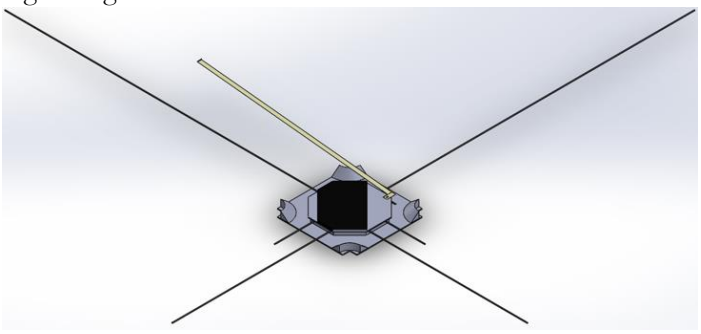
Students of EA417 (EAS)

A 1967 grad requested Mids in EA417 conduct a pre-buy flight test of a 1966 Beechcraft Baron. Tests spanned the Performance and Flying Qualities, comparing the published attributes with those of an old aircraft, engines and propellers, and multiple after-market modifications. Our results were validated through an operational test profile, representative of the missions this airplane might fly in service.

Forest fire Location and Evaluation Knowledge System (F.L.E.K.S.)

Ray Sutschek (EASA), Aaron Ellis (EASA), Nick Fortune (EASA), Phoebe Kirk (EASA), Chris Lumley (EASA)

The goal of this project is to design and build a CubeSat payload capable of proof of concept low resolution forest fire detection from low earth orbit with a specific emphasis on the Amazon Region in South America. The relative inexpensive cost would allow for more accessible services for both government and non-government organizations alike, ensuring continued coverage between, and in addition too, high budget missions.



Multi-functional Law Enforcement UAS

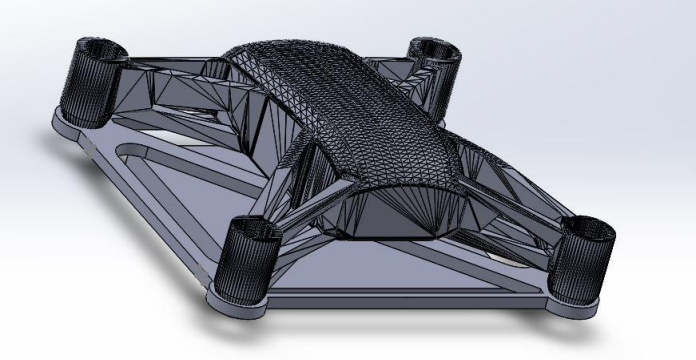
Spencer Almy (EAS), Tryston Brandon (EAS), Sean Lennon (EAS), Matthew Royce (EAS), James Snyder (EAS), Jacob Pederson (EAS), Charlie Kiernan (EAS), Kara Kakascik (EAS)

The goal of this project is to develop a capable Unmanned Aerial Vehicle (UAV), called the Multi-functional Law Enforcement UAS(MLEU), which address the shortcomings of assets currently available to officers on the ground, allowing them to do their jobs more effectively and safely.

NASA University Student Launch Initiative - USNA Rocket Team

Jessika Janusewski (EASA), Michael O'Shea (EASA), Anne Dunigan (EASA), Cameron Hurd (EAS), Cameron Jones (EAS), Maxwell Brill (EGE), Kaden Dohm (EASA), Anna Faux (EASA), Brendan Finn (EASA), Shawn Lee (EAS), Aubrey Leggatt (EAS), Michael Ware (EAS)

Student Launch strives to provide relevant, cost-effective research and development of rocket propulsion systems. The eight-month program requires the student teams to design, build, test and fly a payload and high-powered rocket to 1 mile in altitude. This year the payload must deploy and travel to collect 10 mL of simulated lunar ice from one of five sample locations around the launch field, then navigate at least 10 feet away from the site with the sample safely stored aboard the vehicle.



Naval Academy Satellite Team for Autonomous Robotics

Grant Birindelli (EASA), Alex Hardy (EASA), Bailee Ward (EASA), Trent Tetterton (EASA), Ansley Knight (EASA), Peter Sinkovitz (EASA), Eddie O'Neil (EASA)

The overall NSTAR mission is to develop a model of a robotic arm system that can be used on the International Space Station in the future to assist NASA astronauts with specific tasks including construction and repair of various hardware on the ISS.

Navy Low Speed Aerial Target (LSAT)

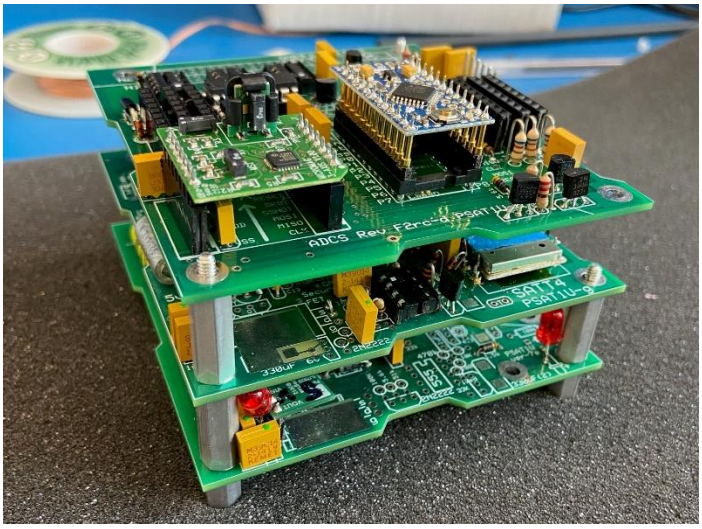
Connor Aspray (EAS), Ray Tallarini (EAS), Sean Caraher (EAS), Sam Damalouji (EAS), Sean Freeman (EAS), Hunter Wargo (EAS), Jake Klosowski (EAS), Enrico Lentini (EAS), Michael Epperly (EAS)

The Naval Surface Fleet requires expendable aerial targets with which to train AEGIS and other shipboard weapons system operators. As a result, our team worked to create a low-cost, highly-observable fixed-wing aircraft capable of long range, high-endurance operations in sea-based target areas. When complete, the LSAT will provide the surface fleet with more consistent live-fire exercise opportunities.

Trident SAR

Gunnar Jongebloed (EAS), Joel Schneider (EAS), Josh Hovance (EAS), Adam Doruff (EAS), Sydney Fortson (EAS), Hassam Syed (EAS), Victor Kim (EAS), Dechlan Mercer (EAS)

The Department of the Interior deploys Unmanned Aerial Systems such as ScanEagle to carry out a variety of missions. Usage of ScanEagle is limited because of high associated costs, so the DOI uses low performance drones made for general utility to fill gaps. Trident SAR is specifically tailored to the Search and Rescue mission. The UAS will provide search teams a rapid response capability, transmitting actionable data while being easy to use and deploy, and capable of all weather recovery.



USNA Ground Station Project

Mackenzie Baer (EASA), Jared Naphy (EASA, SPA), Woo Sub Kim (EASA)

The mission of the Ground Station Project is to develop a mobile ground station capable of establishing a communication link with a PSAT in order to allow the command, control, and downlink of telemetry and payload data. The mobile ground station will be capable of two way communication with a PSAT at one kilometer attenuated to simulate ground to orbital distances. This system should be effectively integrated with payload system architectures to allow for interactive operability and testing.

2-D Visible Light Communication System

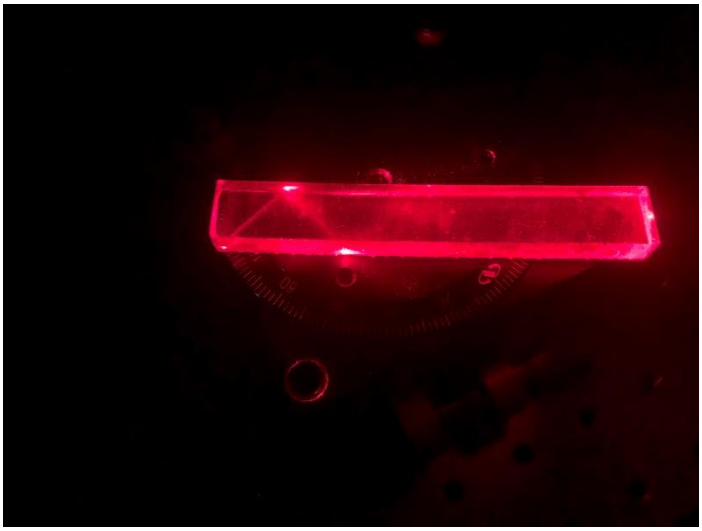
Joshua Ridge (EEE)

The demand for underwater communication has seen drastic growth as both the military and industry work to reap the benefits of employing unmanned underwater systems. This research explores the use of visible light communication methods to transmit data underwater. Specifically, this research analyzes the performance of a free space optical transmission scheme based on 2-D, multi-colored grids.

Additive Manufacturing of Optical Components

Ethan Delannoy (EEE)

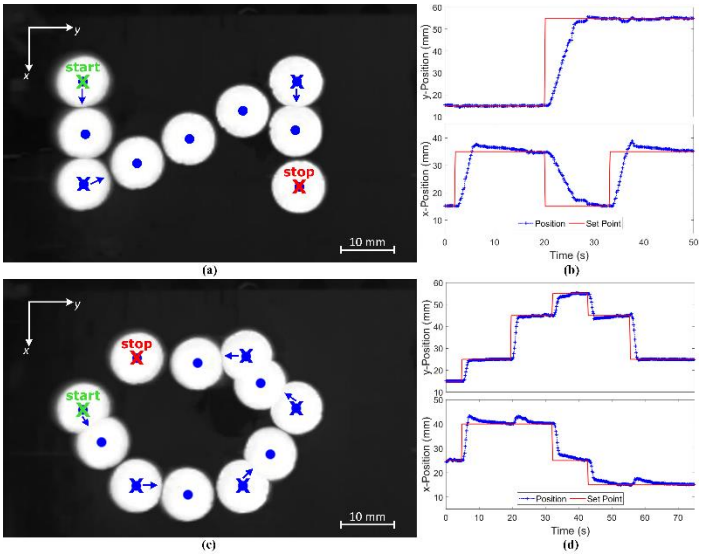
The goal of this research is to use 3D printing to fabricate optical components such as optical waveguides or lenses to control light propagation. Vat polymerization printing techniques were used to fabricate the components. Initial prints showed undesirable light scattering and were post-processed. Scanning electron microscopy, infrared spectroscopy, thermogravimetric analysis and differential scanning calorimetry were used to evaluate the composition of the components.



Analyzing Shipboard Power System Performance with Load Forecasting

Joo Won Lee (EEE)

Naval vessels require controllers to serve large loads. The MP-OPF optimization evaluates the performance benefits from using various lengths of future forecast, for example how much better is a 30 sec prediction than a 10 sec one. This information will inform ship designers as they develop system controllers and make decisions on the predictive functionality of the controller. This future forecast provides the controller with preliminary load demand to assist with power and energy preparation.



Autonomous Milli-scale Assembly Using Optically Actuated Pyrolytic Graphite

Jared Young (EEE)

Pyrolytic graphite (PyG), when levitated above an array of permanent magnets, can be manipulated with variations in local temperature. Using controlled optical irradiation for photothermal heating, targeted manipulation of PyG samples can be carried out. This study used both laser and projector systems with machine-vision closed loop controls to manipulate levitated PyG milli-robots in a novel optomechanical system milli-scale assembly system.

Efficient Architecture Design for the AES-128 Algorithm on Embedded Systems

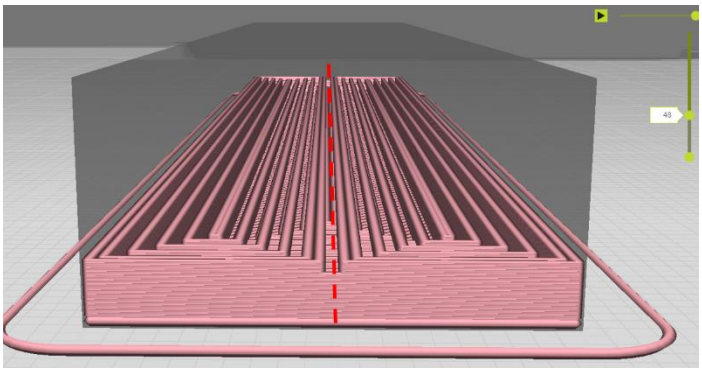
Rupam Mondal (ECE)

Edge devices in wireless sensor networks (WSNs) are resource-limited embedded systems that require an efficient encryption/decryption solution to protect against security attacks. A field-programmable gate array (FPGA) based design and implementation of the Advanced Encryption Standard (AES) algorithm for encryption and decryption were designed to protect edge devices from security attacks. A prototype of the design was developed and proven to be suitable for real-time applications.

Embedded Fiber Optic Sensors & Additive Manufacturing

Hayden Espericueta (EEE)

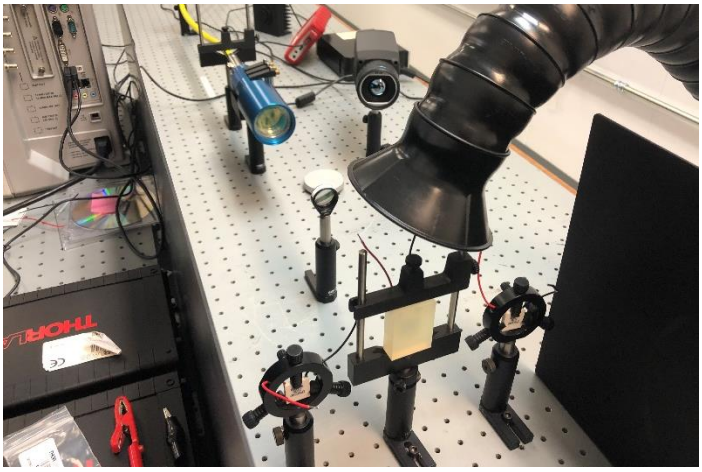
Strain and temperature sensing in structures are common applications of fiber optic sensors, however there are not well-defined procedures for embedding fiber optics in 3D printed structures. It would be beneficial to identify processes that are optimal for the above applications so that parts containing optical sensors to evaluate strain responses and temperature changes can be fabricated using additive manufacturing.



Enhanced Softball Pitching Machine

Leah Gordon (EME), Zach Biggers (EME), Gabby Tath (ECE)

The Softball Team has requested a pitching machine that is capable of realistic and accurate batting practice that will allow them to practice more efficiently. A M3X Pitching Machine has been enhanced with a beagle-bone and motor-drive system to provide it the ability to throw four types of pitches at three types of speeds. This design will allow users to apply a variety of pitches in a repeatable and accurate fashion that mimics a real pitcher.



High Energy Laser Detection through Thermoelectric Generators

Joseph Merkel (EEE)

With laser weapon systems entering the battlespace, there is a demand to quickly detect laser strikes without disrupting the stealth factor of most modern military craft. This project explores the possibility of using thermoelectric generators (TEGs) to detect such strikes. Experiments were conducted using lasers of various power ratings, wavelengths, and beam sizes to strike commercially available TEGs. Designs for a thin-film TEG are being explored for future high energy laser strike testing.

Implementing an Infiltrator-based System Observer

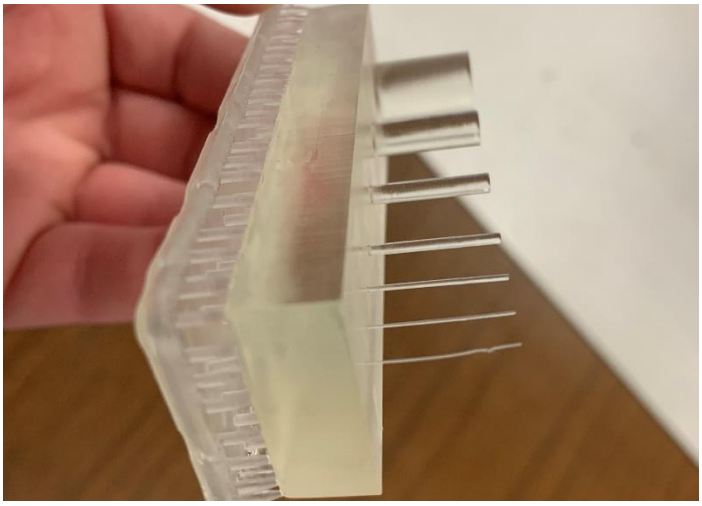
Noah Webster (EEE)

In large swarms it is impossible to directly measure the locations of each agent. Instead of relying on direct measurements of each agent, a compromised agent, or "infiltrator", can act as a system observer in order to create estimations of the states, or locations of each of the other agents.

Microfabrication of microrobots using additive manufacturing methods

Eugene Hong (ECE), Rebecca White (EEE)

Micro-robotics is an advanced field of robotics that has multiple applications for modern and future technology. One of the greatest advantages of the micro-robot is that they can access spaces and work in environments that are physically impossible for macro-scaled objects. Fused deposition modeling and selective laser melting are additive manufacturing processes that are used in this research for explore the suitability of its microrobot microfabrication process.



Radio Frequency Localization with Heat-Mapping

Andy MacGregor (ECE), Anthony Miller (EEE), Ethan Sellock (EEE), Eleanor Zhang (EEE)

The demand for underwater communication has seen drastic growth as both the military and industry work to reap the benefits of employing unmanned underwater systems. This research explores the use of visible light communication methods to transmit data underwater. Specifically, this research analyzes the performance of a free space optical transmission scheme based on 2-D, multi-colored grids.

Robot Football: Leadership and Receiver

Mack Nash (ERC), Logan Opp (ERC), Ethan Falsone (ERC), Nick Forti (ERC), Austin Kyung (EGE)

Robot Football is an annual competitive event pitting undergraduate engineers from various schools in a football tournament with hand-made robots. The leadership component oversees project management and logistics. The receiver component focuses on a single player on the field, the receiver. Its job is to catch balls thrown by a mechanical quarterback. This year's focus of Robot Football is to build of the foundation of teams prior to finally field a full 8 bot team.

Robotic Football Team

Cierra Germann (ERC), Ahmed Borgini (EGE), Mary Claire Ray (ERC)

Design, build, and control a working quarterback robot which can integrate with a team of robots to play the game of football via remote control inputs which will compete against other college robotic football teams as part of the College Robotic Football Competition.

TurtleBot Tracking Using ROS and AprilTags

Tyler Chema (EEE)

Being able to track objects without an external location system can be quite useful when operating in certain environments. The goal of this project is to allow TurtleBots operating using ROS to track each other with the use of AprilTags. AprilTags is an experimental visual location program that uses large QR codes to determine bearing and range of another object. This data can then be used to issue direction and speed commands to the TurtleBot.

Ultrasonic Data Transfer with Sound Fidelity (SoFi) Application

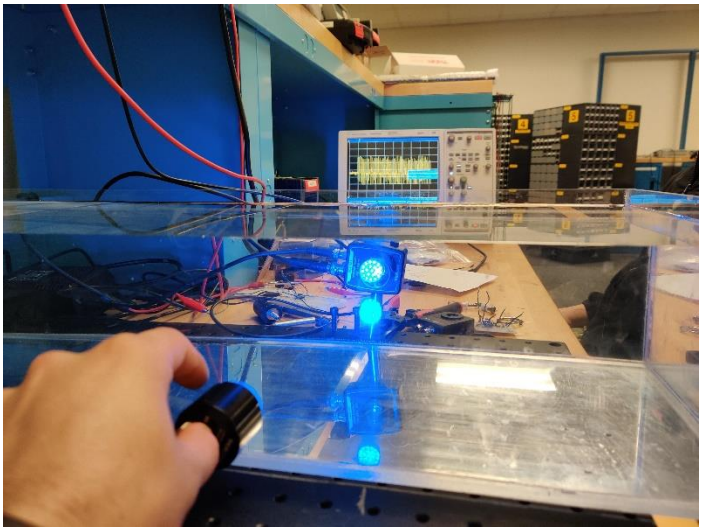
Daniel Fisher (ECE, SCS), Tyler Beck (ECE, EEE)

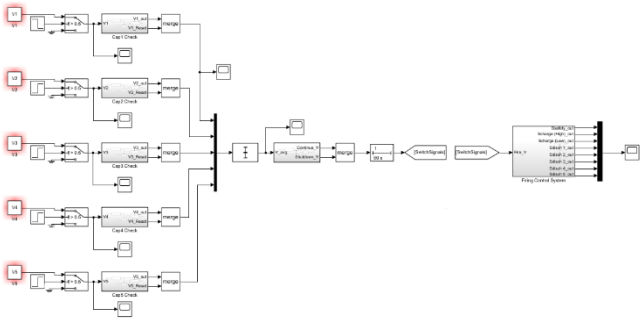
Major advancements have been made in wireless RF and light based networks. As these modes of networking have been explored, other potential options have been overlooked. While many avoid acoustics due to limitations such as propagation speed and bandwidth, there are many applications where sound based communication would prove useful. The goal of this project is to develop and improve upon a sound based networking system in both air and underwater environments.

Underwater Implementation of LiFi

Luca Bielenda (ECE), Tom Hawkins (ECE, SCS), Mike Irizarry (ECE), Michal Bojsza (EEE)

Unmanned Underwater Vehicles (UUV) require instruction codes in order to be controlled. In an underwater application(i.e. the ocean), having this connection send instructions un-tethered is strategic advantage. Using the new olympic sized pool in Hopper Hall, we can simulate these challenges and develop an Arduino based system to send custom instruction packets to the UUV and control its movement.





USNA Railgun

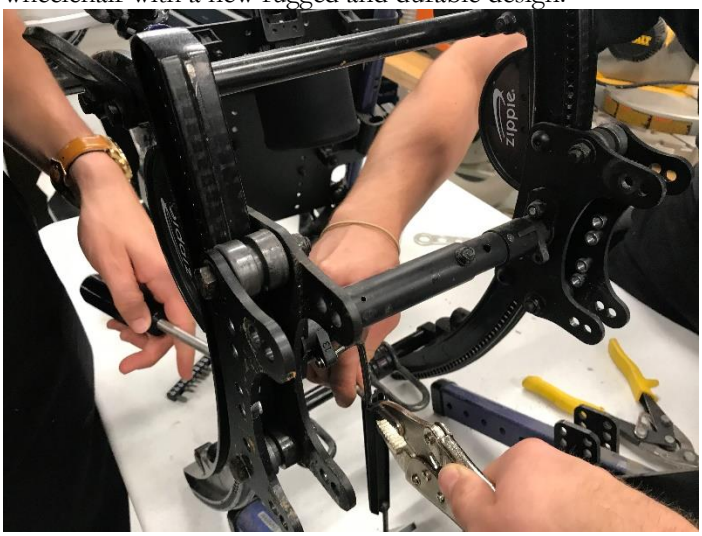
Gordon Livermore (EEE), Andrew Lewis (EGE), Lucas Figi (EGE), Winton Lunceford (EGE), Lucas Udell (ERC)

Electromagnetic launcher that accelerates a projectile using an electrical pulse generated by a Pulse forming network. AY2020 Railgun team is modifying and implementing new systems and networks that optimize the system to become more efficient and to satisfy the customer requirements which include higher velocity, faster rate of fire, efficient charge/discharge, optimized armature, physical design, and consolidation.

Adaptive All-Terrain Wheelchair

Matthew Clark (EME), Andrew Hollister (EME), Greg Durham (EME), Sean Bernstel (EME)

Seamus is an 11 year old with cerebral palsy and schizencephaly. These conditions completely impair his ability to control and stabilize his own body and restrict him to a wheelchair. In order to allow him the ability to enjoy outdoor recreational activities with his family, we will provide a new adaptive wheelchair. This custom build will combine comfort, functionality, safety and longevity by integrating essential components from Seamus' old wheelchair with a new rugged and durable design.



Additive Manufactured Scintillator for Radiation Detection

James Agan (EME), Sydney Barber (EME), Zeke Durham (ENR), James Reneau (ENR), Edmund Valdez (EGE)

The goal of this project was to take advantage of additive manufacturing techniques to develop a scintillation detector that rivals commercial options in cost and effectiveness.

Additively Manufactured Advanced Compact Heat Exchangers

Sean Bernstel (EME)

This research involves developing and testing heat exchanger designs with features developed for enhanced convective heat transfer in laminar flow regimes. The heat exchangers will be developed, constructed using additive manufacturing techniques, and tested to evaluate thermal and hydraulic performance.

Additively Manufactured Temporary Impeller Replacement

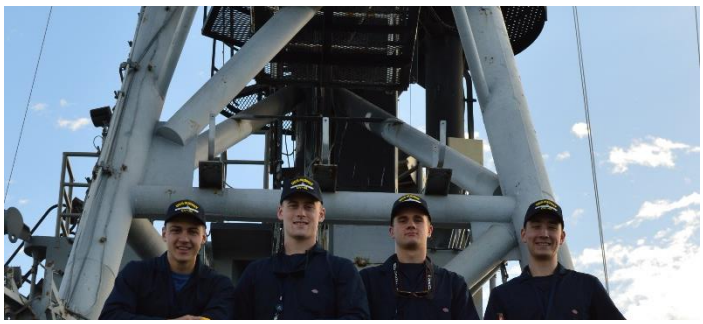
Joe Llewellyn (EOE), Hunter McAlister (EOE), Trevor Owens (EOE), Dane Sur (EME)

The Navy has a great need to be able to replace parts while underway. Traditionally, extra parts would need to be supplied beforehand and the equipment would be not functional until parts could be replaced from shore. With the introduction of additive manufacturing, ships will soon have the capability to print parts they need. Designing and printing an impeller replacement will serve not only as a viable design for the 7m RHIBs, but also a proof of concept for additive manufacturing.

Advanced heat exchanger technology for nuclear energy conversion in space applications

Calvin McDonald (EME, ENR)

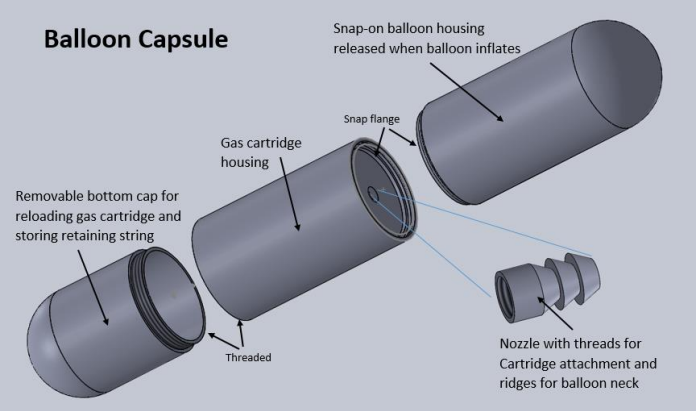
Renewed interest in space missions with high power requirements, such as manned missions to the moon and Mars, have introduced a need for compact, lightweight, nuclear fission reactors. Implementing and analyzing advanced compact heat exchangers into the power conversion cycle design will yield designs with improved thermal efficiency and mass optimization for space missions.



Aerial Drone System for Gathering Corrosion Data on the USS Midway

J.P. Peck (EME), James Cutler (EME), Jordan Rapp (EME), Jerad Nielsen (ERC)

The USS Midway has been decommissioned since 1992, and the mast of the ship has corroded to the point that a restoration project of the ship's mast is scheduled to be completed in 2021. The goal of this project is to design a system that will allow ship maintenance teams to gather corrosion data on ship masts rapidly for accurate assessment of maintenance needs as well as produce a 3-dimensional model of the mast and overlay areas of corrosion with areas of stress concentrations.



Air Force Research Laboratory Competition

Robert Leam (EME), Ethan Hardt (EME), Morgan Taylor (EME), Josh Lampe (EME)

The AFRL competition has tasked our team, "MIDs Down", to design a device that can assist in locating and communicating with an airman that has been downed in open ocean in the vicinity of enemy combatants. Our team is designing a device that can be carried by pilots during normal operations that when needed can be activated by a rescue helicopter and act as a radar signal. This prototype, if successful, could potentially be patented by the Navy.

Alice Pack Frame Redesign

Peyton Adelmann (ENR), Carter Bankston (EGE), Wesley Mehl (EGE), Myles Threatt (EME)

US military missions are negatively affected by the current design of the ALICE Pack frame because of its heavy and uncomfortable frame. Military personnel are slowed and experience unnecessary fatigue due to the current frame design. Using structural optimization, the support frame for the ALICE Pack will be redesigned so that the frame will be lighter, more comfortable, durable, and more modular. This will allow the user to be more effective.

ALICE Pack Redesign

Alex Goff (EME), Caleb Griffith (EGE), Kent Mathes (EME), Tyler Young (EME)

The design of the 60 year old ALICE pack ruck sack is outdated and could see potential upgrades in weight, durability, strength, and corrosion resistance. After redesigning the frame of the pack, a modernized version will reinvigorate the interest across the Department of Defense in the ALICE pack.

Anti-Structure Munition Grenade

Justin Green (EGE), Julia Padilla (EGE), Catherine Porter (EME), Robert Vanacore (EME)

The current Anti-Structure Munition Grenade has the singular function of destroying buildings and structures of enemy combatants. After providing the ASM grenade with the secondary function of lethality, an optimized version of the grenade was analyzed and tested to possibly replace the original product. The addition of fragments, explosively formed penetrators or shaped charge designs to the original weapon's purpose could assist special operating personnel in their mission.

Comparison of MCNP6.1-computed Dosimetric Quantities using Spherical and Full-Body Phantoms

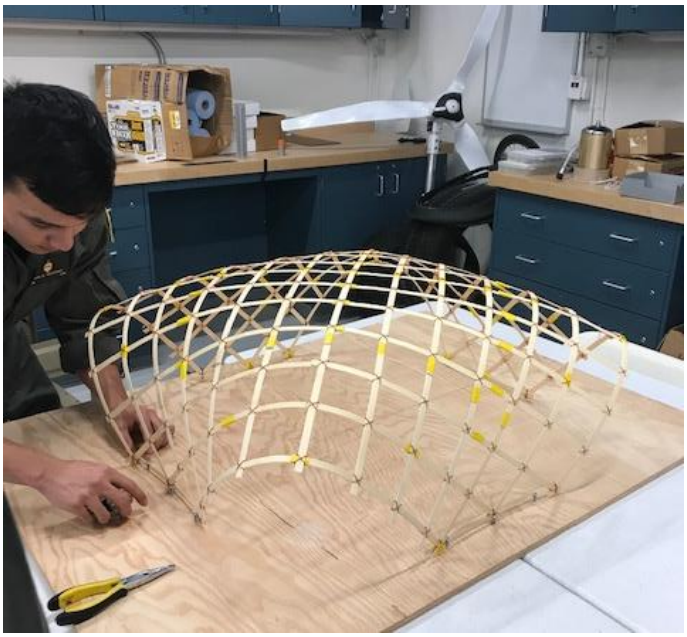
Erin Walker (ENR)

MCNP6.1 models were developed from the VIP-Man computational phantom, which is an anatomically-correct representation of the male body. 92 distinct simulations exposed the phantom to 23 neutron fields in 4 standard irradiation geometries: anterior-posterior, posterior-anterior, left-lateral, and right-lateral. A total of 5,612 in-phantom dose coefficients were computed for 61 organs and compared to tabulated values from ICRP Publication 116 for 10 organs with high susceptibilities to radiation.

Curie-ous George: passive IED detection based on K-40 gamma rays

Elizabeth Troy (ENR), Trent Perry (ENR), Thanakrit Manjai (ENR, EME), Abner Dela Cruz (ENR)

This capstone team is designing, building, and testing a radiation sensing system that can detect an IED from a distance of five meters within a matter of seconds though the gamma signature from potassium-40, a naturally occurring and radioactive isotope found in potassium chlorate, the most commonly used IED explosive.



Deployable Shelter for Disaster Relief

Ryan Dunleavy (EME), Matthew Elia (EME), Nathan Masarik (EME), Thor Wagoner (EME)

Since the formal mandate for the Navy to assist with disaster relief efforts around the world, there has been considerable progress made toward providing basic necessities. However, efforts to rebuild the sense of community have often been neglected. Gridshells provide an ideal solution, as they are rapidly deployable, can be assembled without heavy machinery, and are aesthetically pleasing. This will provide the community a temporary central gathering structure.

Design of a Towed Stereo Particle Image Velocimetry System for the Large Towing Tank Facility.

Zachary Nygaard (EME)

Stereo particle image velocimetry (SPIV) is a measurement technique used to measure the velocity of a fluid in three Cartesian dimensions. SPIV systems for laboratory applications are available off the shelf. However, SPIV systems that can be used in large towing tanks are rare and expensive. The purpose of this project is to design a towed SPIV system that can be employed in the large towing tank facility to make detailed measurements in the wake of submerged, towed bodies.

Detection of Optical Turbulence Using Distributed Optical Fiber Sensors

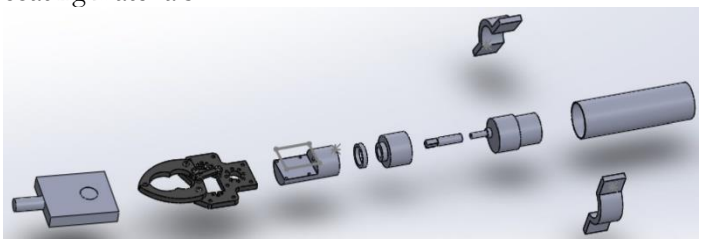
Mary Machniak (EOE)

Laser weapons are adversely affected by temperature fluctuations in the atmosphere, called Optical Turbulence. A better understanding of how to predict this, particularly in complex coastal environments, is required. A new measurement technique using Distributed Optical Fiber Sensors (DOFS) may be used to measure the spatial distribution of temperatures. DOFS were deployed in a field test alongside other instruments, but it was found that further testing is needed to improve data quality.

Development of a Fatigue Strip Blister Test for Elastomeric Composite Coating

Laurel Jaunich (EME)

An experimental research project was initiated to develop and execute a durability test for elastomer coatings to include cyclic loading, wet/dry conditions, and cathodically driven disbondment conditions. The motivation for this project is to improve the life of coating systems (both operational life and extending maintenance intervals) on Navy vessels through the use of improved methods to apply composite coating materials.



Development of a One-Handed Mechanical Reacher

Matthew Gillcrist (EME)

Adam Keys is a triple amputee who is trying to live as independently as possible, but has difficulty with simple tasks such as changing light bulbs, lifting objects, and turning valves. Products currently available are not adequate for all his needs. Team Delta is working to design and build an all-in-one device capable of meeting all Adam's task requirements. This will increase his independence and reduce reliance upon others.

Effect of Powder Morphology on the Corrosion Behavior of Additively Manufactured Stainless Steel

Andrew Shumway (EME)

Additive manufacturing (AM) offers exciting new advantages over traditional material forming processes. The extensive parameter space associated with AM presents a challenge in quality control and making comparisons between traditional and AM processes. This study will examine the effect of feedstock powder morphology on the corrosion behavior of 316L stainless steel.

Effect of Temperature and FSW on Dispersoid Evolution of Self-Ion Irradiated MA956 up to 25 dpa

John McMahan (ENR)

Oxide dispersion strengthened steels, such as MA956, are highly attractive materials for Gen IV reactor components. The purpose of this research is to determine the viability of friction stir welded MA956 under extreme reactor conditions by utilizing self-ion (5 MeV Fe++) irradiation techniques to simulate neutron radiation damage at high temperatures. STEM image processing will be utilized to capture and quantify components of MA956's microstructural evolution.

Energy Recovery during Fluidic Pressure Drop

Peter Ventola (EME)

Energy Recovery during Fluidic Pressure Drop

Fin and Nozzle Assembly Re-Design for 2.75” Hydra 70 Rocket

Braedon Mead (EME), John Buck (EME), Austin White (EME), Joey Siedlarz (EME), Sam Roth (EME)

The aerodynamic characteristics of the hydra 70 rocket fin assembly were not fully explored during original design due to lack of readily accessible computerized simulation tools and there is likely significant room for improvement. This capstone team is attempting to design, build and test a new hydra 70 fin assembly with decreased drag, while maintaining aerodynamic roll moments and stability.

Formula SAE Frames

Steven Vieira (EME), John Cortright (EME)

The Frames Subteam is responsible for the fabrication of the Formula SAE racecar frame. This frame acts as the backbone for the vehicle and safely houses and connects all related components and systems in a stable manner, even while the vehicle is in motion. More importantly, the frame must be able to withstand the various impacts that it may endure during testing and competition to ensure driver safety all while providing proper ergonomics.

Formula SAE Lead

Travis Grant (EME), Noah Rodman (EME), Josiah Ortega (EME)

The lead subteam is responsible for overall management and leadership of the other five subteams working to create the Formula SAE racecar. They play the role of leaders of a small company producing about 50 cars a year for a growing autocross market. The lead team sets overall team goals, tracks schedule, budget and materials and prepares for several "static" competition events such as design event, cost event and business presentation.

Formula SAE Powertrain

Nicholas Andrie (EME), Robert Briggs (EME), Jake Rude (EME), CJ VanDellen (EME)

The Powertrain subteam is responsible for providing all aspects of the motive force behind the Formula SAE racecar. For the engine, they are responsible for designing the intake and exhaust modifications required by competition rules. They also modify the driveline and differential systems to provide the torque and power delivery to satisfy performance goals established by the lead subteam. Finally, they must consider fuel economy as this is a major scored event at competition.

Formula SAE Systems

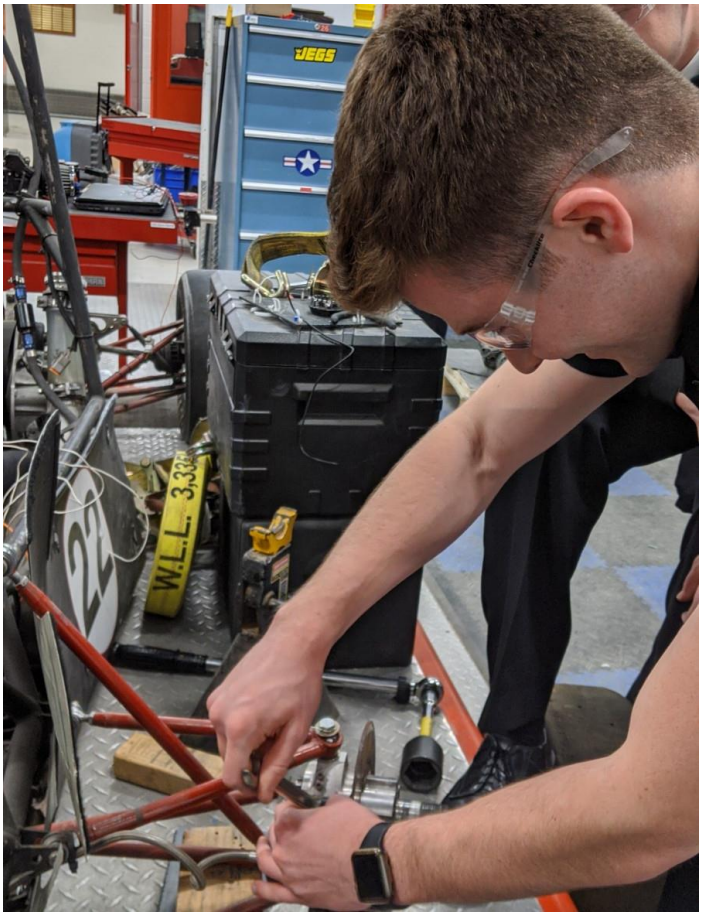
Eli Vernon (ERC)

The goals and functions of the Systems Subteam is to create and install a hardy and accessible control system capable of collecting and processing readable data, powering the necessary actuators, sensors, and components of the active aero and comms systems, and to do so without disrupting the abilities of the other sub teams. This subteam is also responsible for the wiring of the engine.

Formula SAE Vehicle Dynamics

Gonzalo Hernandez (EME), Carter MacMurdo (EME), Christopher Mayer (EME), Jordan Shinkus (EME)

The Vehicle Dynamics subteam is responsible for steering, braking and suspension components of the Formula SAE racecar. They start with tire selection and design the remaining elements to get the greatest level of overall performance out of those tires in support of lead subteams goals related to vehicle acceleration, braking and handling.



Formula SAE: Aero Team

Salvatore Ciolino (EAS), Michael Curtin (EAS), Andrew Knoll (EME)

The Aero subteam is responsible for designing a full aerodynamic package for the Formula SAE racecar. This package includes a front wing, rear wing and under vehicle diffuser to produce downforce to enhance tire grip and the car's lateral acceleration capability. The aero surfaces are developed using extensive computational fluid dynamics software and wind tunnel analysis to create high levels of downforce while reducing drag force.

Human-Powered Tire Cutter

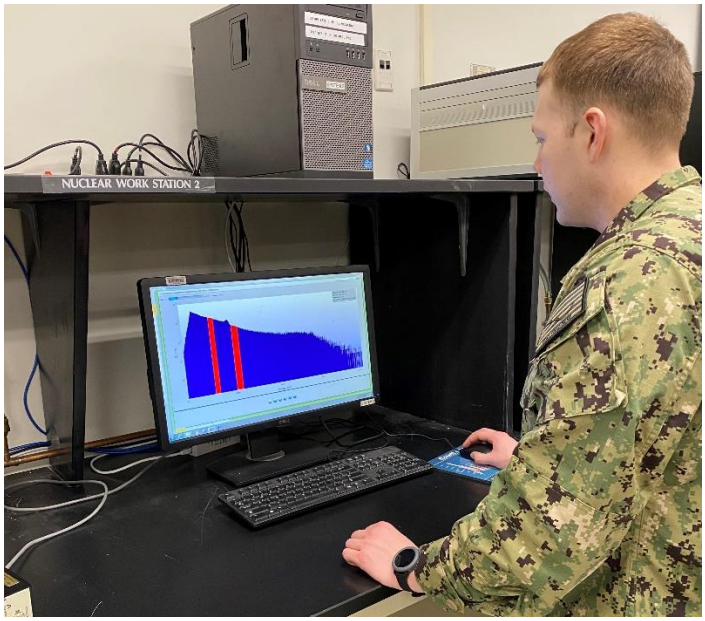
Chandler Derbyshire (EME), Jeremy Douglass (EME), Theo Freidenrich (EME), Weslee Warren (EME)

Design and test a tire cutter to reduce the size of the scrap tires to fit into a 2' x 2' door to an incinerator in Jacmel, Hait. The tire cutter must function without an electrical input or gasoline source. Burning the tires in the incinerator will enable the community to purify water and produce hot water for community use.

IED Detection Using Active Neutron interrogation

Greg Laird (ENR), Vladimir Korol (EEE), Samuel Vickers (ENR), Michael Waldrop (ENR)

Improvised explosive devices are a constant threat to service members and civilians in many of the regions that the United States currently operates. This project aims to use an active neutron source paired with a sodium iodide detector and prompt gamma analysis to positively identify materials that make up homemade explosives. The design will give teams in the field the ability to find potential IEDs without having to rely on traditional metal detectors.



Inhibitors for Oxygen Reduction Reaction and pH-Based Electrode Potential Control on Al-Cu Alloys

Joshua Johnson (SCH)

This research will test the corrosion inhibition capability of Ce, Co, and La solutions at varying pH on Al-Cu alloys. We will utilize an electrochemical cell that exposes the copper-aluminum alloy to a liquid medium and using a potentiostat, measure the open circuit potential on the metal. The US military utilizes various metals in the design of ships, aircraft, and weapons systems. If successful, this research could expand the lifetime of those systems and prove invaluable to the DoD.

Maritime Disablement Operations

Peter Ventola (EME), Quinn Barber (EOE), Nico Sbrocco (EOE), Adam Piendel (EOE), Jack Krall (ENM, EOE)

Modify and adapt parachute sea anchor (PSA) technology with the goal of expanding Naval Special Warfare non-lethal maritime disablement operation (MDO) capabilities to vessels greater than 250 feet in length.

Mechanical Behavior of Additive Manufactured Lattice Structures

James Agan (EME)

Lattice structures can be used to minimize density while maximizing strength or stiffness of a component. They require less material; however, the complexity of their geometry can be difficult to manufacture using traditional methods. This work aims to utilize additive manufacturing to design lattice structures and to investigate the effects of unit cell geometry and number of unit cells on the mechanical properties of these structures.

Navy Racing-Lead

Noah Rodman (EME), Travis Grant (EME), Josiah Ortega (EME)

Collegiate race car design competition (FSAE) held at Michigan that we will compete in. We design and build a race car from scratch that we will be scored on performance capabilities and design.

OSV-Based Molten Salt Reactor for Disaster Relief Electric Power

Grace Kim (ENR), Christian Oldham (ENR), Micah Vincent (EGE), Conner Yun (ENR)

After natural disasters, communities are often left without necessities such as potable water and electricity. An offshore vessel outfitted with a nuclear reactor and desalination units may be able to provide both electricity and drinking water to in-need communities across the world. The project focuses on the viability of a molten-salt reactor and an associated secondary Brayton cycle to generate a power output of 20 MWe.

Parametric Analysis and Optimization of an Elastocaloric Refrigeration Cycle

Sarah Nguyen (EME)

Exploring the heating and cooling effects of endothermic reactions in shape memory alloys in elastocaloric cooling systems. COMSOL Multiphysics will be used to model, analyze and optimize the coefficient of performance (COP) of a bending mode elastocaloric cooling cycle. The model will inform the design of combined bending mode/tension mode elastocaloric cooling cycle prototypes expected to achieve COPs much higher than those of conventional refrigeration systems in medium-scale applications.

Plating of Fe and Cr on Mo Capsules Used in Molten Salt Corrosion Testing

Daniel Moriarty (EME)

The corrosive effects of molten salt were assessed in support of the Department of Energy's Gen IV reactor initiative. Prospective reactor fuel cladding candidate materials were exposed to reactor surrogate conditions including a working fluid of molten salt in molybdenum capsules. The resulting salt, capsule and coupon were assessed using a variety of microstructure analysis techniques including optical microscopy, scanning electron microscopy and transmission electron microscopy.

Power Generation and Storage for Backpacking Application

Bobby Bendick (EME), Ben King (EME), Daniel Malarski (EME), Drew Murphy (EME), Kevin Murray (EME)

An experienced backcountry guide's ability to lead remote expeditions was limited by cumbersome equipment and batteries required for treating his sleep apnea. Testing was conducted on alternative means of generating and storing power to reduce the mass and volume of equipment needed to power a CPAP machine.

Research on the Viability of Pre-injected E85 Fuel in a restricted Formula SAE Engine

Christopher Mayer (EME)

Engines powering the Formula SAE racecar series are required to use a device that restricts maximum air flow thus limiting maximum power. This project investigates the effect of injecting E85 fuel upstream of the restrictor to evaporatively cool incoming air to increase mass airflow. Also extra spark ignition timing advance enabled by the high octane of E85 is employed to further increase engine output and efficiency.

Shielding Design for a Mobile Microreactor

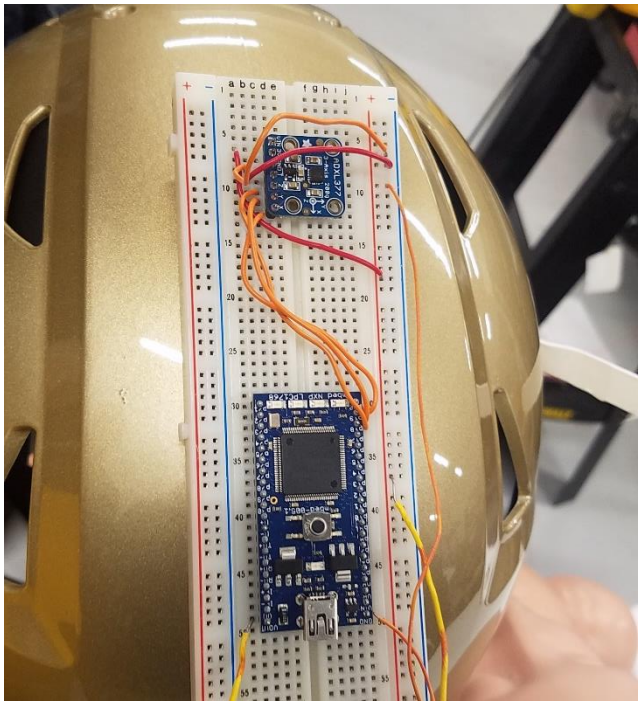
Thanakrit Manjai (EME, ENR)

This research seeks to characterize the radiation shielding properties of expedient force protection barriers. HESCO barriers have been employed in remote/forward operating bases for many years, and some advanced microreactors for military applications may require crediting such barriers as safety-related in order to assure personnel safety. The U.S. Army's ML-1 mobile reactor and a surrogate compact fast reactor are used to determine the effectiveness of expedient barriers to shield radiation.

Team Helmet: Men of Ken

Marcus Edwards (ERC), Cameron Witte (ERC), Niko Yaramus (EME), Tazh Maloy (ERC), Elan Nash (EGE), Bobby Nelson (SCS), Benjamin Mcmillan (EEE)

Providing real time data of force impacts, heart rate, and salinity will improve detection for in game health monitoring and concussion protocol. Providing this real time data to trainers on the sideline will reduce the risk of missed diagnosis and second impact syndrome while tracking head traumas and other health measurables during the game.



Thermoreflectance Measurements of Thermal Properties for Materials with Confined Geometries

Trent Perry (EME)

We use a numerical fitting routine to directly measure the thermal properties of materials having confined geometries via frequency-domain thermoreflectance (FDTR). We use numerical simulations to first quantify the impact of a radially confined geometry on the phase (i.e. temperature) lag on the sample surface. We subsequently demonstrate the utility of fitting thermal properties using a 2-D finite element scheme and experimental measurements on Si micropillars.

Aquatic Park Pier Replacement

Zach Elvin (EOE), Ian Myers (EOE), Luke Ostrowski (EOE), Connor Prince (EOE), Walker Russell (EOE)

The Aquatic Park Pier, built in 1921 and a centerpiece of the San Francisco Maritime National Historic Park, is rapidly deteriorating and in need of replacement. The National Park Service has requested that the new pier design keep the current shape and length, but that the height and width should be designed to account for future sea level rise and to reduce cost. Also, the original pier contains a wave baffle that serves as a breakwater, and the new pier should retain this function.

Artificial Surf Reef Design & Erosion Effects

Mike Chae-Kaslik (EOE), Andrew Hopkins (EOE), Zach Krause (EOE)

The goal for this project is to design and build a scale model of an artificial reef to create a surfable wave, meaning the scale model would create an Iribarren number corresponding to a plunging breaker as well as a peel angle that is ideal for surfing. Based on successful physical modeling, a large-scale reef will be designed to be placed offshore in Northern Cape Hatteras, North Carolina to increase recreational surfing opportunities while minimizing wave energy at the shoreline.

Artificial Surf Reef Design: Brigantine, NJ

Mary Machniak (EOE), Corey Onufrak (EOE), Ally Michaels (EOE), Bo Kendrick-Holmes (EOE)

The goal is to design an artificial surf reef for Brigantine, NJ to increase the number of surfable days in the region while battling coastal erosion through improved longshore sediment transport. The artificial reef design was based on increasing the on-site beach slope to produce more quality waves on a given day. This was accomplished by amplifying wave height and optimizing the surf similarity parameter to create plunging waves and was tested using a model in the Rickover Coastal Lab.

Beaufort Coastal Erosion Project

John Lamb (EOE), Chuck Dimer (EOE), Kathryn Fung (EOE), Riley Schliem (EOE), Matt Siebold (EOE)

The NOAA Coastal Lab on Pivers Island in Beaufort, NC is in danger of flooding due to sea level rise. The current seawall structure surrounding the island is dilapidated and not currently protecting the building structures on the island. This project is implementing a new perimeter for the island to include a mixture of green and gray solutions in order to protect the island from flooding and erosion for the next 50 years.

Burlingame-class Staten Island Ferry

Matt DeMaso (ENM), Jack Morris (ENM), Eugene Kim (ENM)

The mission of this improved Staten Island Ferry design is to provide New York City with a more efficient and comfortable ferry service between Staten Island and Manhattan.

Controlling Flooding and Erosion at Fort Castillo de San Marcos in St. Augustine FL

Josh Engler (EOE), Bailey Proulx (EOE), Annalise Heyward (EOE), Travis Brannan (EOE), Tanner Clemons (EOE)

This project focuses on flooding issues affecting the north and south side sea walls surrounding Fort Castillo. The aim is to provide a range of solutions at varying prices for the customer to choose from.

HBH 50 High Performance Sail Training Yacht

Jonathan Hitt (ENM), Zack Bauer (ENM), George Hamilton (ENM)

This racer-trainer sailboat is designed to be a platform for sailor growth in competitive sailing.

IceKid 5: Arctic Buoy Project

Aaron Bullis (EOE), Eric Kousky (EOE), Annie Shea (EOE), August Will (EOE)

While arctic focus has increased over the past several years, there are still immense gaps in the data collection, causing errors in numerical environmental predictions. Additionally, current buoy systems are extremely expensive. This project focused on designing, developing and deploying (off the coast of Utqiagvik, Alaska) a low cost, expendable buoy capable of measuring water temperature, air temperature and barometric pressure and of surviving 18 months in arctic conditions and ice cover.

Le Blowhole: An Environmentally Conscious Whale Watching Vessel

Eli Roberts (ENM), Chuck Akerblom (ENM), Charlie Thigpen (ENM)

This project aims to design a commercial whale watching vessel for the Puget Sound. This boat will serve 49 passengers, and is designed to reduce the auditory impact of ship noise on whales.

Maine-ly Mollusks offshore scallop aquaculture system

Dustin Carwile (EOE), Evan Wieck (EOE), K.C Navarro (EOE), Alex Wang (EOE), Dominic Pecchenino (EOE)

A scallop aquaculture system is being designed to withstand the ocean environment in the waters of offshore Maine. The objectives of the system design are to minimize the risk of whale entanglement and to be economically viable. Design criteria to minimize the entanglement of the endangered North Atlantic right whale is a primary focus.

Mangrove Restoration in Key West

Marie Jendrysik (EOE), Molly Cox (EOE), Marissa Amodeo (EOE), Christian McKittrick (EOE)

The College of the Florida Keys is in need of a new coastal protection system as the unprotected shoreline, constructed on reclaimed land, erodes. This project aims to mitigate erosion, reduce wave energy, and prevent inland damage while still supporting the region's biodiversity through the creation of a modular living shoreline that utilizes both grey and green engineering options.

Mexican Patrol Craft

Alex Muzzioli (ENM), Cesar Mora (ENM), Jess Stanback (ENM)

This vessel is a high speed offshore patrol vessel for drug interdiction operations and maritime security surrounding Mexico's coastlines.

Military Heavy Icebreaker

Jack Krall (ENMH, EOEH), Nate Auzenbergs (ENM), Claudio Valdes Garcia (ENM)

Design of a U.S. military ice breaking vessel for continued access to polar regions in support of attaining sea superiority, power projection, and supporting the country's national interests.

New Hampshire -- New Opportunity offshore scallop aquaculture system

Jack Higgins (EOE), Victoria LaVeck (EOE), James Osborne (EOE), Gabe Schilke (EOE)

The objective of this capstone design project is to design a scallop aquaculture system for the offshore waters of New Hampshire. The system is intended to minimize the risk of whale entanglement, specifically the critically endangered North Atlantic right whales. Economic viability to show the potential scallops being valuable aquaculture product is also a primary goal.

Philippine Fast Auxiliary Vessel (PFAV)

Aaron Howell (ENMH), John Mall (ENM), Pawie Fornea (ENM, ERC)

The mission of this ship is to provide quick reaction auxiliary support to the Philippine Navy as well as a platform capable of supporting future naval advances like UUVs and AUVs. It is capable of transporting material or troops anywhere within the Exclusive Economic Zone of the Philippines in under 24 hours when stationed in four ports: Appari, Manila, Cebu, and Zamboanga.

Small-Scale Wave Energy Converter

Michael Boyson (EOE), Emma Dryden (EOE), Mason Fridge (EOE), Kevin O'Callaghan (EOE)

This project conceptualized, designed, constructed and tested a small-scale wave energy converter (WEC). The device is designed to produce approximately 100 Watts, and is scaled to be deployable by a small team. The design may be applied to power routine facilities as well as combat systems.

Wave Energy Converter Test Site

James Hine (EOE), Bernard Reilly (EOE), Madeline O'Neil (EOE), Timothy Shea (EOE), Ryan Martin (EOE)

This project designed, developed, and built a small-scale wave energy converter (WEC) test site. The site was designed to accommodate testing energy output of any small WEC and its corresponding efficiency. The design is easily deployable, recoverable, and adaptable in order to test WECs in the Annapolis area with future application anywhere within driving distance.

A Comparison of Machine Learning Techniques with regards to Diagnosing Metastasis in Lymph Nodes

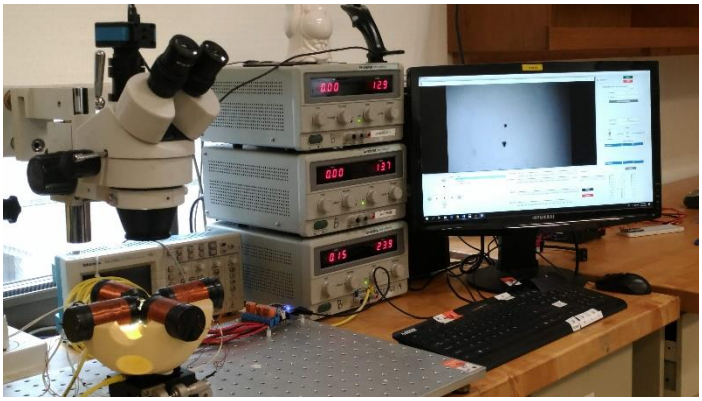
George Gilliam (ERCH, SMAH)

The goal of this project is to develop and then compare a shallow neural network and a deep convolutional neural network that take a data set of cellular images as inputs and output regions of interest where cancer is likely present. The accuracy of these algorithms will be evaluated by the number of false negatives in each slide due to their unique importance in cancer diagnosis.

A Robust Approach to Microrobot Control

John Thompson (ERCH)

In an attempt to utilize robots in the human body, the design of robust control algorithms for microrobots is needed. In this project, we propose a Robust Integral Sign of the Error (RISE) control method to be implemented on the USNA microrobot lab test bed to provide improved positioning performance in the presence of viscous forces and varying external magnetic forces. The proposed algorithm is validated through mathematical analysis, simulation and experimental testing.



An alcohol by volume (ABV) monitoring system

Jacob Baldus (ERC), Thomas Wilson (ERC), Alex Yeiser (ERC)

In this project, an alcohol by volume (ABV) measurement and monitoring system is developed to improve the fidelity of measurement of ABV for brewing enthusiasts. ABV is estimated by capturing and measuring gas content emitted during the fermentation process. The ABV content is logged and displayed in a real-time manner to the user via an interactive display implemented via the Raspberry PI.

An Environment-Adaptive Navigation Model for Small, Sail-Powered Autonomous Surface Vehicles

Drew Robinson (ERCH)

The USNA Sailbot team is developing a sail-powered, autonomous surface vehicle to cross the Atlantic Ocean. Its existing control model relies on preplanned waypoints that do not utilize changing weather patterns to the Sailbot's advantage. This project aims to actively maintain an accurate navigational picture by considering the effect of wind and current patterns on the boat. The resulting solution will determine feasible routes that increase the likelihood of a successful voyage.

Analyzing the Biomechanics of Midshipmen During the Herndon Monument Climb

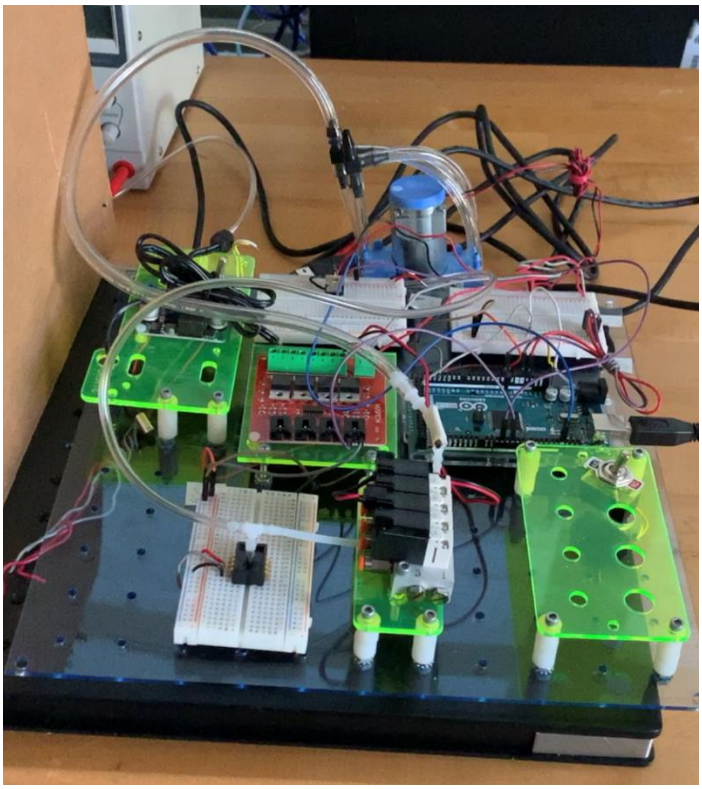
Sofia Figueroa (ERC)

This is an ongoing project that involves analyzing the tower structures formed by the 4/X midshipmen as they climb around the Herndon monument. A mathematical model will be produced based on the footage we have obtained using Hero 5 GoPros to film the event from multiple angles. This model will be compared to another used to predict the size and durability of similar tower structures formed by fire ants. Hopefully this data will help with the development of drone swarming capabilities.

Application of Linear Controllers for Soft-Rigid Robotic Finger Rehabilitation

JJ Musilli (ERC), Mike Graham (ERC)

We will evaluate the performance of linear controllers on a soft-rigid robotic finger used for passive rehabilitation, by creating a testbed for the soft-rigid robotic finger supplied by the University of Texas at Arlington (UTARI) research facility. We will gather data on the soft-rigid robotic finger via computer vision. Different linear controllers will be evaluated and compared with step, ramp, and sinusoidal inputs to find which combination is the best to use in passive rehabilitation.



Autonomous Drone Racing

Austin Credle (ERCH)

We will create a process for a drone to modify its given flight path based on the visual recognition of a gate in order to fly through the gate. The processor will identify the gate, locate it in relation to the drone's current path, and modify the path to fly through the gate. If successful, this will be the first step in creating an autonomous racing drone at USNA.

Autonomous pressure cuff system for tourniquet enhancement

Bethany Spangler (ERC), Zach Richart (ERC), John Finnegan (ERC)

The objective of our capstone project was to design a secondary tourniquet that would reduce the risk of amputation due to over excursion of pressure to the limb. We created an autonomous fluid input tourniquet system with controls that correlate pressure applied to the patient's heartbeat distal to limb. This new tourniquet system will potentially extend the longevity of tourniquet effectiveness and save limbs.

Autonomous trajectory planning to execute extreme maneuvers based on hummingbird display dives

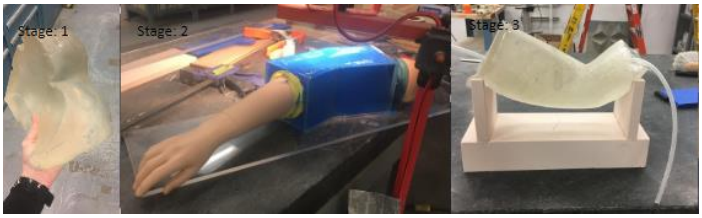
Ethan Marcello (ERCH)

Using a small indoor quadrotor (Crazyflie 2.1), and a multi-camera motion tracking system (OptiTrack) this research seeks to autonomously execute extreme maneuvers observed in flying animals. My primary goal will be to discover the maximum degree to which a small unmanned aerial system can recreate the courtship display dives of Anna's Hummingbirds (Calypte anna) through analysis of a time-scaled root mean square error between the bird and quadrotor trajectories.

Biological survey and sample return from inaccessible islands using UAS

Reina Carroll (EME), Levi Hofland (EME), Jacob Kang (ERC), Jisub Lim (ERC), Bryan Phan (ERC)

The goal of this project is to autonomously survey and sample rare and endemic plants from inaccessible islands within the California Channel Islands using unmanned aerial systems (UAS) launched and recovered onboard a rigid hull inflatable boat. Islands provide isolation barriers and can experience increased rates of diversification and speciation. The inaccessibility of the islands to botanists via traditional techniques makes the project and attractive application of robotics and autonomy.



Bridge Watchstander Operator Decision Aid

Lillian Jones (ERC), Anmol Walha (ERC), Sabrina Frehafer (ERC)

An increase in surface collisions in the 7th fleet has reaffirmed the absolute need for a solution to help bridge watchstanders gain more accurate situational awareness. Bridge watch teams are challenged by modern problems and are constantly asked to do more with less personnel. A decision aid would provide a vital resource for bridge watch teams to increase efficiency and avoid casualties.

Control of Multi-Vehicle Formation with Time-Varying Reference State

Gwendelyn Pattison (ERC)

This project is aimed at multi-vehicle formation consensus under a time-varying reference state while minimizing communication frequencies. Previous control algorithms allow for consensus from stationary reference state to another stationary reference state. This research proposes an augmented control algorithm including an estimate of desired relative velocities, resulting in lower formation errors than before without lagging behind the entire formation.

Creating the Robo-Roach

Alexis Pak (ERC)

Neuromechanics of the American cockroach (Periplaneta americana). This project will attempt electrophysiological preps of a cockroach to probe and control descending motor commands, with the aim of eventually steering it via an external control system.

Cyber-Physical Signature for Additive Manufacturing Processes

Noah Chaskin (ERCH)

The proposed project will create a tamper detection technique to be implemented on additive manufacturing (AM) equipment. This tamper detection mechanism will be used on AM equipment for the US Navy and Marine Corps. This approach will validate the product created against a protected digital file in order to eliminate the need to blindly trust the manufacturing equipment.

Nonlinear Estimation and Path Planning for Autonomous Multi-target Search and Tracking

Harlan Ticatch (ERCH)

The focus of this project is to autonomously search and track targets in an environment using an unmanned vehicle. We utilize a Gaussian Mixture Model Kalman filter (GMM-KF) to assimilate noisy measurements from the search vehicle and estimate target positions. By employing a hierarchical heuristic search algorithm to rank the likelihood of potential targets and design path planning trajectories, the goal is to improve position estimation performance compared to traditional search methods.

Optic-Flow Based Navigation

Se-Hoon Kim (ERC), Daniel Zeuner (ERC)

Design and flight test of a mini-aerial drone navigation and obstacle avoidance system that uses optic flow and computer vision to guide the aircraft through enclosed or confined environments such as an office building , school, or factory

Project Midknight: UAS Trajectory Prediction

George Zolovick (ERCH), Patrick Guinan (ERCH)

This project investigated two methods, a neural network and a traditional curve fitting algorithm, to predict the flight trajectory of a small unmanned aerial system (UAS). Using measured UAS angle and range, the algorithm predicts at least four seconds of future trajectory to enable a counter-UAS salvo.

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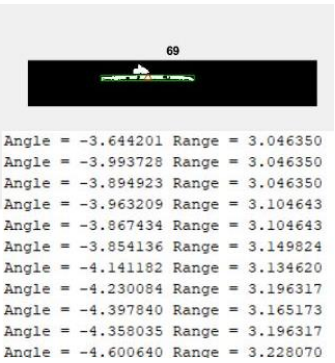


Robot Football Computer Vision

Brennan Amsberry (ERC), Vincent Angelino (ERC), John DiNofrio (ERC), Morgan Steffey (ERCH)

The USNA Robot Football team needs a quarterback capable of autonomously locating targets and defenders with first person view for tackling. The computer vision team is tasked with accomplishing those goals. Using RaspberryPis, webcams, and openCV code, all Robot Football components will have basic computer vision technology that increase the accuracy and and capabilities of the players.

Robot Football: Base Team

Thomas Larrea (ERC), Mitchell Luckinbill (ERC), Isaac Willis (ERC)

We are a subteam within the Robotic Football Capstone Group. Our goal was to standardize and update last year's base to make it modular and game ready. These two focuses required us to comply with each of the leagues rules while also implementing parts that we believed would give our robots an advantage over the other teams.

Robotic Football Competition

Ricco Price (EME), Emily Solis (ERC), Prescillia Truong (ERC)

Design and build a robot to fill the role of a 'center' during the 2020 robotic football competition. The goal of the robot being to pickup the football from the ground, successfully transfer it to the QB, then commence blocking.

Sailbot

Luke Marino (ERC), Alec Plzak (ERC)

The Sailbot is a six foot long autonomous sailing vessel designed to cross the Atlantic without any human input. This project implements a modular control system designed to facilitate future modifications. The NMEA 2000 Controller Area Network standard is implemented to allow for the use of COTS sensors with embedded microcontrollers. A Linux single-board computer is programmed to autonomously position the mast and rudder in order to autonomously navigate to desired navigation waypoints.

Simulated Maritime Inertial Navigation System with Magnetic Aiding

Gregory Burgess (ERCH)

Inertial navigation systems (INS) are commonly used to determine an estimated position during open ocean navigation, but must be aided by an external navigation source, such as the Earth's magnetic field, to limit the estimated position uncertainty. By utilizing navigational data collected from USNA's fleet of Yard Patrol craft and simulated noisy magnetic measurements, extended Kalman Filter performance is analyzed to determine the feasibility of using the Earth's magnetic field as an INS aid.

Smart Chaff - Disposable Autonomous Gliders

Reed Guthrie (ERCH)

Chaff currently used as a radar countermeasure by the US military has significant limitations, especially in regards to controllability and distribution. A new approach to chaff has been developed, focusing on control of a swarm of autonomous micro aerial vehicles. Novel, inexpensive, and lightweight dispoable gliders have been designed to provide limited maneuverability in order to offer a controllable chaff cloud analog. Analysis of flight dynamics and coordinated control are presented.

Soft Robotic Smart Tourniquet System

Zach Richart (ERC), John Finnegan (ERC), Bethany Spangler (ERC)

Create a soft robotics tourniquet with a controllable fluid in order to reduce risks of field tourniquets on patients.

Solutions of the Paraxial Wave Equation in COMSOL

Kyle Jung (SMA)

The paraxial wave equation models laser light propagation, satisfying Maxwell's Equations and the wave equation. Analytical solutions to the paraxial wave equations exist in special circumstances such as laser propagation through free-space. There are few solutions to the paraxial wave equation for modeling laser light through a complex media such as turbulent water. This project will investigate the use of COMSOL to numerically solve the paraxial wave equation using the finite element method.

Student Unmanned Aerial Systems Anaconda Retrofit, Avionics Payload

Moson Fereday (ERC), Alexandra Heller (ERC), Montassar Mouaffak (ERC), Claire Ostrowski (ERC)

The goal of this project is to design and build a retrofit avionics package into the upper compartment of an RMRC Anaconda unmanned aerial vehicle (UAV). The avionics package must house all flight-critical hardware including flight controllers, wireless communication hardware, and onboard processing units while interfacing with the sensors and actuators on the UAV. The overarching goal of the payload design is to house the required equipment with minimal modifications to the existing airframe

Student Unmanned Aerial Systems Anaconda Retrofit, Drop Payload

Lennin Pineda (ERC), Robert White (ERC), Cody Yates (ERC)

The goal of this project is to specify, design, and build a retrofit to an RMRC Anaconda unmanned aerial vehicle (UAV) that is capable of deploying a ground vehicle. This ground vehicle must survive a 500' drop and autonomously navigate to a GPS coordinate. The focus is to design the drop system into the rear payload section of the UAV and interface with an existing avionics package. The design must provide one operational ground vehicle and incorporate any necessary drag/arrestor systems.

Student Unmanned Aerial Systems Anaconda Retrofit, Optical Payload

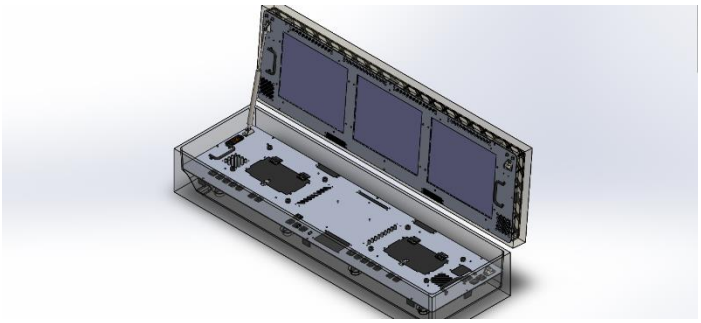
Logan Cameron (ERC), Cole Weber (EME), Peter Zagara (ERC)

The goal of this project is to specify, design, and build a retrofit to an RMRC Anaconda unmanned aerial vehicle (UAV) incorporating a multi-camera optical payload. The optical payload must interface with an existing avionics package to wirelessly stream time and telemetry-stamped video to a ground control station. The optical payload design must fasten to the UAV with minimal modifications to the existing fuselage while accommodating weight and balance requirements of the UAV.

Student Unmanned Aerial Systems Ground Control Station

Pablo Flores (ERC), Campbell Lee (ERC)

The focus of this project is to specify, design, and build a rugged, two-man portable ground control station (GCS) for use during unmanned aerial vehicle (UAV) operations. Specifications for the GCS are driven by the UAV interface design established USNA SUAS team. The GCS design leverages a rifle case retrofit with sunlight readable monitors, a backup battery, two mobile workstations, a single board computer, networking hardware, and radios for long-range command and control communication.



Swarm System Parameter Identification with Infiltrator Input

Alex Yeiser (ERC)

Swarm technology is a growing threat to U.S. forces through the advancements in unmanned vehicles. The purpose of this research is to determine swarm characteristics for a swarm of autonomous agents using input from an "infiltrator" in the system. Assuming we can infiltrate an agent in the swarm and the swarm follows a cyclic pursuit control law, the goal is to use only the inputs and outputs of the infiltrator in order to learn the swarm parameters and to eventually gain control of the swarm.

SWAT-C: VTOL Tail-sitter UAV for Extended Network Coverage

Nathaniel Blount (ERC)

Squad with Autonomous Teammates Challenge (SWAT-C) is a project, which investigates the development and integration of unmanned systems with a Marine squad. Of critical importance to the mission success of a marine squad is maintaining communication network. This project seeks to develop a squad deployable vertical take-off and landing (VTOL) UAV to act as a communication relay.

Humanities and Social Sciences

Analyzing the Effects of Law Enforcement Militarization on Elections

Rory Sprague (FQEH)

In recent decades, local law enforcement agencies have been increasingly supplied with surplus military hardware. The resulting police militarization affects policing methods, and consequently the relationship between law enforcement and communities. This research intends to determine the effects of police militarization on aspects of federal elections through the analysis of county level panel data in multiple federal elections in the past two decades.

Are Speed Limits Effective in the District of Columbia

Chris Adames (FQE)

Highway speed limits in the District of Columbia are currently set at 55 mph. Are they effective in reducing car accidents? Driver safety is a big deal with the millions of car accidents that occur yearly. I will be studying the implications of raising or lowering the speed limit. Including economic cost-benefit analysis, distracted driving, and etc.

Crime Rates and College Education levels over time

Alexis Bolden (FQE)

The project looks at the relationship between college education participation and crime rates over time in the United States. Using data on crime rates by year and various education and economic factors, the project assesses any link between higher education participation and long run trends with the crime rate.

Does it Matter How You Feel? Self-Reported Health in the Construction of Health Indexes

Frey Pankratz (FQEH)

Health surveys frequently ask respondents to self-report their health on numeric or non-numeric scales. These subjective evaluations of health are then used as health indicators in cohort studies and population health indices. Despite the common use of these indicators, their validity remains unclear. I seek to determine how individuals weigh different physical and social characteristics in self-reporting their health.

Effects of Charter School Laws on School Performance

Emma Remis (FQE)

Studying the relationship between charter school laws and over state performance in reading and math. The quality of charter school laws is determined by various factors including the amount of financial autonomy these schools have from public districts.

Is the Race for Renewables Worth It? An Exploration of the Effectiveness of Renewable Energy

Giovanna De Vito (FQE)

This paper explores the production of carbon emissions and renewable energy in nations across the globe to evaluate current policies and potentially provide evidence to change carbon reduction strategy. The goal of this paper is to demonstrate how varying economic development levels of a nation impact renewable energy capabilities and policies.

Maximizing State Budgets: How Raising the Minimum Wage Affects Medicaid Spending

Samuel Pahl (FQE)

Econometrical analysis will be used to prove a correlation or lack thereof between minimum wage increases and Medicaid spending by state. A regression will be used to quantify this effect in addition to an analysis of deadweight loss in tax dollars due to wage rate increases in comparison with state spending on Medicaid and other social programs.

Oil Price Trends

Diego Manrique (FQE)

As the lifeline of industrialized nations, understanding why the changes in prices for oil occur and their trends is extremely important.

Optimization of US Ocean Cleanup Efforts

Tyler Courtney (FQE)

TIDES public data has collected information on trash collection across the United States. In conjuncture with data about our surrounding bodies of water and nearby population we can control for variables that may differ from trash sites. Using this information we can look at the areas to focus our ocean cleanup efforts to reduce the amount of pollution in our oceans.

Predicting the Success of a Broadway Show

Miahnna Nguyen (FQE)

The 41 Broadway theaters that live between 42nd and 53rd street in Manhattan are an immense part of tourism culture and have a significant economic impact on the city of New York. With so many producers competing for stage space to bring their show to life, only so many actually make it to perform on Broadway, but what makes a successful show? Through a regression using panel data from a decade of Broadway statistics predicts how demand and revenue increase based on a wide range of factors.

Real Estate Investments and Military Personnel

Andrew Douglas (FQEH)

This project is an attempt to answer the following question: Do residential properties near military bases prove to be better investments?

The Impact of Monetary Policy on Commercial Bank Profitability in Dynamic Interest Rate Environments

Connor Wilson (FQEH)

Interest Rates within the US Financial Markets have remained at historically low levels for much of the past decade. As such, commercial banks have shifted their operations and risk preferences in order to avoid net interest margin compression and maintain traditional levels profitability. In this research I examine the efficacy of the Federal Funds rate, isolating its impact on commercial bank interest rate risk and profitability.

Traditional College vs. Vocational School

Hannah Milliron (FQE)

The goal of the research is to determine the return on investment for 4-year college education and 2-year vocational education. Research will be conducted on the debt incurred by students and how long it will take to pay off the debt and start to make a profit. Additional data will be collected on income and employment rates for certain fields.

Who is really in charge? The power of advertisement through consumption

Hunter Woods (FQE)

Consumption across America has been at an all time high. It is easier and faster to consume products, with a click on a button we can have groceries, domestic and international products, and complete a transaction behind a desk or a phone screen. The ideal scenario is to make informed purchases that are thoughtful and not influenced by giant data companies that predict your purchasing habits.

Allies at Sea: Anglo-American Naval Relations, 1952

Will Karakul (HHSH)

As part of the honors history major, MIDN Karakul submitted a 52 page thesis detailing Anglo-American naval relations in the NATO context. He concluded that allies in the maritime context, even during times of political and strategic disagreement, can be counted on to perform with a high level of operational and tactical cooperation.

Christian Death: A Lens to Examine Change in 13th Century Iceland

Caroline Huber (HHSH)

In 1000 CE, pagan Iceland voted at their Althing to officially convert to Christianity. However, the process of Christianization continued centuries after the ruling at the Althing. The Icelanders struggled with reconciling their history, stories, ideals, and morals with the teachings of Christianity. In this thesis, I will examine how the relationship between the living and the dead changed as the Icelanders accepted and integrated Christianity into their society.

Komsomol in the Holodomor-Youth Participation in Ukrainian Famine

Zachary Toole (HHS)

My project examines survivor testimonies connected to the participation of the Communist Union of Young People in the Холодомор (Holodomor)-- the systematic starvation of Ukrainians by Russia under Joseph Stalin. CUYP were comprised of youth, aged 14 to 19. They participated in removal of food from peasant communities, which ultimately died in the millions.

Digital Edition of a Recently Discovered Text

Duncan Farrant (HEGH), Kelly Harrington (HEGH), Sydney Hirokawa (HEGH), Spencer McVeigh (HEGH), Massimo Morreale (HEGH), Raquel Palma (HEGH), Tyler Reasner (HEGH), Gabriella Shyne (HEGH)

This online edition presents a critical edition of a recently discovered early modern text, along with collations of variant texts, commentaries, and other resources for students and scholars.

Discipline in the Formative Years of the United States Naval Academy

Julia Speranzo (HHS)

An archival, qualitative analysis of discipline and its enforcement in the first decade of the United States Naval Academy, specifically examining the intentions of the founders and consistency across leadership changes and time.

Man Closest to the President: Milton Eisenhower and U.S. Cold War Foreign Policy in Latin America

Madeline Angeli (HHSH)

The strong relationship between Dwight and Milton, led to Milton assuming the role of his brother's closest adviser. Rising populist nationalism in Latin America led to the Eisenhower administration abandoning its non-interventionist stance to deter perceived communist threats. Milton Eisenhower's 1953 policy recommendations following his Goodwill Tour contributed to new U.S. economic policies in Latin America and formed the basis for Kennedy's Alliance for Progress program.

Peacekeepers and Enforcers: Assessing Military Police in Occupied Japan

Harrison Jones (HHSH)

The role of American military police during the occupation of Japan has been an overlooked subject in the history of the postwar era. Using archival sources from the National Archives, I examined hundreds of police reports that highlight the threatening existence of GI and Japanese crime. MPs played an essential role in enforcing occupation policy and keeping the peace in the postwar era at the lowest administrative level of the occupation.

The Enlightenment after Dark

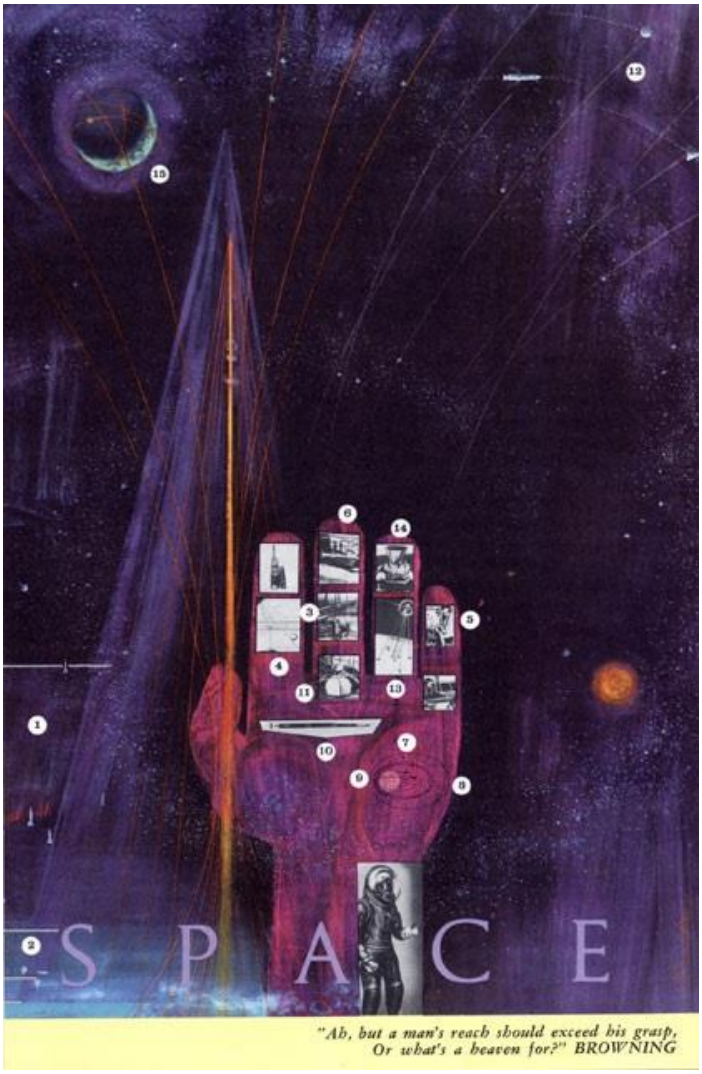
Regan Kibby (HEG, HHS), Jessie Brodeur (HEG), Samantha Geere (HEG), Joseph Goff (HEG), Camila Healey (HEG), Megan Lysford (HEG), Thomas McGowan (HEG), Ricardo Ontiveros (HEG), Joshua Roetman (HEG), David Tolentino (HEG)

Students in this literature capstone are researching topics related to gender, sexuality, and relationships in eighteenth-century England. Based on this research, they will collaboratively create five podcast episodes and one accompanying poster.

The Forgotten Scottish Martyrs: The United Scotsmen and the Crises of the 1790s

Kendall Zotti (HHSH)

In late 1790s Scotland the United Scotsmen emerged as an underground and secretive organization that protested and rioted against the government for universal suffrage, annual parliaments, and a greater place in the Union. They are important to Scottish history because they speak to the contingencies of Scotland's radical tradition, evolution of political participation, and reveal how a distinct community interacted with the complexities of the 1790s.



The Science Advisor in National Strategy: The Arctic and the International Geophysical Year

Joshua Walton (HHSH)

This paper investigates the socio-cultural relationships between the American federal research structure and Arctic national defense strategy in the early Cold War through an examination of the International Geophysical Year (1957-1958)

Finding Peace in the Israeli-Palestinian Conflict

Robert Bellantoni (FLA, FPS), Joel Oviedo (FLA)

Is peace possible in the Israeli-Palestinian Conflict? This research project explores the different roads to peace from official policies and conferences to local grassroots initiatives. It will also explore the role of art in helping the peace process by examining various artistic initiatives that played a role in bringing Arab and Israeli youths closer to understanding each other.

"Women and Gender issues: pre and post Islam"

Sebastian Zuleta (FLA)

The project intends to explore the evolution of women's rights from the pre-Islamic period commonly known as the Jahiliyya, to their rights after the birth of Islam and how it changed their roles in society through an examination of Quranic chapters and verses dealing with women's rights and place in Muslim society.

Arab female authors and political commentary across the Middle East/North Africa

Juliet O'Brien (FPS)

In this capstone, I will analyze how social and political commentary in the Arab world manifests in literature by female authors across the MENA. By reading works by female authors, I aim to show how sometimes repressed voices in Arab society interpret political upheaval specifically through literature. I will focus on a few distinct episodes in the political and cultural history of the MENA region and explore each of these instances through the lens of a few works by women authors.

Hidden Soldiers: The Lives of Women and Minorities in Arab Armies

Mara Riley (FLA, FPS), Darcy Stack (FLA, HHS)

The project intends to explore the lives, struggles, and triumphs of women in Arab armies. These norms and ways of life are compared and contrasted with the lives of other minorities serving in their nations' armies, such as that of the Kurds, in addition to gender norms in the US military.

Humanitarian Aid and the Syrian Refugee

Lydia Williams (FLA)

The Syrian Refugee Crisis has had a strong global impact. Millions of Syrians have fled their homes and live in devastating conditions. The project will explore the lives of Syrian refugees and ask whether humanitarian aid is currently effective. The project will also examine ways in which humanitarian aid programs have impacted refugees.

Muhammed Choukri, Moroccan Writer of Forbidden Literature

Reilly Treat (FLA)

The project will study the works of Muhammed Choukri, a 20th Century Moroccan author whose work was banned from his own country for many years. His works are about his life and describe the reality of Morocco in the 20th century, during and after the French Protectorate.

Nizar Qabbani: a timeline analysis of his poems

Lucas Bolding (FLA)

The research explores the Syrian poet Nizzar Qabbani, one of the most influential voices in the history of Arab literature. The project intends to look at how his love poems reflect the experience of women in traditional Muslim society.

Political Dissidents in Saudi Arabia

Georgia Deems (FLA)

This research compares and contrasts the detention of various Saudi Arabian political dissidents such as Jamal Khashoggi. In the past decade many people have been arrested or detained for publicly disagreeing with the government. The research will look at why they disagreed, what happened to them, and the rising power of Crown Prince Mohammad Bin Salman.

The Cultural Impact of the Arab Spring

Thomas Evans (FLA)

The project focuses primarily on the artistic movements rooted in Egypt, Tunisia and Libya during and after the Arab Spring. Numerous artists and their respective bodies of work will be analyzed. The range of material analyzed will stretch from poetry to graffiti to comics to songs and performed poetry.

When You Argue with the Qur'an

Melissa Ramkissoon (FLA)

The research addresses women's rights in Morocco with a focus on the Moroccan author, Fatima Mernissi (1940-2015), a pioneer in the feminist movement and known for reinterpreting the Qur'an. This project will inquire into the extent of her influence on women's rights today.

Will the increase of urbanization in the Middle East cause an increase of democratization?

Anna Cutler (FLA)

Historically, large population density, such as big cities, enables the public to come together to stand up against repressive governments. This project studies countries in the Middle East that are distinct in their government, history, economies and freedoms and will consider the role of those factors in the democratic development in the region.

National Security in the Context of Foreign Investment: A Legislative History of the Debate

John Guillotte (FPS)

The degree to which national security relies on the state of the economy has been a matter of debate in the United States since the American Revolution. This capstone reviews the origin of the concerns regarding foreign investment and national security, assesses the legislation in place to mitigate it, and offers an analysis of the need for and efficacy of the statutory solutions intended to resolve the potential issues it raises in an increasingly globalized economy.

Outrage in Social Media and its Effects on Polarization in American Politics

Emilyanne McInnis (FPS)

This capstone project examines the phenomenon of "outrage" discourse in American politics, specifically in the use of social media. Utilizing a case study analysis of U.S. Senators from Florida, the project analyzes the impact of outrage media on polarization as measured by bipartisanship behavior in the U.S. Senate.

Strategic Foreign Policy Engagement: An Analysis of Secretary of State Travel (1950-2020)

Donny Lofe (FPS)

Travel by key members of the Executive Branch of government is not well understood in the political science literature. While some scholars have examined travel by the President of the United States, the Secretary of State is a key figure with respect to executive travel during an Administration. This capstone project examines the variation in Secretary of State travel abroad in support of foreign policy goals.

The Impact of a Presidential Run on Legislative Effectiveness in the United States Senate

Emma Seckinger (FPS)

This capstone project examines the legislative effectiveness of U.S. Senators before and after an unsuccessful campaign for the presidency. With so many Senators seeking the presidency, the effects of raising a politician's national profile are largely unexamined in the political science literature. This project analyzes this question utilizing Legislative Effectiveness Scores (LES) developed by Volden and Wiseman.

WikiLeaks, Freedom of the Press, and their Impacts on Law and National Security

Zach Abraham (FPS)

I examine how freedom of the press must be considered in the modern age to deal with new means of information sharing, and how the government must reevaluate both its approach to protecting information, and prosecuting those who unlawfully share it. Cases such as that of Chelsea Manning, constitutional law, supreme court decisions, and congressional hearings are used to evaluate solutions and impacts of information sharing on national security

Mathematics and Science

A Molecular Dynamics Study of Fuels Containing Alkylcyclohexanes

Stephanie Downing (SCH)

This project uses computer simulations to model physical properties of binary surrogate fuels composed of alkylcyclohexanes and a branched alkane. Properties, such as density, bulk modulus, and viscosity can be predicted. These property predictions can be used to identify new surrogate fuels. In addition, changes in properties with composition can be attributed to specific changes in molecular packing due to the nature of molecular simulations.

An Atom's First Approach to Plebe Chemistry

Trevor Clark (SCH), Sebastian Yocca (SCH)

An Atom's First approach was used in the Plebe Chemistry course. This research analyzed the work of Atom's First students to identify the strengths and weaknesses of an Atom's First curriculum. Student free response and multiple-choice answers were coded and analyzed to identify which concepts plebe chemistry students found most challenging.

Analysis of Vintage Dyes and their Degradation Products

Aimee Dervishian (SCH), Justin Goodwin (SCH), Connor King (SCH)

From 1893 until 1976, the Monroe Chemical Company sold Putnam Fadeless Dyes. These dyes were used by consumers to color numerous types of textiles. Using samples acquired from Putnam product displays of the 1920's-1930's, we developed a micellar electrokinetic capillary chromatographic (MEKC) method of analysis of fabrics containing these dyes.

Changing the Ligand Specificity of a Riboswitch from Guanine to Hypoxanthine

Andrew Hong (SCH), Adam Esqueda (SCH)

We are using an in vitro selection strategy to find RNAs that can serve as sensitive and specific sensors for the in vitro detection and quantification of hypoxanthine.

Construction of Complex Nanocrystal-Molecule Assemblies

Eric Cal (SCH)

We are developing a general synthetic approach for functionalizing the surfaces of sub-10 nm colloidal nanocrystals with redox-active molecules. The photophysical properties and colloidal stability in various media of these nanocrystal-molecule hybrid materials is of interest for applications in photoredox catalysis and optoelectronics

Controlled Ring-Opening Metathesis Polymerization Using Vanadium Initiators

Brennen Bowen (SCH)

Ring-opening metathesis polymerization (ROMP) is a powerful method for the synthesis of controlled polymers. Many commercially available initiators for this reaction are highly active and selective, but are based on rare and expensive metals. This project aims to expand controlled, living ROMP to vanadium, an abundant, inexpensive base metal, which has recently shown activity in olefin metathesis reactions.

Cultural Heritage Research: Non-destructive Analysis of 17th Century Manuscripts .

William Plouffe (SCH)

In collaboration with The Naval Academy Museum, we are investigating two 17th Century manuscripts have among the earliest representations of flags of nations and city states. Understanding the material used, particularly the paint pigments can inform historical, art conservation and display issues. X-ray Fluorescence (XRF) and Raman Spectroscopy (RS) were chosen because of their complementary data (metals with XRF, organics with RS) and their non-destructive character.

Degradation of Chemical Warfare Agents using Metal Organic Frameworks

April Kruse (SCH), Ruth Langat (SCH), Christopher Saker (SCH), Joel Smith (SCH)

A family of metal organic frameworks (MOFs) were synthesized and characterized. The MOFs were embedded in cotton fibers and evaluated for their ability to degrade a nerve agent mimic.

Developing vanadium-oxygen clusters as synthetic precursors for metal oxide nanocrystals

Ashley Sweet (SCH)

Complex vanadium oxides containing either bismuth, copper, or manganese are candidate materials for driving chemical reactions using sunlight. We are investigating the preparation of colloidal complex vanadium oxide nanocrystals using anionic vanadium-oxygen clusters as a vanadium source. Vanadium-oxygen clusters structurally resemble fragments of the oxides, and when chemically linked together, may provide a synthetic pathway to the target materials.

Development of a tandem catalytic methodology for the trifluoromethylation of aryl bromides

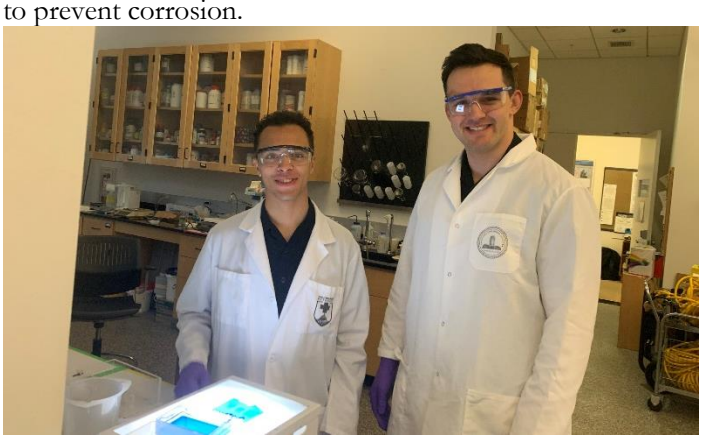
Michael Cedillo (SCH)

Progress toward the development of a concurrent tandem catalytic (CTC) methodology for the trifluoromethylation of aryl bromides will be reported. In the first step of the method, an aryl bromide will be converted into the corresponding aryl iodide. The more reactive aryl iodide will subsequently undergo a coupling reaction to produce the desired trifluoromethyl arene. The effect of reaction variables such as the catalyst (metal and ligand), temperature, and time will be discussed.

Evaluation of Anti-Corrosion Coatings Using Scanning Electrochemical Microscopy

Jordan Paramore (SCH)

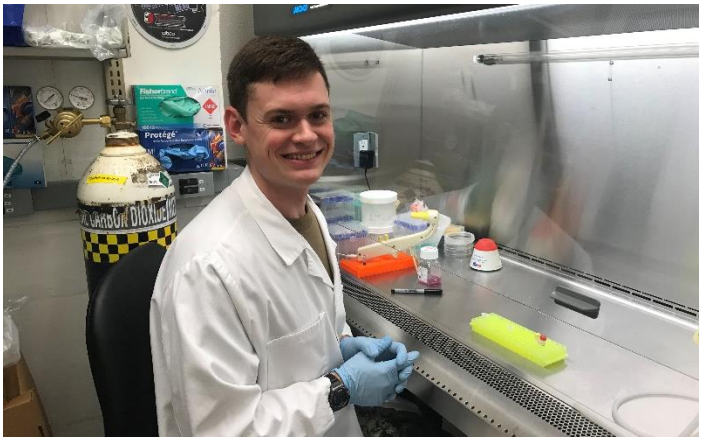
Anti-corrosion coatings can limit the degradation of metal substrates. The Navy seeks to find a non-toxic anti-corrosion coating that works efficiently. The Scanning Electrochemical Microscope (SECM) can be used as a rapid screening technique to analyze, characterize, and determine a coating's resistance to corrosion. This project evaluates several anti-corrosion coatings with varying amounts of cerium oxide nano-particles in order to determine its ability to prevent corrosion.



Examination of Antisense Transcription in the Human Endogenous Retrovirus Type K

Benjamin Phelps (SCB)

Human Endogenous Retroviruses (HERVs) are ancient viral sequences that comprise ~8% of the genome. Products coded by these sequences often appear in autoimmune diseases and many types of cancers. Our research explores the mechanism of double-stranded RNA formation which could lead to autoimmunity.



Investigating the Reactions Catalyzed by Mycobacterial L,D-Transpeptidases

Grace Lane (SCH), Katherine Marapese (SCH, SCB)

Cross-linked peptidoglycan (PG) is an essential component of most bacterial cell walls, and transpeptidation (cross-linking) is the final step in PG biosynthesis. Mycobacterial PG is uniquely 3⟶3 cross-linked by L,D-transpeptidase (Ldt) enzymes, and Ldts are inactivated by the (carba)penem class of β-lactams. Mycobacterial genomes encode multiple Ldts that likely serve distinct physiological roles. Here, we explore the reactions catalyzed by mycobacterial Ldts.

Iron(II) octaperfluorophenyltetraazaporphyrin: In search of a reversible colorimetric CO sensor

Garrett Forrester (SCH)

We reported an iron(II) tetraazaporphyrin (TAP) that reversibly binds CO but not O2 – in sharp contrast to all hemoproteins and analogs. This behavior likely derives from a positively shifted iron (II/III) potential. In order to explore this hypothesis further we have synthesized iron(II) octaperfluorophenyltetraazaporphyrin. We report here our synthesis and characterization of this material. We also report ligand binding studies and comparisons to structurally similar iron(II) macrocycles.

Isolation of novel arctic and temperate marine psychrophiles and characterization of endotoxin

Timothy Brough (SCH), Alexander Murray (SCB)

Endotoxin is a critical membrane component and structural scaffold for adaptation to cold growth conditions in arctic psychrophiles. To investigate this phenomenon and reveal possible systematic differences in structure and capability between arctic and temperate psychrophilic bacteria, we characterized the genetic identity and endotoxin structure of bacteria isolated from the Sagavanirktok and Kuparuk River watersheds of Alaska and also from winter water of the Severn River in Maryland.

Separation and Identification of Hydrolyzable Tannins from Northern Red Oaks

Ixel Ochoa (SCH), Breanna Akins (SCH)

Hydrolyzable tannins may be produced by oaks as defense compounds, protecting oak leaves from Gypsy moth larvae and other insect predators. As part of a project to understand the role of tannins in oaks, we are isolating and identifying the individual compounds in a complex mixture of tannins. This project involves chromatographic separation of the individual compounds followed by identification by mass spectrometry.

Structural and functional characterization of the human endogenous retrovirus type K.

Christophe Theodore (SCB), Tyler Martin (SCH)

HERV-K is a type of heritable retrovirus identified as a risk factor in cancer and autoimmune and neurological diseases. We analyzed the structure of an RNA element that is necessary for HERV-K production. We also purified HERV-K and HIV proteins to study RNA-protein interactions involved in HERV-K production.

Synthesis of Antimalarial Compounds

Juliana Bae (SCH), Daniel Dolan (SCH)

Structural modifications will be made to a promising class of molecules with the goal of enhancing their physiochemical and antimalarial properties. New compound structures will be designed, synthetic routes to these targets will be developed, and synthesis of the targeted compounds from purchased chemical starting materials will be conducted.

The Impact of Natural Fiber Welding on the Surface Area of Biopolymer Materials

Julia McFarland (SCH)

Natural Fiber Welding (NFW) applies the unique properties of ionic liquids (ILs) to mobilize and reconfigure natural biopolymer materials. NFW processing variables such as time, temperature, type of IL, and reconstitution solvent have a significant impact on the resulting biomaterial properties. In this study, we apply gas physisorption and microscopy methods to measure changes to the surface area of cellulosic materials due to systematic variations of NFW process variables.

USNA Acute Blood Lactate Response to Interval Exercise with Compression and Cooling

Christina Quigley (SCH), Lauren Heaton (SCH)

The purpose of this study is to distinguish the correlation of subjective measures of exertion and lactic acid "burn" with the measured whole blood lactate response the human body experiences during different stages of exertion. Evidence from this study could provide information necessary to apply new technology to conventional interval training.

Analyzing Android to Assess Networking Functionality and Privacy

Caroline Sears (SCS)

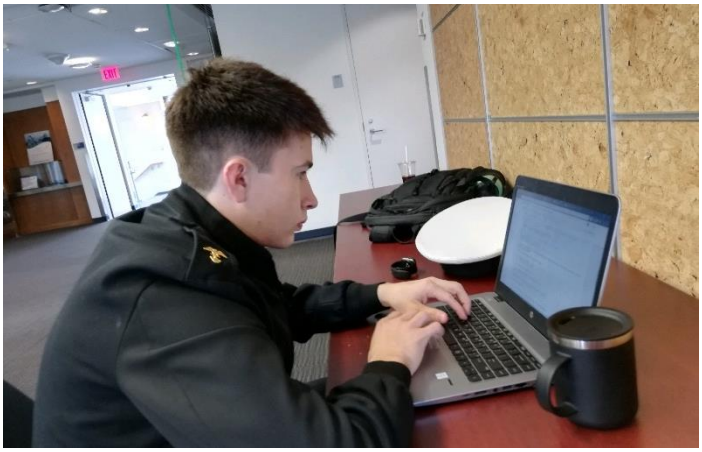
WiFi MAC address randomization protocols are used by a variety of mobile devices to thwart

physical tracking based on wireless signals. We intend to assess a corpus of Android devices and determine which protocols they use to randomize MAC addresses, identify flaws, and report a state of knowledge on randomization in real-world mobile devices in the present day.

Cancer Survivability Prediction

Jason Henry (SCS), Deon Odom (SCS), Hitoshi Oue (SIT), Tanner Strawbridge (SIT)

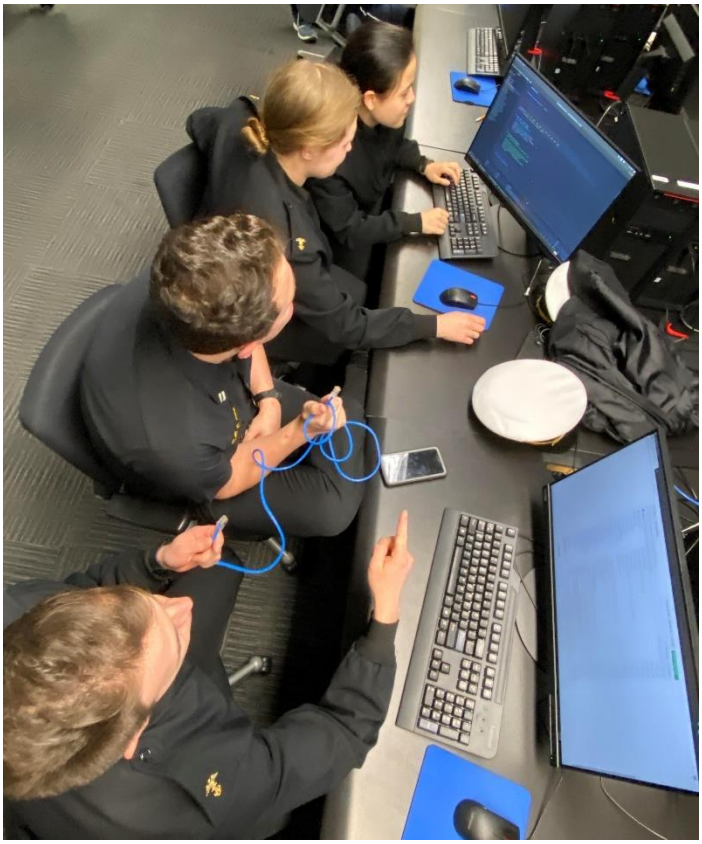
This project implements different Machine Learning Models trained to predict the survival rates of cancer patients. Cancer patient data is compiled from the National Cancer Institute of Research for use. These models aid a web-based tool with patient diagnosis capabilities. The web-based tool allows a user to request a prediction from the system based on a set of input features provided by the user.



ChatBot

Lani Davis (SCS, SIT), Ryan Eilers (SCS, SIT), Michael Garcia (SCS), Caroline Sears (SCS)

Create a ChatBot for the My Navy Portal (MNP) website to enable users to efficiently locate resources provided on MNP and associated systems. MNP currently has an ineffective search method for locating the resources it offers. The ChatBot will utilize Natural Language Processing (NLP) to allow the Chatbot to effectively and naturally communicate with users.



Counter Drone System

Jake Brophy (SCS), Adam Kobylka (SCS, SIT), Brian Tat (SCS), Kevin Volkov (SCS)

This capstone is a Counter Drone System (CDS) that relies on relevant radio frequency signatures to detect and disable a drone. The CDS will detect the presence of a drone using an experimentally derived radio frequency signature with a Software Defined Radio. The CDS will then broadcast incorrect GPS data in an effort to confuse the drones onboard software and disable the drone.

Cover Me!

Danielle Corpuz (SIT), Luke Goodson (SCS), Josh Lee (SCS), David Vine (SCS)

The Cover Me project is intended to find a replacement for when a user has to miss an event, whether it is teaching a class in the case of a professor, watch in the case of midshipmen, or a work shift in the case of many others. It will maintain a record of how often each user requests for help and covers events in order to attempt to enforce fairness. Each user will also be a member of a group(s) that qualifies or disqualifies them from covering an event.

Guardian Angels Mobile Application

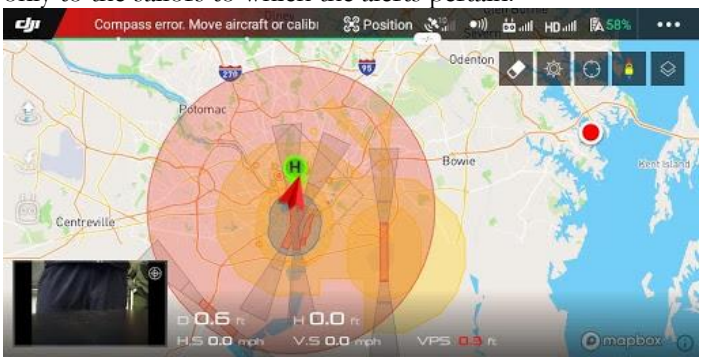
Chris Daves (SCS, SIT), Patrick Dowd (SCS), Chesley Kruh (SCS), Christopher Murray (SCS)

Guardian Angels is a program stood up by the ADEO staff at the United States Naval Academy which encourages Midshipman to look out for each other by ensuring inebriated Midshipman are safe as they drink on the weekends. This capstone developed a mobile application to further the mission of the Guardian Angel program, by providing easy, quick access to a variety of resources an inebriated Midshipman may want to use, such as calling an Uber, a nearby Guardian Angel, or the Shipmate van.

NAVADMIN/ALNAV Targeted Alerts

Bradley Buchter (SIT), Allison Gonzales (SCS), Oluf Olubajo (SIT), Sawyer Kaye (SIT)

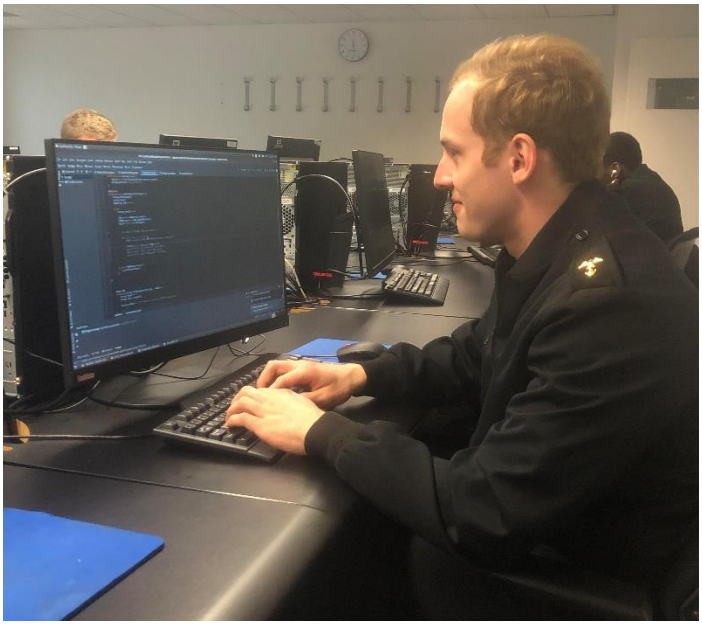
Sailors often receive alerts from the Navy informing them of varying things and events. The challenge with this process is that these alert messages are sent to all naval personnel when they only pertain to a certain group of sailors. The solution is to create a program that combs through these messages picking out keywords in order to filter the alerts to be sent only to the sailors to which the alerts pertain.



QUIC Chat

Jo Martin (SCS), Alec Aldritt (SCS), Chris Smith (SCS, SIT)

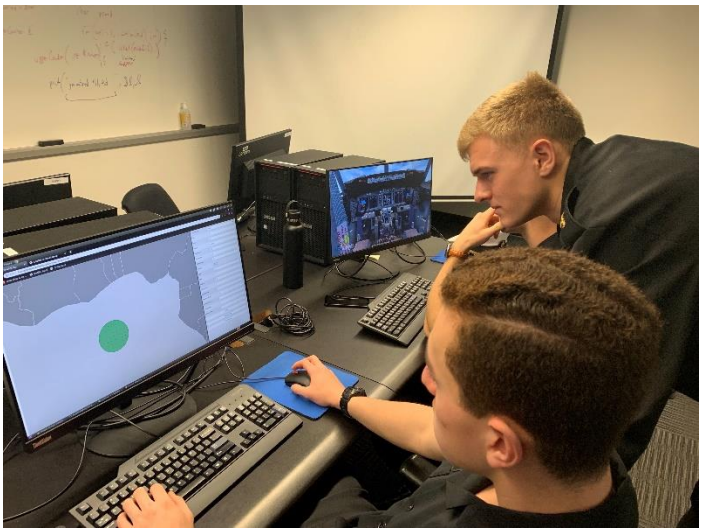
Networks were originally designed with stationary computers in mind. With the popularization of smartphones, computer usage is becoming ever more mobile. However, the way networks connect and pass data has remained centered on this early concept of stationary end-points. A new, experimental protocol, QUIC, has been created to bring the way networks transfer data into the modern age of computer usage. The QUIC Chat project implements QUIC into an instant messaging application.



Sonobuoy Optimization for Submarine Detection

Kevin Chick (SCS), Matt Frazier (SCS, SIT), Kevin Lu (SCS), David Olds (SCS), Drake Bodine (SCS, SIT)

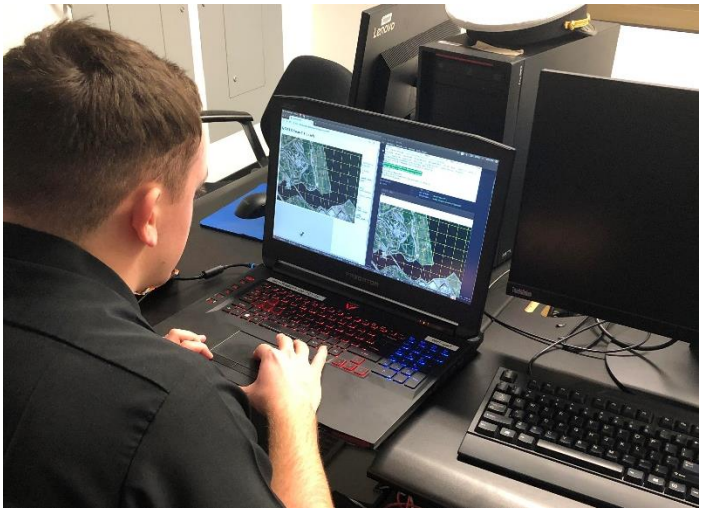
This project aims to improve submarine detection and tracking by P-8 aircraft with an efficient GUI application. Our algorithm produces optimal sonobuoy drop points given the submarine's Area of Uncertainty, expected operating posture, initial direction and distance of the P-8, and several other inputs. Once the buoys are deployed, the project provides real time tracking information (position, course, speed) from the time, bearings, and tonal frequency of buoy detections entered by the user.



Spot

Jared Wiltshire (SIT), Josh Thompson (SCS), Sion Harrington (SIT), Servando Varela IV (SIT)

Develop a web application to make it easy for Midshipmen, Officers, Faculty and Staff to find available parking spots on the yard. Vehicle detection software will analyse live video from cameras connected to single-board computers that are placed in strategic locations to observe traffic flowing in and out of parking areas. The data will be sent wirelessly to a central server for collection and presentation that will allow all authorized users to find parking quickly, and efficiently.



SWAT-C

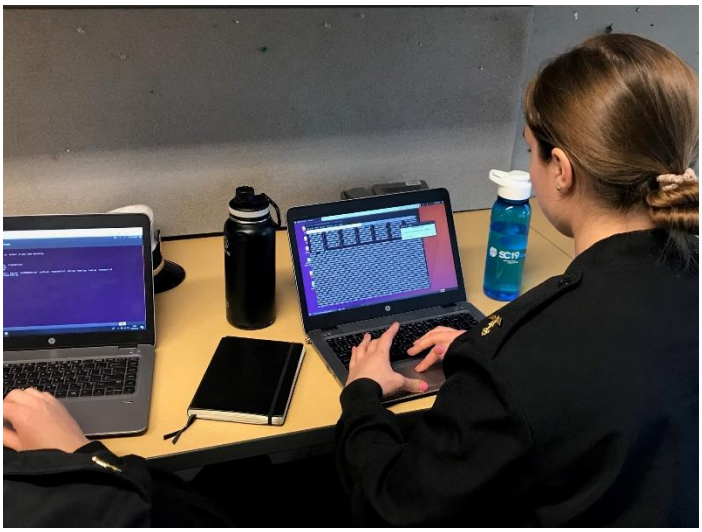
Connor Howard (SCS), Matt Bender (SCS), Stephane Mekoua (SIT)

The goal of this project is to improve the web design and database performance of the user interface as well as the artificial intelligence capabilities of the drones used for the Squads With Autonomous Teammates Challenge (SWAT-C). The drones are used for surveillance and reconnaissance in a squad versus squad tactical competition where they can travel around the area and survey buildings.

Ultrasonic Data Transfer with Sound Fidelity Application

Tyler Beck (ECE, EEE), Daniel Fisher (ECE, SCS), Madeline Mattingly (SCS), Brody McDonald (SCS)

This project uses acoustic and ultrasonic waves as a transmission medium. While it may have limitations such as propagation speed and bandwidth, there are multiple applications where sound based communication would prove useful, such as underwater system control networks. The goal of this project is to develop and refine a sound based transmission system, conducting research into improving key metrics including bit error rate, data rate, and propagation range.



Analysis of Commercial Solid State Drives through Reverse Engineering

Sim Bowden (SCY)

The CRUCIAL Mx200 is a solid state drive (storage device) that features a JTAG interface. Using tools such as the JTAGulator and a Bus Pirate, it is possible to extract sensitive information about the device via the JTAG interface. This information could aid in determining whether or not the Mx200 (and other devices like it) is infected with malware.

Analyzing Video for Intelligence Assesments

Robert Finch (SCY), Grace Lawrence (SCY)

The goal of this project is to develop a program that can monitor video while running in the background, and when keywords are found reach out to a server. The program will send nmap information of the network to the server.

Appeasement in Cyber Space

Julia Buckner (SCY), Piper Freed (SCY), Collin Kane (SCY)

The goal of this Capstone is to provide a guide for action to Upper Level Administrators in the public and private sectors after experiencing a Ransomware attack.

Automobile Fingerprinting and Identification

Yixin Ye (SCY), Ryan Chow (SCY)

This project aims to explore privacy and security issues surrounding wireless transmissions from automobiles to IoT devices. Open-source tools and commercially-available hardware will be utilized to perform fingerprinting and geolocation, focusing mainly on Tire Pressure Monitor System telematics in automobiles.

Cyber-China Policy: Entangle, Align, and Advance

Ryan Grady (SCY)

Increasingly so, there has become a dire need for clear, consistent, and holistic cyber policies to guide us in our engagement with China. The respective economic and geopolitical magnitudes of both nations are unmatched globally and deeply inter-dependent. This policy recommendation aims to advance the long-term security interests of the US in diplomacy, the economic security of its citizens, and the physical security of the US through the strategy of "Entanglement, Alignment, and Advancement."

Decentralized Web Application for Blockchain Data Logging

Andrew Halus (SCY), Jacob Lindow (SCY), Ben Van Duyne (SCY), Garrett Yu (SCY)

This project seeks to determine whether a smart contract on the Ethereum blockchain can be used as a decentralized web application for logging mission critical data to ensure both integrity and availability of data. This project employs the Truffle Framework as a local Ethereum client combined with a front end web server to receive and store data on the blockchain as smart contract transactions.

Electronic Voting

Almas Baishan (SCY), Erich Eden (SCY), Nikoleta Georgieva (SCY)

This timely project aims to solve the difficult problem of assuring confidence in election systems. Our end-to-end voting scheme digitizes an existing ballot system called Scantegrity in order to deliver fast and accurate vote counts while also allowing individual voters and independent auditors to verify that their votes were counted as they should have been.

Exploitation of ADS-B Signals

Sofia Hruby (SCY), Harry Naughton (SCY), Kevin Nguyen (SCY)

This project aims to assess the cybersecurity of the aviation navigation protocol ADS-B. Through demodulation and characterization of the signal, potential vulnerabilities and exploits of the signal protocol are highlighted.

Exploiting Commercial-Off-The-Shelf Drones for Autonomous Public Defense

Jonathan Corbin (SCY), Spencer Stallone (SCY), John VanHouten (SCY)

This project examines the capabilities of commercial-off-the-shelf (COTS) drones for autonomous flight in defense applications. The goal of this research is to explore how such drones may be trained for semi-autonomous and autonomous navigation using organic assets (built-in camera, bluetooth communications) as well as how such capabilities may be augmented through the addition of an on-board processor such as a Raspberry Pi.

Exploiting SIB-17 Messages in the LTE Protocol to Track Mobile Devices

Juliet Yu (SCY)

The LTE cellular protocol includes a feature called WiFi Interworking that allows providers to handoff a mobile device to a WiFi hotspot instead of the cell tower, freeing up bandwidth and reducing costs. The message responsible for this behavior (SIB-17) is not encrypted. We explore the possibility that this message can be crafted using a Software Defined Radio and sent to a target device, forcing it to connect to a known WiFi access point and allowing it to be tracked by a nearby adversary.

Factors That Affect a Software Developer

Connor Jaenke (SCY), Erick Bleakley (SCY), Margaret Madigan (SCY)

This project aims to determine if there are demographic similarities between individuals who pursue and obtain employment in Cyber/Computer Science Related fields. Using designed interviews and surveys, we explore participants early life. Variables include topics such as education, exposure to computing, parental income, etc. This project will ultimately be used to contribute to a recruiting tool to determine what young people are most likely to go into Cyber/Computer Science Related fields.

Factors that Affect a Software Developer

Connor Jaenke (SCY), Maggie Madigan (SCY), Erick Bleakley (SCY)

This project aims to determine if there are demographic similarities between individuals who pursue and obtain employment in Cyber/Computer Science Related fields. Using interviews and surveys created by the team, we explore participants childhood and adolescence. Variables include topics such as education, school exposure to computing, (insert one or two more things here). This project contributes to a recruiting tool for industry, the military and government agencies.

Fingerprinting Tor: How Malicious Websites Can Generate Identifiable Tor Traffic

Allie Freedman (SCY), Colin Gavin (SCY), Kestrel Kuhne (SCY), Annie Oakley (SCY)

The goal of this project is to create a web server that produces uniquely identifiable traffic when a user connects to it through the Tor browser, as well as create an algorithm to detect traffic from our specific server. This would prove the ability to implement traffic correlation attacks at scale, assuming a destination web server has been compromised.

Implementation of 5G infrastructure and Security Risk of using Huawei technology

Juan Santana (SCY), Ben Valdes (SCY), Jemaira Mathissertic (SCY)

The prospect of Huawei's national implementation of 5G technology has created concerns about the resulting cybersecurity of the U.S. telecommunications infrastructure. As these faults are brought to light, we look at policies and protocols that can mitigate the vulnerabilities associated with the use of Huawei's 5G products.

IoT Risk Perception Among Military Families

Elizabeth Drake (SCY), Julia Kalshoven (SCY), Ruth Krueskamp (SCY), Clare McCarthy (SCY)

This project is meant to evaluate security and privacy risks in Internet of Things children's toys, and then gauge awareness of those risks among military families. Ultimately, the goal is to create basic best practice guidelines among military families to enable the safe use of such devices.

Measuring the Illusory Superiority Bias in Resilience to Phishing

Montana Braxton (SCY), Rae-Kelly Hamilton (SCY), Zoe Kelley (SCY)

Psychologists have shown that people believe they perform individually better than the average person in any particular skill; this phenomenon is termed the illusory superiority bias. Exploring the cyber security implications of this notion, this project aims to measure the presence of illusory superiority bias and the impact of previous experience on an individual's susceptibility to phishing attacks.

Mobile Orienteering Platform

Connor Weber (SCY), Eric Lee (SCY)

An application and server framework which allows for the approximation of the movement of an individual. Attempts to work with this to not require an active GPS or data link. The application currently works with android only. The server is built around the LAMP stack which runs the database and apache2 components of the framework. This will hopefully allow for users to spin up functionality easily using EC2 micro stacks on AWS as needed.

Navy Trash Becomes Enemy Treasure

Kathia Castaneda (SCY), Andrew McCarthy (SCY), Noah Smith (SCY)

This project assesses the United States Naval Academy's vulnerability to a cyberattack enabled by dumpster diving.

Overcoming Competing Global Interests to Establish and Maintain Norms in Cyberspace

Collin Kane (SCY), Piper Freed (SCY)

The problem this research addresses is how to combat the difficulties in sustaining cyber norms across nation-states with antithetical interests (ex: the United States and China). More specifically, this research determines whether a bilateral or multilateral approach is most appropriate in sustaining these norms, as well as a mechanism for enforcing these norms to establish and maintain peace in cyberspace.

Pluggable Transports in Tor

Pedro Castillo-Valdes (SCY), Joaquin Gabriel (SCY), Jordan Gonyea (SCY)

The purpose of our capstone is to develop a third-party application for Minecraft users to obfuscate a connection to an external Tor network. Our program uses Minecraft protocol as a lower-layer channel for server-client connections and forwards packets to relays on Tor, thus effectively enabling covert communication.

Red Teaming TAK

Paul Carothers (SCY), Jacob Harrison (SCY), Marie Montehermoso (SCY), Eric Towe (SCY)

This project aims to determine critical vulnerabilities in the Tactical Awareness Kit (TAK) used by special teams in the U.S. government and military. By attempting denial of service attacks and penetration tests, our recommendation includes a comparative analysis between 3 different firewall configurations.

Red Teaming USNA CAC Readers for Better Security

Allison Annick (SCY), Brandon Del Rosario (SCY), Reed Leesman (SCY)

This project aims to analyze and perform a penetration test of the current access control system for the United States Naval Academy while offering an unbiased perspective on the strengths and weaknesses of the current system. While the ability to test the live USNA security network is prohibited, in depth research into the current methods and technologies is conducted in addition to a penetration test of a simulated USNA electronic physical access control system.

Set Drones to Stun: Using Cyber-Secure Quadcopters to Disrupt Active Shooters

Miguel Huerta (SCY), Zack Quilty (SCY), Liam Rock (SCY), Andrew Shea (SCY)

This project examines the use of commercial off the shelf drones operating in a controlled environment and makes a design recommendation for a drone enabled response system to counter the active shooter threat to civilian 'soft targets' such as schools or train stations.

Side channel tracking of mobile devices

Connor weber (SCY), Eric lee (SCY)

Using the suite of sensors on the phone to use minimal battery and gps to covertly track and record positions through dead reckoning.

Special Agent Alexa: Unintentional Recording/Eavesdropping Vulnerabilities on Amazon Echo Devices

Alex Lopez (SCY), Emily Klitgard (SCY), Brittney Slook (SCY)

This project presents various ways in which an attacker could trigger an Amazon Echo device to record or eavesdrop without its owner's knowledge. These vulnerabilities are then applied to various scenarios in which the attacker can use these capabilities to commit blackmail, theft, or gather evidence for a court of law.

State of Knowledge on Wi-Fi MAC Randomization

Eric Towe (SCY)

The goal of this project is to analyze the methods that smartphones use to disguise their wireless signals in an effort to prevent physical tracking. With a focus on MAC randomization, this project analyzes trends in randomization schemes and device signatures while assessing if manufacturers have deployed known best practices, and whether the techniques can be circumvented.

Tweet Authorship Attribution

Luis Castillo (SCY), Connor Kusch (SCY), Kallman Parry (SCY), Valentine Vena (SCY)

This project makes progress toward one of the fundamental problems of cyberspace by exploring the notion of limited text (tweet) authorship attribution using machine learning methods. The end product includes a literature review, results from machine learning experiments, and an analysis of the implications for defense.

Visualizing Networks using Hololens

Jacques Henot (SCY), Knute Jones (SCY), Brandon Shields (SCY), Andrew Piehl (SCY)

Augmented reality presents an opportunity in cyber security to represent large amounts of closely related security data in novel ways using a third axis. This Capstone project synthesizes network scans to create a three dimensional, network "topology" which could be used to rapidly identify vulnerable devices, connections or ports on a network.

Analyzing Cryptographic Zero Knowledge Proofs with Rubik's Cubes

Ryan Orce (SMA)

The crux of modern cryptography is the difficulty of a particular Algebraic problem. Similarly, the difficulty in the Rubik's Cube puzzle is finding a particular set of permutation that can be viewed as algebraic operations. This project will be analyzing applying zero knowledge proofs to Rubik's cubes based on the paper "Zero Knowledge with Rubik's Cubes and Non-abelian Groups" by Volte, Patarin, and Nachef.

Analyzing Pollard's (p-1) Algorithm and it's Weaknesses

Benjamin Provost (SMP)

The RSA Cryptosystem is one of the most widely used methods of encryption for secure data transfer. It succeeds based on the fact that it is difficult to factor large numbers. I will analyze the Pollard (p - 1) Algorithm, and analyze for which types of numbers the algorithm fails. We find that the algorithm works only on factors that are B-powersmooth, where B is an unspecified smoothness bound. The weaknesses of this algorithm led to the development of faster and more reliable algorithms.

Aviation Flight Readiness Optimizer for VAQ-129

Catlen Goss (SMO), Nicole Gibson (SMO), Cheyenne Coughlin (SMO), Steel Templin (SMO)

VAQ-129 trains EA-18G pilots and EWOs. The squadron has difficultly developing a time efficient weekly plan that they are able to stick to. To aid the squadron's future operations schedule writer, as well as their 24 and 48 schedule writer, we formulated a heuristic algorithm that writes into Excel and interacts with their current scheduling software in order to construct a one to two week outlook for the schedulers to advise squadron scheduler's allocation of time.

Classifying Linear Models of Tropical Rainfall

Shaun Rodock (SMA)

In the tropics, rainfall is coupled with dynamics in a complicated way, and often different mechanisms are proposed to underlie different modes of variability. Here linear models are analyzed for different convective adjustment regimes. For both one and two levels of moisture the models are analyzed to find sufficient condition which allow both convectively coupled equatorial waves and the Madden–Julian oscillation.

CRACUNS (Corrosion Resistant Aerial Covert Unmanned Nautical System) ISR Network Deployment

Connor Caniglia (SMO), Natalie LaPlaca (SMO), Brandon Storch (SMO)

CRACUNS drones are deployed as a back-up system to ensure ISR capabilities and vulnerabilities are not compromised in the event of satellite denial or unavailability. This project examines the optimal number of CRACUNS needed and their location to conduct surveillance over hotly contested ocean areas.

Designing for Maintenance (or Not)

Steven Fedorovich (SMO), Maya McPartlin (SMO)

We present an analysis on how to minimize life-cycle costs for a deep water mooring system. Batteries with enough capacity to power the system for an extended period are highly expensive, but the cost to replace and maintain an underwater power supply is also very costly. This project examines if designing a system with a battery large enough for the entire system service life, or designing a system with smaller batteries to be replaced periodically, is the more cost effective solution.

How to Leak a Secret with Lattice Based Cryptography

Alexandros Psichas (SMPH)

We review lattice definitions to describe lattice cryptosystems. We implement the knapsack cryptosystem, to study trap doors; the Gaussian Heuristic, to quantify the difficulty of finding the shortest vector in a lattice; and Babai's Algorithm, to study an iterative solution to the closest vector problem. We also implement the Goldreich-Goldwasser-Halevi (GGH) and NTRU cryptosystems to help us create a unique contribution to the cryptographic field by designing a lattice-based ring signature.

KodakOne Blockchain and Digital Rights

Richard Tapia (SMA)

KodakOne has utilized blockchain theory and cryptography to create its own form of currency, Kodakcoin, in order to have more secure rights for personal photography and uploads on the internet.

Numbers in Nature: Fibonacci, Phi, and Phyllotaxis

Logan Grove (SMA)

We investigate the Fibonacci sequence and Phi - commonly called the Golden Ratio- mysterious mathematical phenomena that frequently occur in nature as if by magic. These mysterious forces are common at scales as small as our DNA up to the vastness of galaxies. We also seek to understand the related phenomenon phyllotaxis, the arrangement of leaves on plants. Lastly, we consider the underlying reasons why these wonders are so frequent in nature, and useful applications we can derive from them.

Optimizing Poker Hand Ranges

Ford Higgins (SMP), Lili Pantaleon (SMA)

The structure behind games of chance, such as poker, allows for careful mathematical analysis of strategies. Texas Hold 'Em is among the most sophisticated games of chance, as the optimal strategy is dependent on other players' choices and is not fully predictable from the start of the game, as with blackjack or other games. Understanding the game better than your opponent is advantageous, as in fleet scenarios. We investigate optimal strategies using a variety of mathematical tools.

Pathway-based Integrative Modeling of Genomics Data

Anirudh Murali (SMPH)

Cancer is a highly complex disease. Developing genetically-based targeted therapies is an essential step towards revolutionizing treatment approaches. Statistical models are an effective tool to identify potential genetic targets for such treatments. These models benefit from integrating different genetic data types, as well as gene pathway information, into a single model. This project proposes a methodology to incorporate genes with multiple pathway memberships.

The Geometry of Gerrymandering and Reshaping Maryland's Congressional Districts

David Duenas (SMA), Nicholas Williams (SMA)

The process of divvying up states into congressional voting districts can be analyzed using geometry and topology. Using techniques from advanced geometry, we will investigate the possibility of redesigning Maryland's congressional districts into quantifiably fairer shapes.

The Uncrackable King: The Tale of Chess and its Secret Message

Matthew Lee (SMA)

Cryptography is the study of altering pieces of information to prevent the public eye from understanding. Chess is the strategic game with over 84 trillion possible combinations in the first four moves alone. This number increases exponentially move after move. As a result, the probability of two chess games to be exactly the same is 1 in 10^40. This low probability makes the game of chess a viable asset to cryptography.

Training Air Wing Two- Time to Train

Morgan Frazier (SMO), Kayla Harris (SMO), Parker Loftus (SMO), Chris Pham (SMO)

Currently VT-22 is requested by CNATRA to get their TTT (Time to Train) to be 45 weeks. With their current resources, VT-22 believes that their TTT is approximately 65 weeks. Our project gives VT-22 an accurate TTT with their current system in place. This is done by creating a model in Jaamsim that portrays how their system is currently operating using real life data over the past few fiscal years. Our project also analyzes how changing their current system can affect the overall TTT.

Using Sudoku Matrices for Image Encryption

Alex Wayne (SMP)

The ability to encrypt images securely is vital to information security in any network where images or videos are used. Using a secret-key Sudoku based encryption provides a method whose possible key space grows proportionally to the factorial of the side length of the matrix used. The project will show an implementation of such a cryptosystem as well as some possible attacks on it.

Waterway Intruder Detection System Optimization

Ian Hamilton (SMO), Sarah Naldo (SMO), Noah Sirianni (SMO)

This project examines the ability to detect enemy divers in a port using a combination of sonar and UUV technology. We apply this problem to the security of the United States Naval Academy along its 2.88 mile perimeter seawall. We use search and detection theory to determine optimal coverage with different combinations of sonar systems and UUVs, and minimize overall system cost while maintaining a required threshold for probability of detection.

Where, Oh, Where Should Our 3D Printers?

Bill Ulrich Villacorta (SMO), Lindsay Arvin (SMO), Jenna Kugel (SMO), Patrick Urrutia (SMO)

Additive manufacturing is 3D printing that could potentially be the future for Naval and Marine Corps Aviation. This will allow the Navy and Marine Corps to produce "airworthy" replacement parts either as needed or as a preventative measure. The goal of our project is to figure out the type, the quantity, and also the location of 3-D Printers for the Navy and Marine Corps.

Wide-Area Active Shooter Protection (WASP) System Employment at USNA Facilities

Jordan Burkart (SMO), Matthew Christensen (SMO), Michael Kacergis (SMO)

Our project examines the use of the Wide-Area Active Shooter Protection (WASP) system for disrupting an Active Shooter scenario at the United States Naval Academy. The WASP system is a network of semi-supervised autonomous drones that deploy from nests. The nests are strategically placed to monitor and protect specific areas and are controlled from a remote base station. We use nodal analysis to determine the optimal placement and configuration of nests to ensure maximum protection.

Agriculture and Urbanization in Egypt: The view from Landsat, 1982 to 2020

Elana Kozak (SMAH), Camille Volk (ERC)

This project will explore the relationship between agricultural success and expanding urban areas across Egypt. We will study satellite images from the Landsat archive over the years 1982 to present. By comparing the land area used for farming to that of cities and large towns, we hope to find a strong correlation between successful agriculture years and more urbanization. We will contrast the results from space with the ground truth from our spring break LREC.

Annual-to-Decadal Scale Hot-Spots for Regional Changes in Arctic Sea Ice Extent

Samantha Fox (SOC), Luke Cota (SOC), Madison Runge (SOC)

Satellite-derived data and imagery was analyzed to identify annual-to-decadal scale hot spots for regional-scale changes in of Arctic sea ice extent. Results were examined in the context of other potential changes (i.e. chlorophyll concentrations, upper ocean heat content) in the Arctic basin to identify current and future potential regional climate feedbacks.

Automated Detection and Identification of Bottom-Mounted Objects in Shallow Coastal Marine Waters

Kent Kirby (SOC), Candace Gordon (SOC), Connor Knowles (SOC)

In collaboration with the University of Delaware, College of Earth, Ocean and Environment, Robotic Discovery Laboratories (RDL), aerial and surface autonomous platforms were used to collect imagery over bottom-mounted objects to test a neural network model for detecting and identifying of bottom-moored objects in in clear, shallow coastal marine waters.

Erosion, Urbanization, and Agricultural Changes in the Nile River Delta Over the Last 35 Years

Grace RoviraMelendez (SOC), Nina Cartwright (SOC)

In this study we will look at the changes in erosion, agriculture, and urbanization at the mouth of the Nile River Delta near Alexandria. We will use GIS software to analyze 35 years of Landsat satellite imagery. Analyzing coastal erosion since the construction of the Aswan High Dam will provide a better geographical understanding of the area, and even suggest future possibilities for agriculture and urbanization in the changing environment.

Exploring the Madden-Julian Oscillation in CMIP6 climate model simulations

Cameron Jackson (SOCH)

The Madden-Julian Oscillation is a leading mode of atmospheric variability that progresses eastward in the tropics with a period of 30-60 days and exerts major influence on weather and climate patterns globally. The intensity and variability of the MJO was examined in the recent Coupled Model Intercomparison Project (CMIP6) climate model output using empirical orthogonal function (EOF) analysis, enabling other MJO teleconnection studies by future students in this project.

Extreme blocking in the North Atlantic Arctic in future climates

Nina Cartwright (SOCH)

GBI, the Greenland Blocking index has been used to quantify large scale disruptions of the Rossby Wave circulation in the North Atlantic, however, it has not largely been represented in future climate scenarios. This project focused on the analysis of data from the climate model inter comparison project to build a climatology of Greenland Blocking within model space. This will then be further connected to Integrated Vapor Transport within that sector of the Arctic.

Forecasting Arctic Sea Ice Extent Using Artificail Neural Networks

Julia Sinkus (SOC)

In this project I will build an artificial neural network model for sea ice extent using wavelet coefficients of several forcing mechanisms. The mechanisms include ENSO, NAO, MJO, and Arctic Oscillation. Monthly predictions of sea ice extent will be compared to actual sea ice measurements for several years.

Improvement of SHARC Model Predictions for Chemical Releases in Dynamic Estuarine Systems

Matthew McClelland (SOC)

As part of ongoing validation and verification of System for Hazard Assessment of Released Chemicals (SHARC) waterborne hazard fate and transport model predictions, studies were performed in the Chesapeake Bay and the Severn River, MD to investigate the potential for improving SHARC model predictions through the integration of physiochemical water column parameter predictions derived from field data run through machine learning algorithms.

Investigating Variability of Antarctic Sea Ice on Subseasonal-to-Seasonal Time Scales

Aspen Bess (SOC)

Antarctic sea ice has been studied for several decades and is an important part of the climatology of the region. The Antarctic can be divided into five sectors: the Weddell Sea, the Indian Ocean, the western Pacific Ocean, the Ross Sea, and the Bellingshausen/Amundsen seas. In this study, trends in sea ice concentration, extent and area in each sector are examined, extending previous studies to include the most current observations.

Land Destruction from Australian Wildfires: Analysis with lidar and satellite imagery

Walter Fagan (SOC)

Wildfires have scorched millions of acres in southeast Australia during a historic dry season. High resolution commercial satellite imagery in the visible and near infrared from Planet Explorer and lidar topography are used to monitor the destruction. Geospatial Analysis shows the true scale of the impacts of this destruction.

Madden–Julian Oscillation, a stochastic nonlinear oscillator model sea surface temperature analysis

Madeline Arbogast (SOCH)

The Madden–Julian Oscillation (MJO) stochastic skeleton model simulates many characteristic MJO features: a slow eastward wave train speed of 5 m/s, realistic pressure and velocity structure and intermittency of MJO events. In prior studies, model solutions have been found using simple background sea surface temperature states. We investigate realistic satellite observation-based sea surface temperature forcing functions and analyze both deterministic and stochastic model solutions.

Measurements of the Optical Properties of the Severn River with an Autonomous Underwater Vehicle.

Jordan Neal (SOC), Dan McDonald (SOC)

Using an EcoMapper (AUV) with side-scan sonar equipped with an Exo1 that measures temperature, salinity, turbidity, fluorescent dissolved organic matter, and chlorophyll-a will be deployed to identify changes in the optical conditions along the winter salinity gradient of the lower Severn River estuary, MD.

Microplastics in digestive systems of winter fish assemblages in the Severn River

Andrew Malick (SOC)

The prevalence of micro and nanoplastics is increasing in ecosystems worldwide. This study builds upon work by K. Shinavski (USNA 2017) to assess prevalence of plastics in the gut contents of winter and spring fish assemblages in the Severn River. Fish were collected from Jan-April. Stomachs were removed, digested, analyzed via microscopy, and compared to controls. Results of this study are an important first step to determine the effect of microplastic pollution in the local waters around USNA.

Optimization of Chlorine Levels to Prevent or Reduce Biofouling in Shipboard Systems

Pia Mackie (SOC), Lauren Vernazza (SOC), Brennen Means (SOC)

Cooper-nickel plates were deployed in the Severn River and subject to challenge waters to investigate the efficacy of chlorination in preventing or reducing biofouling and the potential impacts of chlorination/dechlorination on shipboard systems. Results will contribute to the ongoing efforts with the Center for Corrosion Science & Engineering, U.S. Naval Research Laboratory and Pearl Harbor Naval Shipyard to improve the use of pierside chlorination to control biofouling in submarine systems.

Preliminary Characterization of Springtime Soundscapes on Two Chesapeake Bay Oyster Reefs

Bo Hyun An (SOCH)

Sounds serve as cues for many aquatic organisms, and therefore soundscapes can be related to multiple ecological processes. In this study we deployed a hydrophone at two Chesapeake Bay oyster reefs exposed to differing levels of anthropogenic stress. Presence of soniferous fish was then compared between the two sites. Though our study was limited by the inability to sample the sites simultaneously, it serves as important first step in relating oyster reef soundscapes to anthropogenic influences.

Sampling and Quantification of Microplastics and Other Synthetic Particles in the Severn River

Meer Syamansoori (SOC), Caroline Kelly (SOC), Abigail Ebersole (SOC)

Standard field sampling and laboratory analytical methods were employed to identify and quantify microplastics in surface waters of the Severn River to establish a baseline for follow-on studies as to the sources, transport, and fate and potential ecological impacts of microplastics in the Severn River and other similar estuarine and coastal marine ecosystems.

Seasonal Variability in Material Fluxes in Rivers and Streams on the Alaska North Slope

Emily Doyle (SOC)

The U.S. Naval Academy Polar Science & Technology Program is leading a 3-year field study to identify material sources and quantify variability in fluxes of materials through rivers, creeks, and streams on the U.S. North Slope of Alaska. Results of the biogeochemical analysis of surface waters collected in June – October 2019 are presented to provide an assessment of the spring-to-summer variability in surface water chemistry and material fluxes in response to landscape changes.

Spectral Casting of Water Quality Variability in the Chesapeake Bay

Marissa johnsen (SOC)

The goal of the is project is to capture the high frequency variability of dissolved oxygen at continuous monitoring sites using a wavelet decomposition technique. This variability is then cast on to lower frequency sites in order to recover the hidden signal. This technique may be used to improve hypoxic volume calculations a modeling in estuarine environments

Subseasonal Variability of the Ocean Currents and Chlorophyll-a in the Bay of Bengal

Diego Caballero (SOC), James Swanson (SOC)

OSCAR currents of the Indian Ocean were used to identify sub-seasonal variability of ocean currents in the Bay Of Bengal region. The OSCAR data was then compared with their corresponding phase of the Madden -Julian Oscillation (MJO) to determine the MJO's affect on the ocean currents. Satellite measurements of Sea Surface Temperature and Chlorophyll-a concentrations were used to identify upper-ocean processes that occur during certain phases. Land-based nutrient discharges were also examined.

Tracking the Returns of the Suez Canal Corridor Area Project

Peter Zagara (ERC), Patrick Bishop (SCS)

The goal of this project is to track the development of the Suez Canal and the benefits of long-term Egyptian economic interests. They recently dredged a new canal in order to facilitate traffic in two directions which will increase the capacity of goods transported through the Canal; this will result in the Suez Canal becoming a more competitive trade route. Egypt's economy will benefit from additional commerce and new job opportunities which will develop urban communities.

Upper Ocean Response to Hurricane Dorian (2019)

Julia VonFecht (SOC)

Understanding ocean conditions in the wake of a tropical cyclone is critical to accurately forecasting tropical cyclone (TC) intensity. Here, three transects of Airborne eXpendable BathyThermograph (AXBT) observations across the wake of Hurricane Dorian are explored as the storm passed over the Bahamas. The observations are examined in the context of TC proximity and intensity, the proximal eddy field, and the evolution of the radial wind structure between 31 August and 03 September 2019.

Using high-resolution ICESat-2 point clouds to evaluate 1 arc second global digital elevation models

Tera Geoffroy (SGS)

There are three typical global digital elevation models: ASTER, AW3D30, and SRTM. We looked at data from Brazil to evaluate two things: (1) the accuracy of global 1-3 arc second DEMs which measure some surface above the ground, and (2) the possibility of using ICESat-2 to improve those model. The ICESat-2 data is a high-resolution point cloud converted from the photon data using the freeware MICRODEM program.

Validation of ICESat-2 satellite with hydrographic measurements derived from SIZRS flights

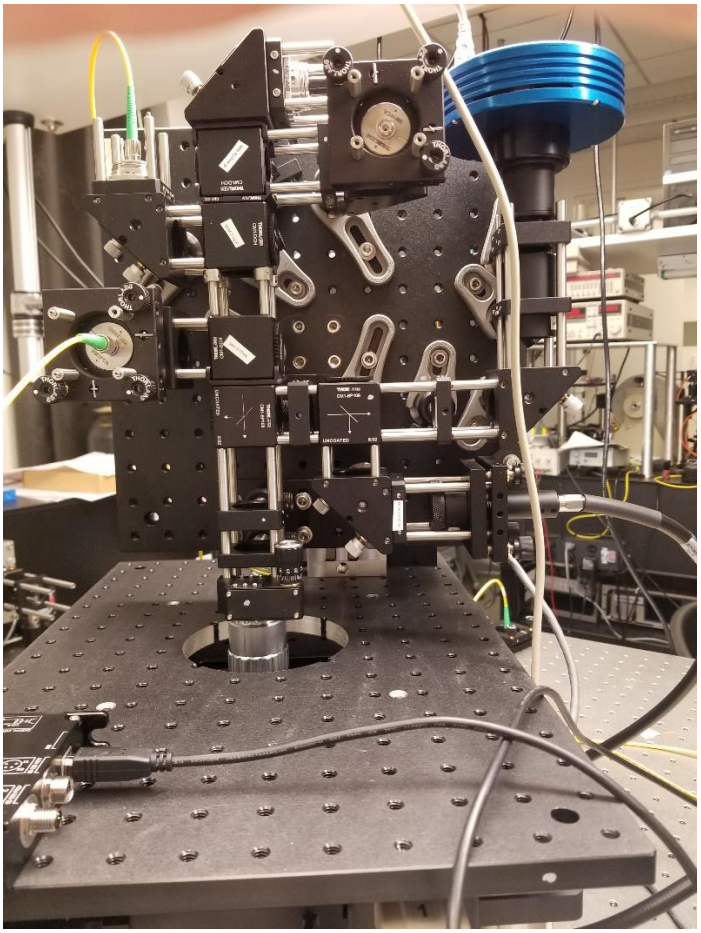
TR Sheehy (SOC)

The Seasonal Ice Zone Reconnaissance Surveys (SIZRS) are a series of ocean, ice, and atmospheric measurements across the Beaufort-Chukchi Sea seasonal sea ice zone. In this study, we focus on validating newly released ICESat-2 ATLAS photon counting LIDAR altimetry with SIZRS derived dynamic ocean topography. Successful validation of this new remote sensing capability will provide high latitude researchers important information about the evolution of pan-arctic ocean circulations.

Active Noise Cancellation for Underwater Sound Applications

Madison Falvey (HEG)

This project explores the possibilities for active noise control as a plausible and practical tool on naval vessels. Founded in acoustics and implemented through electrical engineering, the project combines multiple disciplines to attempt to provide an applicable solution to the Navy's need for stealth in the underwater environment.



Atomic Armor for Photocathodes

Matthew Critchley (SPHH)

We look at the optical effects of monolayer graphene coatings on known substances in order to improve the lifetime of photocathode materials. This project looks at the optical effects a monolayer coating of graphene has on copper and nickel surfaces. We analyze the optical effects via theory by developing an effective dielectric medium model, computation by using Density Functional Theory, and experiment with graphene and nickel coated copper samples.

Carbon Nanotube Arrays as the Homeotropic Aignment Agent in a Liquid Crystal Device

Lukas Atwood (SPHH)

We have designed an electro-optic homeotropic liquid crystal (LC) device employing vertically aligned (VA) carbon nanotube (CNT) arrays. The standard polyimide homeotropic alignment agents have several disadvantages, such as a wide distribution of pre-tilt angle and enhancing ionic impurities in the LC. The vertically aligned carbon nanotube arrays as the alignment agents have the potential to solve these problems.

Dynamic Mode Decomposition of the Arctic Sea Ice

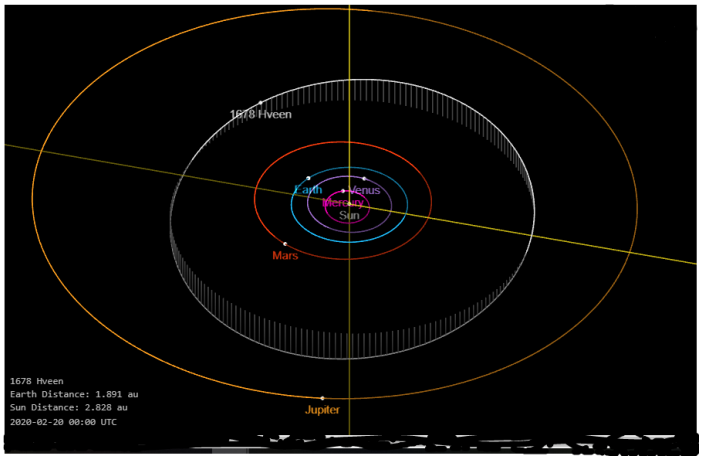
Alexandra Smith (SPHH)

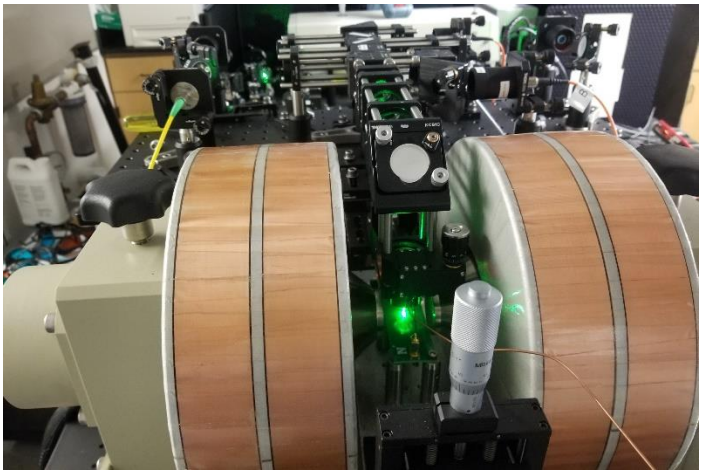
This research performed nontraditional analyses on Arctic sea ice data from satellite imagery collected by the NSIDC in the last 35 years. The nontraditional analysis is DMD, which revealed the spatiotemporal structures and large scale flow characterization created by the complex nonlinear system in the Arctic to create a linear dynamical model. This model is a predictive reconstruction generated by the eigenmodes of the system which will begin to determine the validity of data-driven modeling.

Effect of transverse magnetic field on an isotopically engineered diamond NV ensemble

Jon Campau (SPHH)

The nitrogen vacancy (NV) in diamond is a leading candidate for quantum sensing applications such as magnetometry. Here, we study the effect of a transverse external magnetic field on the spin coherence of an ensemble of nitrogen vacancy centers in diamond with applications to high-sensitivity magnetometry.





Experiments with Acoustic Levitation

Celeste Fohey (SPH)

We will construct from an adapted kit upper and lower discrete ultrasonic transducer arrays to generate a focal region. The region between the arrays will be able to levitate small light objects. We will observe the theory that describes the stability region of the levitated particle and change the relative arrays of the lower spherical to higher special elements to change the position of the levitated object. We will also design a ultrasonic probe to measure the acoustic sound pressure field.

Investigation of ensembles of SiC Vacancies and defect density on single spin coherence

Alec Grant (SPH), Jon Campau (SPHH)

In the past, it has been shown that single spin defects in crystal lattices can be utilized for quantum information processing and magnetic resonance detection and imaging techniques. SiC lattices have recently emerged as an alternate candidate to provide useful defects with similar properties to NV centers. Although single defects in SiC lattices have been extensively studied, the effect of surrounding ensembles on single spin properties of silicon vacancies is not yet well understood.

Monte Carlo Modeling of Cobalt Vanadate

Seamus Dwyer (SPHH)

Cobalt Vanadate (CVO) is a material that features magnetic moments in a kagome staircase lattice structure with competing magnetic interactions. We use a Monte Carlo program to investigate and model the material's magnetic structure at specific temperatures and magnetic field conditions, in an attempt to replicate neutron diffraction data taken at NIST in the process.

Using Simultaneous Spectral Sampling to Examine Bright Spots on Asteroids

James Welch (SPHH)

This project takes a series of near simultaneous images of various asteroids in the visual near infrared spectrum to look for composition variations with rotation. Parts of an asteroid should vary with color due to their formation via aggregation, but there should not be a strong, localized color variation due to effects like space weathering . New limitations on the project such as phase and size will be examined and used to refine the observational method.

Thank you to the lab technicians, educational technicians, shop technicians, carpenters, model makers, machinists, welders, naval architects, enlisted support staff, research librarians, writing tutors, financial specialists, purchase card holders, and all of the other staff members that make these programs possible.

Your time, effort, dedication, and experience are critical to the education of our students.