



# **THE MARITIME SECURITY CENTER (MSC)**

**AT STEVENS INSTITUTE OF TECHNOLOGY  
HOBOKEN, NJ**

## **ANNUAL REPORT**

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## **1. Background**

The Maritime Security Center (MSC), a Department of Homeland Security (DHS) Science and Technology (S&T) National Center of Excellence (COE) was established in 2014 as a result of a competition conducted by DHS's Office of University Programs (OUP). MSC is led by Stevens Institute of Technology and this report is based on activities that were conducted by the MSC at Stevens under the Cooperative Agreement during Year 5 (July 1, 2018 through June 30, 2019).

MSC is composed of a consortium of internationally recognized research universities, including Stevens, MIT, the University of Miami, the University of Puerto Rico, Louisiana State University, Florida Atlantic University, Purdue University, and Elizabeth City State University as well as industry partners, including the American Bureau of Shipping (ABS). The contributions of each partner institution during the reporting period are provided with the corresponding projects in this report.

MSC's mission is to develop both fundamental and applied research to support DHS's and other agencies' maritime security mission goals, including improved detection and interdiction capabilities, enhanced capacity to respond to catastrophic events, and a more secure and efficient Marine Transportation System (MTS). MSC has been focusing on interdisciplinary DHS mission-driven research, education, and technology transition in maritime security, maritime domain awareness, and resiliency issues. Our goal is to develop and transition research and technology solutions and educational programs to DHS maritime stakeholders, such as the US Coast Guard, Customs and Border Protection, Immigration and Customs Enforcement, and other related agencies and to improve capabilities and capacities for preventing and responding to events in the maritime domain. The next section describes the research projects.

## **2. Research Projects**

This section discusses the Predictive Port Resilience Tool to Assess Regional Impact of Hurricanes and the Social Media Analysis and Reporting Tool (SMART) for the US Coast Guard research projects. These projects were in the work plan that was approved for Year 5. The full reports are available on the MSC website at <http://stevens.edu/MSC>.

### **2.1. Predictive Port Resilience Tool Project**

#### **2.1.1. Project Overview**

A modeling and simulation-based framework has been developed for predicting the consequences of disruption at ports in a region due to the passage of a hurricane event. The tool uses modeling and simulation to predict consequences of disruptions at regional ports due to a hurricane event, in support of seeking improvements in the regional preparedness of ports. The effort is based in particular on adapting archival data for resilience analyses of the coastal ports affected by Hurricane Matthew, a category 5 Atlantic hurricane that skirted the southeast US coast in October 2016. Port operations leading up to Hurricane Matthew and observed losses in system functionality during and following the

storm are used to quantify the impact on six case-study ports using time dependent performance analysis. Modeling and simulation involve first modeling the port systems on a VISSIM software platform and establishing baselines for normal port operations on the waterside and landside in the region, based on archived statistics. Impacts of Hurricane Matthew on the six case-study ports (Port of Miami, FL; Port Everglades, FL; Port of Jacksonville, FL; Port Canaveral, FL; Port of Savannah, GA; Port of Charleston, SC) are considered. Baseline operations are established in terms of port service and throughput at these ports. Simulations of baseline vessel operations are conducted using the Monte Carlo simulation approach of Inverse Transform Sampling. Once the baseline models are established, disruption due to Hurricane Matthew is simulated to determine the consequences of the disruption. The predictions are compared with available observed data for the event. The tool framework can be extended to other ports and regions. Further, the detailed models developed for the six ports can be used to address additional stakeholder questions pertaining to these ports.

### 2.1.2. Methodology

This research obtains and adapts archival Nationwide Automatic Identification System (NAIS) and Department of Transportation (DOT) data for resilience analyses of the coastal ports affected by Hurricane Matthew. Port operations leading up to Hurricane Matthew and observed losses in system functionality following the storm are used to quantify the resiliency of the various ports using time dependent performance analysis. Modeling and simulation involves first modeling the port systems and establishing baselines for normal port operations on the waterside and landside in the southeast region, based on archived statistics. Impact of Hurricane Mathew on the Ports of Miami, Jacksonville, Savannah, Charleston, Canaveral and Port Everglades were considered. Baseline operations were established in terms of port service and throughput at these ports. The simulations of baseline vessel operations were conducted using the Monte Carlo simulation approach of Inverse Transform Sampling. The simulations were developed on the PTV VISSIM platform. Once the baseline models were established, disruption due to Hurricane Mathew was simulated to determine the consequences of the disruption for a range of responses. The tool was demonstrated quantitatively through statistical analysis and measures of effectiveness. A stakeholder workshop was held to obtain stakeholder input and feedback.

### 2.1.3. Project Schedule

Task	Duration (Days)	Start Date	End Date
Total Tasks	246	7/19/2018	6/27/2019
Kick-off meeting	0	7/19/18	7/19/18
Data Collection	78	9/4/18	12/20/18
Simulation model development	71	12/21/18	3/29/19
Test scenarios and case studies	53	1/16/19	3/29/19

Develop Resilience Framework	32	2/14/19	3/29/19
Hold Stakeholder Workshop at FAU	0	3/29/19	3/29/19
Demonstrate and evaluate tool	34	4/1/19	5/16/19
Submit final technical report	15	5/17/19	6/30/19
Establish predictive tool at FMRI, FAU and provide manual	0	7/31/19	7/31/19
Submit Journal publication	0	9/27/19	9/27/19
Engage graduate and undergraduate students	203	9/18/18	6/27/19

#### 2.1.4. Milestones and Performance Metrics

The following project milestones and performance metrics are identified. The milestones and the performance metrics will be reviewed with the project champion at the kick-off meeting and updated.

#	Milestone Description	Performance Metrics	Status
<b>M1</b>	Kick-Off Meeting with Stakeholders	Stakeholder feedback	Completed
<b>M2</b>	Data collection completed	Critical datasets from at least five regional ports acquired	Completed
<b>M3</b>	Simulation Model development completed	Landside and waterside calibration and validation coefficient of determination will be equal to or greater than 0.90 and 0.80, respectively.	Completed
<b>M4</b>	Case studies completed	Regression analysis of the resiliency plots will show a coefficient of determination greater than or equal to 0.80.	Completed; Regression coefficient is high where sufficient data are available
<b>M5</b>	Resilience framework developed	Framework replicates consequences of past events to within 75% accuracy	Completed
<b>M5.1</b>	A peer review article submitted to TRB	Number of citations and article downloads	TRB Publication under preparation
<b>M6</b>	Final Technical Report	Number of citations and report downloads	Technical Report submitted; manual near completion

### **2.1.5. Accomplishments**

Milestone 1 (kickoff meeting) with USCG helped define the scope of the project and project deliverables and plan for transition of the tool. Initiation of work following the kick-off meeting was delayed due to a delay in project funding being put in place. We worked expeditiously to achieve milestones 2 and 3. Significant amount of data was obtained from the Florida Department of Transportation and Marine Traffic Inc. on landside and water-side traffic over a period of one year encompassing Hurricane Mathew to determine baseline conditions and the impact of Hurricane Mathew. Milestone 4 was achieved through completion of modeling of the six case-study ports and conducting regression analysis of the data. It was found that the regression coefficient is high if significant data are available at a port, but low if insufficient data are available at a port. In achieving milestone 5, four separate datasets were used in the calibration and validation of the simulation model. The model calibration and validation were conducted through a). qualitative assessment of how the models preformed, and b). quantitative evaluation of the Goodness-of-fit in the form of the coefficient of determination, also known as R-Squared value. A peer-review publication is under preparation. A draft final report was submitted by 7/3/2019 and the final technical report was submitted on 7/12/2019 per milestone 6. The tool is being housed at the FAU Freight Mobility Research Institute at FAU where it will be made available to stakeholders as part of the tool's transition. A manual for running the tool is being put together.

Three graduate-level students participated in the year-long project. Two were USCG graduate students enrolled at FAU and one graduate student from Embry-Riddle Aeronautical University (ERAU).

### **2.1.6. Stakeholder Engagement**

Significant stakeholder engagement through a well-attended workshop on 3/39/2019, visits to ports and periodic meetings with USCG personnel, and other forums resulted in useful input to the development of the project.

The proposed effort is consistent with DHS Mission 5: Strengthen National Preparedness and Resilience that call for facilitating recovery following a disaster through promotion of infrastructure resilience guidelines and development of continuity plans for communities, government entities, and private-sector organizations. It is also consistent with Mission 2: Secure and Manage our Borders that calls for strengthening the security and resilience of the global supply chain and the international travel system through establishing and enforcing security standards and plans that maintain or restore infrastructure capabilities, including at ports, to be resilient from attacks and natural disasters. The proposed effort is aimed at developing tools that facilitate assessment and planning for evolving threats and hazards to a port and its waterside and landside distribution capacity, in support of avoidance and mitigation of damage and capacity reduction and aiding rapid recovery from disruptions.

### **2.1.7. Potential Impact of Project Outcome**

The modeling and simulation-based framework that has been developed enable determining consequences of disruption at ports in a region due to the passage of a hurricane event. In particular, disruptions at a group of case-study ports due to Hurricane Matthew, a category 5 Atlantic hurricane that skirted the southeast US coast in October 2016, are considered. The application of the tool has the following primary benefits: 1) It provides assistance with hurricane preparedness, planning and COOP at ports, in support of reduction in vulnerability of ports to hurricane events; 2) It leads to reduction in uncertainty of the impact of a hurricane event; and 3) It provides a capability to predict and compare consequences resulting from alternative responses to a hurricane event, in support of better decision-making in response to the event. The results of the research demonstrate the benefits of the simulations in quantifying the consequences of a disruptive event and facilitating evaluation of the effects of alternate responses. In the case studies considered, the impact of enhanced service capacities at ports in clearing backlogs was quantified. Such quantitative assessments provide meaning, context, and relevance to port stakeholders that may not be readily apparent at face value. This research also shows that Automatic Identification System (AIS) data could be utilized to create new methods and metrics for the assessment of resiliency in maritime systems. The time dependent performance models developed from this data show the cascading effects of disruptions and quantify the benefits gained by recovery efforts in a time-progressive series. The data show, in quantifiable terms, reductions in performance resulting from the simulated disruption. On a broad level, these findings also represent some of the first steps toward the development of standardized metrics for quantifying MTS operational resiliency. The modeled six ports provide opportunities for pursuing other potential applications.

The full report is available at <https://www.stevens.edu/research-entrepreneurship/research-centers-labs/maritime-security-center/reports-publications>.

## **2.2. Social Media and Analytics Reporting Tool Project**

### **2.2.1. Abstract**

This research project's aim is to increase the understanding of information and intelligence integration within maritime operations, with a focus on advancements in technologies and command and control systems that utilize crowdsourced information. The research project's objective is to explore how social media analytics can most effectively lead to improved safety outcomes during natural disasters, emergencies, and other important safety events. The project achieved this objective through structured interviews and targeted questionnaires of the previous use of social media, and the Social Media Analytics and Reporting Toolkit (SMART) during the past several years, including during the 2017 hurricane season. The outcome is a report on the U.S. Coast Guard's use of SMART with lessons learned and suggestions for improvements and training.

### 2.2.2. Project Scope

The DHS Visual Analytics for Command, Control, and Interoperability Environments (VACCINE) Center had developed the Social Media Analysis and Reporting Tool (SMART) to utilize crowdsourced data to increase situation awareness during normal monitoring, special events, and unexpected situations, such as the four hurricanes in 2017. The current iteration of SMART has been successfully deployed by DHS components and both local and regional public safety organizations to a variety of highly sensitive events. However, SMART's use has been on a case-by-case basis by scattered personnel across the service, and for each use by a new group, training sessions need to be run, accounts need to be created, and situation-specific information needs to be customized.

Therefore, the goal of this project under the Maritime Security Center was to conduct an in-depth user study with the USCG in their use of the SMART software and overall social media analytics to better understand the needs, modifications, and utilization as well as providing updated training material. From the study results, Purdue University developed and delivered a report and submitted a conference paper on the use of social media and SMART, lessons learned, best practices, and suggestions for future use of social media analytics.

### 2.2.3. Milestones and Outcomes

The following summarizes the milestones and outcome from the project workplan:

***Milestone 1 – Report on USCG use of social media analytics: October 1, 2018 to April 15, 2019***

**Milestone 1 Outcome – Comprehensively report on how the USCG has used social media analytics, guidelines for use, and improvements to SMART.**

- **Outcome 1a** – A white paper and briefing delivered to the Coast Guard Cyber Command and Assistant Commandant for Command, Control, Communications, Computers and Information Technology.
- **Outcome 1b** – Present research findings at conferences, such as the *2019 IEEE International Symposium on Technologies for Homeland Security* about the use of social media analytics in the 2017 hurricanes, and the *2019 International Conference on Information Systems for Crisis Response and Management* on more general lessons learned and output of Milestone 1.
- **Outcome 1c** – Deployment of some initial training material and small improvements to SMART for USCG use to increase its utility to USCG. Any simple changes to SMART will be implemented and deployed and a short PowerPoint presentation explaining the use of SMART will be created. We will have SMART available through VACCINE's servers and website.



The following was completed:

- Interviews with previous SMART users were conducted and summarized in a comprehensive report on USCG and FFRG use of the SMART system as well as social media analytics in general, best practices for social media analytics for disaster response, and suggested future topics of research.
- Research findings have been submitted to (and accepted to be presented and published in the proceedings of) the *2019 IEEE International Symposium on Technologies for Homeland Security*.
- Purdue University created and updated training material describing the latest improvements to SMART and have been deploying it when training new users on the SMART system. It is available through VACCINE, and Purdue has provided the system to thirteen new user groups since the beginning of this study.

All proposed deliverables were completed. Some deliverables were delayed. The final delivery of the white paper and report was moved from the initial March 15, to April 15, and then to May 20 (with the Maritime Security Center and Program Manager approval). The IRB approval for interviews took much longer than expected, delaying the entire project. Many USCG and FFRG personnel that VACCINE had hoped to solicit feedback from were unavailable (some at the time due to the government shutdown, and some due to lack of interest in participation), which delayed the information-collecting process. However, in the end, we were successful in delivering the required material and disseminating SMART use.

The full report is available at <https://www.stevens.edu/research-entrepreneurship/research-centers-labs/maritime-security-center/reports-publications>.

### **3. Education and Outreach**

#### **3.1. Overview**

MSC has established a robust portfolio of high-impact educational programs designed to provide hands-on, research-based learning opportunities for aspiring homeland security professionals. The Center's educational programs leverage the subject matter expertise and research capabilities of its academic partners to provide relevant programs for a broad audience of college-level students, DHS stakeholders, and STEM educators. During Year 5, MSC offered the following homeland security-focused educational programs:

- Summer Research Institute
- MSI STEM Educators Workshop
- Undergraduate and Graduate-level Research Assistantship Programs
- MSI Outreach and Engagement

MSC's educational programs are offered in collaboration with the Center's network of stakeholders. MSC stakeholders include the U.S. Coast Guard, Customs and Border Protection, National Urban Security Technology Laboratory (NUSTL), Port Authority of New York and New Jersey (PANYNJ), and DHS's Intelligence and Analysis (I&A) Directorate to name a few. These stakeholders have contributed to the Center's educational programs by hosting field visits, facilitating student internships, giving feedback on program curricula and student research projects, and providing student employment opportunities.

This section of the report provides a summary of MSC's education milestones, followed by a detailed account of the MSC's educational programs and outreach activities during Year 5.

## **3.2. Summary of Education Milestones**

### **3.2.1. Summer Research Institute**

Twenty-five students participated in the Center's 10th annual Summer Research Institute held from June 3 to July 26, 2019 at the Stevens Institute of Technology in Hoboken, NJ. Organized into six teams, the students collaborated with MSC research investigators and Stevens faculty on projects related to maritime domain awareness and technology development. The students participated in field visits to DHS operational environments, attended faculty and guest lectures, and networked with DHS practitioners. Outcomes from the 2019 SRI included six student team research reports, presentation slides and posters.

### **3.2.2. MSI STEM Educators Workshop**

The MSC, in collaboration with Stevens Institute of Technology's Accessing Careers in Engineering and Science (ACES) held a Fundamentals of Sensing Technologies workshop tailored to STEM educators from underserved and underrepresented schools in the New York/New Jersey metro area on March 22, 2019. The workshop provided instruction on sensing technologies and their applications to maritime safety and security. The workshop included the participation of USCG Sector New York personnel who discussed the Coast Guard's Search and Rescue Optimal Planning System (SAROPS). At the end of the workshop, the participating educators received curriculum materials and sensor kits for use in their respective classrooms.

Following the Sensing Technologies Workshop, the Center hosted a student-focused version of the workshop for high school students at Paterson Charter School for Science and Technology in Paterson, NJ.

### **3.2.3. Undergraduate and Graduate-level Research Assistantships**

MSC provided tuition and stipend support for two Graduate Research Assistants during the 2018/2019 academic year. As part of their Assistantship requirements, the students each engaged in 20 hours per week of homeland security relevant research. One student focused on developing models to advance the detection of vessel traffic anomalies,

while the other aimed to develop algorithms to enhance the autonomous path finding capabilities of underwater ROVs. Both students completed final reports (one Master's thesis) and presented their research outcomes in formal presentations to MSC researchers, stakeholders and Stevens faculty.

The Center also engaged four undergraduate students in research tasks and projects throughout the academic year. Funding support for the undergraduate students was provided as an in-kind contribution through Stevens Institute of Technology.

#### 3.2.4. MSI Engagement

MSC collaborated with two MSI schools to submit research proposals for the 2019 DHS MSI Summer Research Team Program (MSI SRTP). Following review by the DHS Office of University Programs, the proposal submitted by the University of Puerto Rico-Mayaguez (UPRM) titled "*A Multispectral Infrared Remote Vessel Emission Monitoring System*", was selected for funding and participation. A few weeks prior to the start of the summer program however, the UPRM faculty member withdrew their participation due to personal reasons. However, leveraging remaining funds in the Center's budget, MSC received DHS Office of University Programs approval to extend admission offers for the two UPRM students who were to have accompanied the visiting faculty member, to attend the Center's Summer Research Institute.

### 3.3. College-Level Experiential Learning and Research-Based Programs

#### 3.3.1. The 2019 Summer Research Institute

Milestones	Performance Metrics	Status/Discussion
1. Featured lectures by MSC researchers and invited guests. (Weeks One – Eight) (6/3/19 – 7/26/19)	<ul style="list-style-type: none"> <li>- A minimum of three faculty/guest lectures will be provided during the eight-week research program.</li> <li>-The quality of and knowledge learned from the lectures will be assessed through a post- program student survey.</li> </ul>	<p>Completed: MSC hosted Bert Macesker, Executive Director, USCG Research and Development Center and Grace Python, Operations Research Analyst for a guest lecture on June 24. The students also participated in program lectures by Dr. Barry Bunin and briefings provided by CBP and USCG Sector NY as part of the Center's coordinated field visits.</p> <p>Completed: A post-program survey was distributed to the SRI student participants.</p>

<p>2. Field visits and field-based activities. (Weeks One – Seven) (6/3/19 – 7/26/19)</p>	<ul style="list-style-type: none"> <li>- Students will engage in a minimum of two field-based activities during the summer research program. (e.g., participation in a stakeholder meeting/workshop/training, research experiments/deployments, operational facility tours)</li> <li>-The impacts of the field visits and field-based activities on student professional development and networking skills will be assessed through a post-program student survey.</li> </ul>	<p>Completed: Four field visits were facilitated this summer. Including CBP – Port of New York/Newark, CBP Laboratory and Scientific Services – New York Laboratory, USCG Sector NY, and security observations on the NY Waterways and Staten Island Ferries.</p> <p>Completed: Students participated in multiple experiments, including the deployment of an ROV at the USMMA and in the Davidson Laboratory Towing Tank.</p> <p>Completed: A student survey was administered and completed by 24 of the 25 participants.</p>
<p>3. Diversity of student participants. (6/3/19 – 7/26/19)</p>	<ul style="list-style-type: none"> <li>-Diversity will be measured according to the range of engineering and science majors represented in the program. A minimum of four different disciplines will be represented per SRI program.</li> <li>- Student diversity will be measured by the percentage of women and minority students participating in the program each summer. A diverse student population will include a minimum of 50% women and/or minority students.</li> </ul>	<p>Completed: The SRI 2019 student cohort included students from 11 unique academic disciplines.</p> <p>Partially Completed: 48% of the students who accepted the Center's offer of admission and who attended the SRI were from underrepresented communities (women and minority students). Out of the 7 universities represented in the program, three were MSI's.</p>
<p>4. Research Reports, Presentations and Posters. (Week Eight) (7/22/19 – 7/26/19)</p>	<ul style="list-style-type: none"> <li>-A minimum of two student research team reports will be prepared at the end of each SRI program.</li> <li>-Students will engage in weekly status update presentations during weeks three – seven.</li> <li>-Stakeholder engagement will be assessed by representation of MSC stakeholders attending the final student team presentations.</li> </ul>	<p>Completed: Six student research reports were completed. The student teams also prepared final presentation slides and research posters.</p> <p>Completed: The student teams provided status update presentations and discussed their research progress during weeks 3 – 7.</p>

	<p>-Quality of SRI research outcomes will be assessed by MSC research mentor feedback and the number of projects selected for presentation at conferences and/or for publication.</p> <p>-Program impacts, e.g., professional development, technical skills learned, student interest in advanced academic study or careers in homeland security will be assessed by a post-program student survey.</p>	<p>Completed: Representatives from CBP (Field Operations and Laboratories and Scientific Sciences), USCG Sector NY, DHS I&amp;A, DHS S&amp;T, and NUSTL, attended the SRI final student research presentations.</p> <p>Completed: Responses to the SRI survey showed that students significantly improved their capabilities in several skill areas. 79% of the students reported that the SRI had enhanced their interest in careers in homeland security.</p>
5. Post-Program and SRI alumni survey. Post-program surveys to be conducted (Week Eight) (7/22/19 – 7/26/19)	-A minimum of one student survey will be conducted at the end of each summer research program. The survey will be used to measure the strengths and weakness of the program, the program's impacts on student interest and skills development, and to gather feedback to enhance the future delivery of the program.	Completed: A student survey was completed by the program participants and assessed by the MSC. 24 out of the 25 student participants completed the survey.

MSC held its 10<sup>th</sup> Annual Summer Research Institute from June 3 to July 26, 2019 at the Stevens Institute of Technology campus in Hoboken, NJ. Several months prior to the start of the program, MSC administrators put out a request for student project topics in the Center's monthly stakeholder newsletter. Distribution for the newsletter reaches more than 200 Federal, state and local homeland security stakeholders. Responses to the posting resulted in project requests related to risk management tools, underwater threat detection systems and systems for improving intelligence and analysis.

Stakeholder input ensures that our student research projects continue to be relevant and reflect the needs and interests of the maritime and homeland security community, Taking into consideration the Center's available Stevens Institute of Technology faculty resources and existing MSC and Stevens on-going research projects, the MSC was able to develop a portfolio of six student research projects that addressed the stakeholder requests. Discussions on each of these projects follows below.



**Figure 1. SRI 2019 Program Brochure**

During Year 5, the MSC hosted 25 student participants in the SRI. Collectively, the students represented seven universities, including New Jersey Institute of Technology, Stevens Institute of Technology, SUNY-Maritime College, University of Alaska-Anchorage (MSI), University of North Carolina-Pembroke (MSI), University of Puerto Rico-Mayaguez (MSI) and Virginia Tech. Out of the student cohort, 88% were undergraduate students and 48% were from underrepresented communities (e.g. women and minority students).

To offset the costs of the SRI (e.g., student housing, stipends and travel), the Center leveraged existing Stevens Institute of Technology programs to recruit students who could attend the program fully funded through external funding sources. Out of the 25 participants, eleven students attended the program leveraging funding from Stevens Institute of Technology, including the university's Pinnacle Scholars Program (9), Clark Scholars Program (1), and the Innovation and Entrepreneurship Scholars Program (1). Funding for the remaining 14 students was provided by the Maritime Security Center.

The MSC-funded students were selected through the Center's academic partnerships and through a competitive admission process. The students admitted into the program were endorsed by their academic professors and met or exceeded the Center's admission criteria. Figure 2 below shows the students on a field visit to CBP New York Laboratory. Table 1 identifies the participants and the funding sources leveraged to support their participation.



**Figure 2. SRI 2019 student participants attend a field visit to the CBP New York Laboratory.**

**Table 1. Summer Research Institute 2019 Participants and Leveraged Funding**

University	Student	Major	Funding Source
NJ Institute of Technology	Shreena Mehta	Computer Science	MSC
Stevens Institute of Technology	Eamon Bontempo	Software Engineering	MSC
	Liam Brew	Software Engineering	MSC
	Jason Chang	Mechanical Engineering	Pinnacle Scholar
	Tanagorn Chiamprasert	Engineering Physics	Pinnacle Scholar
	Caroline Corr	Biomedical Engineering	Clark Scholar
	Dante D'Amico	Computer Engineering	MSC
	Ronald Estevez	Computer Science	Pinnacle Scholar
	Eric Fernandes	Software Engineering	Pinnacle Scholar
	Alice Huston	Software Engineering	MSC
	Matthew Kirby	Engineering Undecided	Pinnacle Scholar
	Daniel Lentini	Mechanical Engineering	MSC
	Maria Manousasakis	Mechanical Engineering	MSC
	Mathew Seedhom	Mathematics & Computer Science	Pinnacle Scholar
	Asif Uddin	Mechanical Engineering	Pinnacle Scholar
	Kevin Ward	Computer Engineering	Pinnacle Scholar
	Samuel Yakovlev	Applied Artificial Intelligence & Computer Engineering	MSC
	Herb Zieger	Software Engineering	Innovation & Entrepreneurship Scholar
SUNY- Maritime College	Danielle Dobbs	Maritime Studies	MSC
Univ. of Alaska-Anchorage	Tristan Goers	Data Science	MSC
Univ. of North Carolina - Pembroke	Khalil Hardy	Computer Science	MSC
Univ. of Puerto Rico-Mayaguez	Alec Espiña Santiago	Electrical Engineering	MSC
	Yousef Salaman	Electrical Engineering	MSC
	Maclara		
Virginia Tech	Emily Jannace	Civil Engineering- Transportation Infrastructure and Systems Engineering	MSC

### 3.3.2. Student Qualifications and Documentation

Participation in the SRI requires that students be actively enrolled in an undergraduate or graduate-level degree program at an accredited university. Undergraduate students must possess a minimum GPA of 3.0, and graduate-level (Masters and PhD) students are required to have a GPA of 3.5 or better. This past summer's participants were required to complete an online application form, write a personal statement of interest, submit letters of recommendation and transcripts upon request. In accordance with the Stevens admission policy, visiting SRI students were also required to demonstrate proof of health insurance and submit immunization records.


### 3.3.3. Summer Research Stipends and Housing

Each MSC-funded student received a summer stipend of \$4,000 and was provided with on-campus accommodations as needed. Travel reimbursements up to \$1,000 were also provided for transportation to and from the start and end of the program for students residing outside of the state of New Jersey.

### 3.3.4. Program Administration

The 10<sup>th</sup> annual SRI was organized and coordinated by MSC Director of Education, Beth Austin-DeFares in conjunction with Dr. Barry Bunin (Research Professor, Civil, Environmental and Ocean Engineering). Ms. Austin-DeFares served as the primary program facilitator, while Dr. Bunin participated as the lead faculty mentor and curriculum developer. He also served as the overall technical lead on the summer research projects and provided assistance to students in both theoretical and practical implementation of the projects. In addition to Dr. Bunin, SRI student team mentorship was also provided by Dr. Brendan Englot, Director of the Robust Field Autonomy Laboratory and Assistant Professor in Mechanical Engineering at Stevens Institute of Technology, Dr. Hong Man, Professor, Electrical and Computer Engineering, Dr. Jeffrey Nickerson, Professor and Associate Dean, Stevens School of Business, and Dr. Paul Rohmeyer, Professor, Stevens School of Business.

### 3.3.5. Program Format and Curriculum

  
Summer Research Institute  
June 3 – July 26, 2019

WEEK 1	JUNE 3 (Monday)	JUNE 4 (Tuesday)	JUNE 5 (Wednesday)	JUNE 6 (Thursday)	JUNE 7 (Friday)
	9:30am Welcome – Beth Austin-DeFares  9:45am Faculty Mentors Introductions & Project Overviews <ul style="list-style-type: none"><li>• ROVs/USVs in Maritime and Port Environments</li><li>• AIS Anomaly Detection CG Risk Management Dashboard</li><li>• UAS Buoy System</li><li>• Red team/Blue team Game Development</li></ul>	9:00am Maritime Lectures <ul style="list-style-type: none"><li>• Intro to Marine Transportation System (MTS)</li><li>• Observations, Analysis and Threat Assessments</li></ul>	9:00am Observations Report-out and Discussion –	9:00am Team Project Time	9:00am Team Project Time
	10:45am Break	11:30am Lunch	Lunch	Lunch	Lunch
	11am Student Introductions 12noon Group Lunch  1pm Intro to Research – Dr. Barry Bunin  2pm Mentor/Student team project meetings  4:30pm –Student Guest ID's & Campus Tour (non-SIT students)	1pm Field Visit - New York and New Jersey Ferry Tour	1pm Team Project Time	1pm Team Project Time	1pm Team Project Time

**Figure 3. Schedule for Week One of the 2019 SRI.**



The eight-week program included in-class lectures, hands-on student team research projects, professional development activities, and field visits to DHS operational environments. One week prior to the start of the program, the students were asked to complete pre-reading assignments and homework. During Week One, the assignments were reviewed and the student participants attended a sequence of maritime domain and homeland security-focused lectures. The lectures, delivered by Dr. Barry Bunin, included talks on maritime security policies, maritime industry and government stakeholders, port facility infrastructure and operations, and current and emerging threats.

During Week One, the SRI student participants were also assigned into one of the following six project teams:

- USCG Sector NY Risk Management Dashboard
- Unmanned Aerial System (UAS) Buoy System – Prototype Development
- Automatic Identification System (AIS) Vessel Anomaly Detection
- Enhanced Perception and Navigation for the BlueROV Underwater Robot
- WAMV - Unmanned Surface Vehicle (USV) Simulator
- Red Team/Blue Team Exercises

Starting Week Two, the program format shifted from time spent in the classroom to time spent engaging in team research projects, field-based visits and experiments, and meetings with maritime and homeland security practitioners. During the next five-week period, the student teams also began to provide status updates on their research in the form of weekly presentations. Each team was responsible for providing a fifteen to twenty-minute presentation discussing their research progress, project activities, and any challenges they were encountering. MSC also hosted guest speakers from the USCG Research and Development Center and facilitated field visits to Customs and Border Protection Field Operations at the Port of NY/NJ, CBP Laboratory and Scientific Services – New York Laboratory, USCG Sector New York, and trips aboard the NY Waterways and Staten Island Ferries for security observations and reporting. Details regarding the guest speakers and field visits are provided later in this report.

During Week Seven, the student teams synthesized their research outcomes and started to compile their final reports, presentations and research posters. In Week Eight, the last week of the summer research program, students presented their research to an audience of DHS stakeholders, including representatives from the DHS S&T network (Office of University Programs and NUSTL), DHS Intelligence and Analysis, CBP, USCG Sector NY, NJ State Police and from Duro UAS, a manufacturer of scientific buoys for industry and government.

Tables 2 and 3 below illustrate the program activities and guest speakers for each week of the 2019 summer research program.

**Table 2. SRI 2019 Program Activities Weeks One to Eight**

Schedule	Topic	Faculty /Guest Speakers	SRI 2019 Activities
Week One June 3 – 7	Orientation - MTS and Mari- time Security Overview	Faculty: Dr. Barry Bunin	Discussions/lectures on mari- time security and vulnerabili- ties.  Field visits: NYC ferry termi- nals.
Week Two June 10 - 14	Team Re- search Pro- jects		Field visit: CBP Field Opera- tions at the Port of NY/Newark. Experiment: ROV deployment, test and evaluation at USMMA
Week Three June 17 - 21	Team Re- search Pro- jects		Field visit: CBP Laboratories and Scientific Services – New York Laboratory  Experiment: Davidson Labora- tory Tow Tank / Buoy Proto- type Development – Stevens STAR Center Machine Shop Status Update Presentations
Week Four June 24 – 28	Team Re- search Pro- jects	Guest Speaker: USCG Re- search and Development Center	Status Update Presentations Buoy Prototype Development – Stevens STAR Center Ma- chine Shop
*Note that activities after July 1 for the SRI are considered planned activities for Year 5 but are reported here for consistency and program continuity.)			
Week Five July 1 – July 5	Team Re- search Pro- jects		Status update discussions with faculty mentors
Week Six July 8 – 12	Team Re- search Pro- jects		Status Update Presentations
Week Seven July 15 - 19	Research Syn- thesis		Report writing, presentation slide preparation and research posters. Status update presen- tations and rehearsals  Stakeholder Exercise: PA- NYNJ Active Shooter Exercise – Cape Liberty Cruise Termi- nal (select student participa- tion)

Week Eight July 22 – 26	Research Outcome Presentations and Reports	DHS S&T stakeholders & industry guests (CBP, DHS S&T, DHS I&A, USCG Sector NY, Duro UAS)	Final presentation on research outcomes, reports and posters.  Completion of SRI feedback survey.
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**Table 3. SRI 2019 Guest Speakers**

Guest Speaker	Organization	Lecture Topic
Bert Macesker, Executive Director and Grace Python, Operations Analyst	USCG Research and Development Center	USCG Mission Briefing and Research Projects
Supervisory Officer Scott Rutledge	CBP Field Operations Port of NY/Newark	CBP Mission Briefing (Field Visit)
Jason Boyer, Assistant Director	CBP Laboratories and Scientific Services – New York Laboratory	CBP Laboratory Services Mission Briefing (Field Visit)
John Hillin, Safety and Security Division Chief	USCG Sector NY – Fort Wadsworth, Staten Island, NY	USCG Sector NY morning briefing with the Sector Commander. (Select student participation)

### 3.3.6. Field Visits and Meetings with Practitioners

Field visits to ports and homeland security facilities are a key component of the Summer Research Institute. Field visits provide a first-hand opportunity for students to observe the operational activities and responsibilities of homeland security professionals in the field (see Figure 4 below).



**Figure 4. SRI 2019 participants discuss CBP's Vehicle and Cargo Inspection System (VACIS) in a field visit to the Port of New York/Newark.**

This summer's program featured field visits and coordinated activities with representatives from the following organizations:

- Customs and Border Protection (CBP) Field Operations Division, Port of New York/Newark (Field visit and briefing)
- CBP Laboratory and Scientific Services, New York Laboratory, Newark, NJ (Field visit and briefing)
- U.S. Sector New York, Ft. Wadsworth, Staten Island, NY ((Field visit and briefing)
- Port Authority of New York/New Jersey, Bayonne, NJ (Full-scale Active Shooter Exercise at a Port)

This was the Center's eighth annual student field visit to CBP at the Port of NY/Newark and its first annual visit to the CBP New York Laboratory. The visit to CBP at the Port of NY/Newark included observations of radiation portal monitors, high-energy mobile non-intrusive inspection (NII) equipment scanning cargo containers, and a tour of a Centralized Examination Station warehouse where cargo is physically inspected and analyzed.

The visit to CBP New York Laboratory included a briefing by Jason Bory, Assistant Laboratory Director and a meeting with Dr. Adam Hutter, Director, as well as a sequence of demonstrations and briefings by the Laboratory's team of scientists.

Students on the Risk Management Dashboard team were also invited to participate in a morning briefing with Captain Jason Tama, Commander of USCG Sector New York and to tour the Sector's Command Center and Vessel Traffic System operation at Fort Wadsworth in Staten Island, NY.

On July 17, several SRI students volunteered to participate in a full-scale active shooter exercise coordinated by the Port Authority of New York / New Jersey (PANYNJ). The exercise included a series of hypothetical active shooter scenarios occurring during the embarkation and debarkation at a cruise terminal. The event exercised the emergency response capabilities of several Local, State and Federal law enforcement and first responders. The opportunity allowed the students to observe firsthand the process, procedures and techniques emergency responders employ in confronting and mitigating crisis events.

### **3.3.7. Student Research Projects**

The SRI 2019 student research projects were developed at the request of and in conjunction with the Center's stakeholders. The Risk Management Dashboard project for example was developed in response to a request by the Safety and Security Division Chief at the USCG Sector New York to develop a computer dashboard that can be used to visualize and analyze incident trends. The AIS Anomaly Detection project was proposed to the Center by representatives from CBP's National Targeting Center, and the Red Team/Blue Team adversarial game project was developed based on conversations with a special agent from DHS Homeland Security Investigations.

The summer research projects and student team assignments are described below.

### **Research Team/Project: USCG Sector NY Risk Management Dashboard**



**Figure 5: The students on the Risk Management Dashboard team meet with John Hillin, USCG Sector NY (pictured far left) following their final research presentation.**

Students on the Risk Management Dashboard team collaborated with John Hillin, Safety and Security Division Chief, USCG Sector New York to develop a computer dashboard tool that could be used to visualize and conduct trend analysis of incidents occurring in the Sector New York Area of Responsibility (AOR).

The team utilized open source incident data provided by Sector NY to interpret and parse out data into a custom database and then in an iterative process designed and built the dashboard structure and functionality.



**Figure 6. The Risk Management Dashboard tool graphically displays incident data collected in the USCG Sector NY AOR.**

A synopsis of the student team's research, including the team's research question, importance to homeland security, methodology and outcomes are provided below in Table 4.

**Table 4. SRI 2019 – USCG Sector NY Dashboard Project Overview**

<p><b>Project Title:</b> USCG Sector New York Risk Management Dashboard</p>
<p><b>Research Question</b> <i>How can the United States Coast Guard Sector New York incident data be displayed and analyzed more efficiently to identify trends and help quantify risk?</i></p>
<p><b>Research Importance to Homeland Security:</b></p> <ul style="list-style-type: none"> <li>• The USCG collects massive amounts of incident data.</li> <li>• Dashboards allow for quick visualization and an in depth look into incident trends</li> <li>• The tool allows the USCG to be data driven and proactive versus reactive in resource planning and allocation</li> <li>• The dashboard uses the Coast Guard’s pre-existing system to give meaning to thousands of rows of incident data</li> </ul>
<p><b>Prospective End-User:</b> The dashboard tool was custom developed for USCG Sector NY, however, the tool can be modified and used broadly across all USCG Sectors and potentially other DHS components.</p>
<p><b>Project Abstract:</b> The USCG maintains a large data base of information pertaining to maritime safety, security, and law enforcement incidents. These incidents include vessel collisions or near collisions, pollution, breach of security and so forth. The data base is referred to as the MISLE (Marine Information for Safety and Law Enforcement) system. Information is entered into this system by operations officers on a nationwide basis. Although this information may provide valuable insights into risk areas and subsequent risk management initiatives on a national level, it is not analyzed to permit effective risk management on a port specific operational level. In this task, students will conduct research to mine open source USCG incident data to enable trend analysis and more effective management of risk. Outcomes from the project will include a prototype for a risk management dashboard.</p>
<p><b>Methodology:</b></p> <ul style="list-style-type: none"> <li>• Interpreted and assessed incident data</li> <li>• Collectively created an initial design</li> <li>• Met with Sector New York and revised with feedback</li> </ul> <p><b>Design of Dashboard</b></p> <ul style="list-style-type: none"> <li>• Dashboard Graphical Time Scales <ul style="list-style-type: none"> <li>◦ Structured to present data in an informative, but non-cumbersome way</li> </ul> </li> <li>• Analysis Page <ul style="list-style-type: none"> <li>◦ Provide the option to “drill down” into the data</li> </ul> </li> <li>• Geographic Understanding of Data <ul style="list-style-type: none"> <li>• Give context to data through zone clustering</li> </ul> </li> </ul> <p><b>Building the Dashboard Tool</b></p> <ul style="list-style-type: none"> <li>• Received and analyzed open source data</li> <li>• Parsed and uploaded the data for use in the dashboard database</li> <li>• Created a spatial `database and ran queries on the data</li> <li>• Fed the results to graphs and maps</li> </ul>

**Research Outcomes:**

At the culmination of the eight-week program, the student research team developed a working prototype of a dashboard visualization and trend analysis tool. In its current form, the tool can be provided to Sector New York for use. The team recommends the following next steps in further developing the tool: Improve the functionality of the tool by creating customizable graphs and maps, improve the design of the tool by enhancing the color coding of incident type, and build out the capabilities of the tool to include predictive modeling.

Additional details regarding the team's project can be found in their final research presentation slides and research poster located on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>. Table 5 below identifies the student team members, their academic disciplines and their university affiliations.

**Table 5. Dashboard Student Research Team**

Student	Academic Discipline	School
Danielle Dobbs	Maritime Systems	SUNY- Maritime College
Tristan Goers	Data Science	Univ. of Alaska-Anchorage
Emily Jannace	Civil Engineering- Transportation Infrastructure and Systems Engineering	Virginia Tech
Mathew Seedhom	Mathematics and Computer Science	Stevens Institute
<b>Faculty Mentor:</b> Drs. Paul Rohmeyer and Barry Bunin, Stevens Institute		

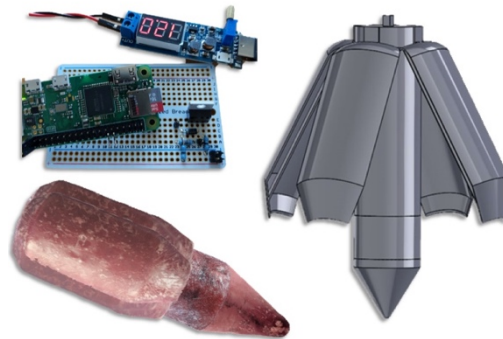
**Research Team/Project: UAS Buoy Team**

**Figure 7. The UAS Buoy Team constructed a prototype of a buoy design in the machine shop at Stevens STAR Center.**

A team of four students conducted research to build a prototype of a buoy system initially conceived during the Center's 2018 Summer Research Institute. The objective of the

team's work was to develop a lightweight, sensor-equipped drifter buoy that could be deployed by an Unmanned Aerial System (UAS) to support Coast Guard missions, including search and rescue and drug interdiction. The concept of operations for the team's work included the use of a UAS to quickly and effectively deploy a self-locating datum marker buoy (SLDMB) for real time tracking of jettisoned drug bales, or to reduce the size of search patterns and aid in faster response times during search and rescue missions. Figure 8 shows a schematic of the team's buoy design.

#### Physical Prototype & Electronics



**Figure 8. The UAS Buoy system prototype design.**

A synopsis of the student team's research, including the team's research question, importance to homeland security, methodology and outcomes are provided below in Table 6.

**Table 6. SRI 2019 – UAS Buoy Project Overview**

<b>Project Title:</b> Modular Self-Locating Datum Marker Buoy Deployment from Unmanned Aerial Systems (UAS)
<b>Research Question:</b> <i>How can a UAS-based buoy system be designed to enable a rapid, low cost deployment capability to enhance USCG and CBP operations?</i>
<b>Research Importance to Homeland Security:</b> <ul style="list-style-type: none"> <li>• Search and Rescue</li> <li>• Drug Interdiction and Tracking</li> <li>• Refining Ocean Models</li> </ul>
<b>Prospective End-User:</b> U.S. Coast Guard



**Project Abstract:**

The purpose of this project was to design, fabricate and test a self-locating datum marker buoy (SLDMB) based on the “Modular Self-Locating Datum Marker Buoy Deployment from Unmanned Aerial Systems” project from the 2018 Summer Research Institute (SRI). The SLDMB is to be utilized to assist the U.S. Coast Guard in missions related to search and rescue, drug interdiction, illegal fishing and illegal immigration. Through contact with professionals in environmental monitoring devices, the team redesigned the SLDMB and began steps to construct the prototype. The redesigned system omitted the release mechanism of the previous design in favor of an aerodynamic SLDMB attached directly to a drone as the payload that would be released via a solenoid release system. The software to calculate the trajectory and release GPS coordinates described in the previously stated project was created, as well as a simplified sensor suite for proof of concept, including GPS and Cellular Communication.

**Methodology:**

- Prototype construction using 3D printed parts and fiberglass molded components, electrical circuitry, GPS communications and software development for drone latch release and buoy tracking.

**Research Outcomes:**

Over the course of the eight-week program, the team successfully built a fiberglass prototype of their buoy design and were able to demonstrate the functionality of the drone buoy release mechanism. Following the SRI program, the team hopes to continue to build out a fully constructed buoy and to test and evaluate its deployment by drone.

A copy of the team's final research presentation slides and research poster can be found on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>.

Table 7 below identifies the student team members, their academic disciplines and their university affiliation.

**Table 7. UAS Buoy System – Student Team**

<b>Student</b>	<b>Academic Discipline</b>	<b>School</b>
Jason Chang	Mechanical Engineering	Stevens Institute
Eric Fernandes	Software Engineering	Stevens Institute
Maria Manousasakis	Mechanical Engineering	Stevens Institute
Herb Zieger	Software Engineering	Stevens Institute
<b>Faculty Mentors:</b> Dr. Barry Bunin, Stevens Institute		

**Research Team/Project:** *Automatic Identification System (AIS) Anomaly Detection*



**Figure 9. The AIS Anomaly Detection team utilized machine learning techniques and neural network models to analyze anomalous vessel patterns.**

The concept for the AIS Anomaly Detection’s team’s project came from discussions with MSC’s partners from the CBP National Targeting Center. Tasked in part with identifying maritime vessel threats, the agency continuously seeks to enhance its situational awareness and surveillance capabilities. Given the robust amount of data derived through the global use of AIS, the student research team was given the challenge to see how AIS data could be used to identify potentially nefarious vessel activities by identifying anomalous vessel behavior.

An overview of the student team’s research including the team’s research question, methodology and outcomes are provided below in Table 8.

**Table 8. SRI 2019 – AIS Anomaly Detection Project Overview**

<b>Project Title:</b> Detecting Anomalies in Vessel Behavior based on AIS Data: a Deep Learning Approach
<b>Research Question:</b> <i>How practical are deep learning models for detecting anomalous vessel behavior, based on their course, speed, and positions acquired from AIS data?</i> <ul style="list-style-type: none"> <li>• <i>How well do these models predict behavior of different vessel types?</i></li> <li>• <i>Can such models be used effectively for real time analysis?</i></li> </ul>
<b>Research Importance to Homeland Security:</b> <ul style="list-style-type: none"> <li>• Improve the detection of potentially nefarious maritime vessel behavior</li> <li>• Utilize machine learning techniques to fill gaps in missing AIS data</li> </ul>
<b>Prospective End-Users:</b> U.S. Coast Guard and Customs and Border Protection
<b>Methodology</b> In order to predict vessel behavior, the team used a Recurrent Neural Network, a model designed for use with data sequences of variable length. This model structure links together sequences of 30 AIS points (containing Latitude, Longitude, Course over Ground, Speed over Ground, and Heading) and establishes relations over a sequence of 30 datapoints to predict the next point. This methodology was used to train individual models for pleasure craft, cargo, tanker and tug vessels in the Port of NY/NJ, and for tanker, tug, and cargo vessels in the Port of New Orleans. Finally, a model trained on tanker vessels was applied to real AIS data collected by the AIS

server in the Maritime Security Center in order to establish the practicality of the team's approach.

**Research Outcomes:**

- Real-time anomaly detection has potential
- Deep learning models can effectively detect anomalous vessels

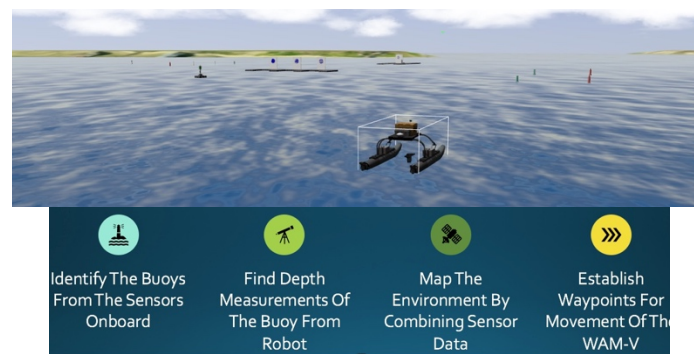
A copy of the team's final research presentation slides and research poster can be found on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>.

Table 9 below identifies the AIS Anomaly team members, their academic disciplines of study and their university affiliation.

**Table 9. AIS Anomaly Detection – Student Research Team**

Student	Academic Discipline	School
Eamon Bontempo	Mechanical Engineering	Stevens Institute
Khalil Hardy	Computer Science	Univ. of North Carolina-Pembroke
Samuel Yakovlev	Applied Artificial Intelligence and Computer Engineering	Stevens Institute
<b>Faculty Mentor:</b> Dr. Barry Bunin, Stevens Institute		

**Research Team/Project: *Wave Adaptive Modular Vessel (WAM-V)***



**Figure 10. An outline of the associated WAM-V project tasks.**

Students on the Wave Adaptive Modular Vessel (WAM-V) team leveraged the newly released Virtual RobotX (VRX) simulation environment to simulate the operation of an unmanned surface vehicle (USV) as it navigates complex and obstacle-filled marine environments. The RobotX challenge is a university-based competition that requires teams of students to operate an autonomous USV to patrol and inspect its surroundings, while maneuvering and occasionally docking in a collision-free and time-efficient manner. The SRI 2019 student team utilized the simulation software to prototype the autonomous navigation capabilities that will eventually be deployed on the Stevens physical WAM-V platform.

An overview of the student team's research including the team's research question, methodology and outcomes are provided below in Table 10.

**Table 10. SRI 2019 – WAM-V Simulator Project Overview**

<b>Project Title:</b> Wave Adaptive Modular Vessel (WAM-V) - Unmanned Surface Vehicle (USV) Simulator
<b>Research Question:</b> How can the virtual command and control of a WAM-V be used to compete and navigate prescribed tasks in the university-based RobotX competition?
<b>Research Importance to Homeland Security:</b> <ul style="list-style-type: none"> <li>• Unmanned surface vessels can be used to perform maritime security operations.</li> <li>• USVs like the Wave Adaptive Modular Vessel (WAM-V) can be used for persistence surveillance and enhanced situational awareness in open ocean and remote environments or in busy seaports.</li> <li>• Enhancing the autonomy of USVs/WAM-V can have a positive impact on maritime security applications.</li> </ul>
<b>Prospective End-User:</b> U.S. Coast Guard, CBP, maritime security operators
<b>Project Abstract:</b> When intercepting a foreign hostile threat on open seas near coasts, humans are put into the line of danger resulting in setbacks and injuries. Humans should not needlessly endanger themselves when robotic solutions can automate these processes. In open waters, a swarm of Unmanned Surface Vessels (USV) can be deployed to intercept and deflect the trajectory of incoming vessels. In particular, the Wave Adaptive Modular Vessel (WAM-V) is a viable and scalable solution to create a security perimeter around an area. To develop the autonomy of the WAM-V, the research group has focused on mapping the Virtual RobotX simulated competition environment using the Wave Adaptive Modular Vessel with a combination of LiDAR and rectified image data. These two datasets were independently processed to detect objects and then cross-referenced to determine if the predicted object locations were valid. Once verified to be the significant objects, or buoys in the context of Virtual RobotX, their locations were plotted in a 3-D space using a package called OctoMap and then projected into a 2D occupancy map. The WAM-V's ability to autonomously classify objects and find their position with respect to the map shows that the current mapping algorithm can be combined with pathfinding algorithms such as A* to plot and execute a series of maneuvers to traverse navigation channels. The methods used in this project could also be abstracted to more refined object classification and probabilistic pathfinding in extreme marine conditions.
<b>Methodology:</b> The team focused their efforts on accomplishing the tasks and requirements outlined as part of the Virtual RobotX (VRX) Competition. Their approach included the virtual navigation of an unmanned surface vehicle through the sensing and mapping of a shipping channel. The VRX competition takes place in a simulated world and requires the use of the software environment ROS and visualization packages RViz and Gazebo.
<b>Research Outcomes:</b> Over the course of this project, data from cameras and LiDAR were combined to create a complete map of the WAM-V's virtual environment. The team's approach to image filtering is capable of finding and classifying buoys in an image based on color. These buoys are then paired with their bearing and applied to a map in order to find

each buoy's position in reference to the rest of the environment. All code produced during this project has been made publicly available on Github.

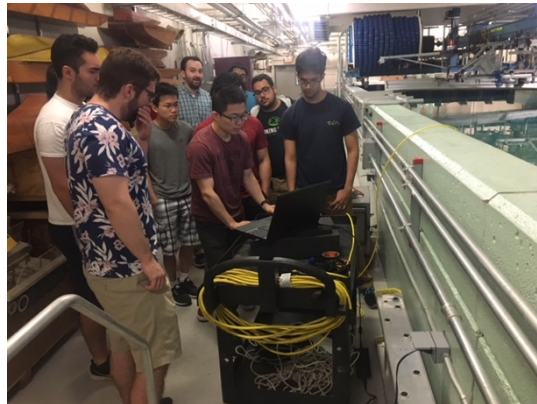
A copy of the team's final research presentation slides and research poster can be found on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>.

Table 11 below identifies the WAM-V team members, their academic disciplines of study and university affiliations.

**Table 11. WAMV– Student Team**

Student	Academic Discipline	School
Alice Huston	Software Engineering	Stevens Institute
Asif Uddin	Mechanical Engineering	Stevens Institute
<b>Faculty Mentor:</b> Dr. Brendan Englot, Stevens Institute of Technology		

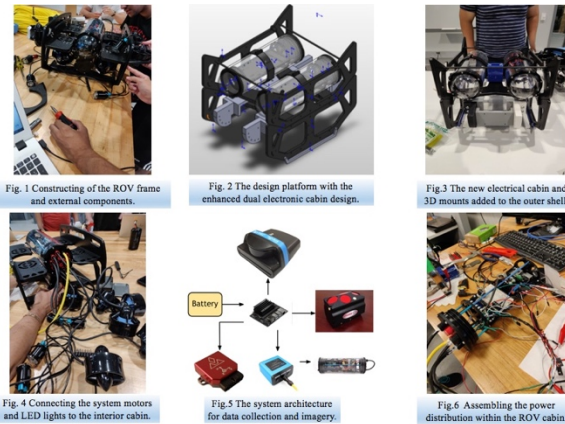
### **Research Team/Project: BlueROV Underwater Robot**



**Figure 11. Students on the BlueROV Underwater Robot team tested their custom ROV design in the towing tank at Stevens Institute of Technology.**

Students on the BlueROV team were tasked with designing and building an underwater Remotely Operated Vehicle to include a suite of sensors for enhanced path finding and mapping capabilities. The customization and electrical work completed on the ROV required the use of SolidWorks and 3D printing to develop sensor mounts and structural supports and space limitations and constraints required that all electrical and communications components had to be tightly bound and integrated.

The team was able to successfully test and evaluate the functionality of their ROV design in the Davidson Laboratory towing tank at Stevens Institute of Technology. The team's work will continue to be utilized by the Robust Field Autonomy Laboratory in their ongoing research in the area of autonomous underwater robots.



**Figure 12. BlueROV2 system architecture and construct.**

An overview of the student team's research including the team's research question, methodology and outcomes are provided below in Table 12.

**Table 12. SRI 2019 – BlueROV2 Project Overview**

<b>Project Title:</b> Enhanced Perception and Navigation for the BlueROV Underwater Robot
<b>Research Question:</b> How can we increase the BlueROV2's payload capacity while still allowing agile autonomous navigation?
<b>Research Importance to Homeland Security:</b> <ul style="list-style-type: none"> <li>Remotely operated vehicles (ROVs) can be utilized for a range of maritime security applications.</li> <li>Advancements to an ROV's functionality, including path finding, mapping, perception and autonomy can greatly enhance the detection of underwater safety and security threats.</li> </ul>
<b>Prospective End-Users:</b> CBP and U.S. Coast Guard
<b>Project Abstract:</b> The use of human divers to fix deep sea oil spills and perform underwater infrastructure inspections is both expensive and time consuming; using an ROV holds the potential to be quicker and more cost efficient. The BlueROV team investigated the balance between payload capacity while keeping agile autonomous navigation. By splitting into mechanical, electrical and software sub-teams, the BlueROV2 team worked together in order to design, construct, and test a BlueROV2 model. The team equipped the <i>Aquaman</i> with two Oculus sonar sensors, a doppler velocity log (DVL), and an inertial measurement unit (IMU), as well as robot operating system (ROS) software developed by the Robust Field Autonomy Lab (RFAL) at Stevens Institute of Technology. The BlueROV2 was capable of human-controlled roll, yaw, and movement along the x-y-z axes, along with having functional subsea lights, camera, and depth stabilizer. The BlueROV2 also communicated with all sensors to read data.
<b>Research Outcomes:</b> The BlueROV2 team successfully designed, built, and tested a customized BlueROV2 capable of diving and exploring underwater environments. The BlueROV2 had a free



range of motion along all axes and two rotational axes, and the team was able to construct and communicate with a sensor network consisting of multiple sonar and positioning sensors on the underwater robot.

A copy of the team's final research presentation slides and research poster can be found on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>.

Table 13 below identifies the student team, their academic majors and their university affiliations.

**Table 13. BlueROV2 - Student Research Team**

<b>Student</b>	<b>Academic Discipline</b>	<b>School</b>
Dante D'Amico	Computer Engineering	Stevens Institute
Alec Espiña Santiago	Electrical Engineering	Univ. of Puerto Rico-Mayaguez
Matthew Kirby	Engineering Undecided	Stevens Institute
Daniel Lentini	Mechanical Engineering	Stevens Institute
Federico Macchiavelli	Electrical Engineering	Univ. of Puerto Rico-Mayaguez
Kevin Ward	Computer Engineering	Stevens Institute
<b>Faculty Mentor:</b> Dr. Brendan Englot, Stevens Institute of Technology		

### **Research Team/Project: Red Team / Blue Team Exercises**



**Figure 13. Students on the Red Team/Blue Team**

Students conducting research on the Red Team/Blue Team project utilized an adversarial game approach to collect and generalize data as it pertained to tactics and strategies that drug traffickers (the red team) may take to smuggle contraband goods and those that law enforcement (the blue team) may take to catch the smugglers. The goal of the project was to gain insight into how to better defend borders in the face of creative adversaries.

The team's project included three parts, the first included the development and design of a two-person adversarial game, the second part involved playing the game many times in order to generate data, and the third part included the analysis of player actions to gain insight into player strategies.

An overview of the student team's research including the team's research question, methodology and outcomes are provided below in Table 14.

**Table 14. SRI 2019 – Red Team / Blue Team Project Overview**

<b>Project Title: Red Team / Blue Team Adversarial Game Exercises</b>
<b>Research Question:</b> <i>How can a simulation game help DHS agents identify strategies to better mitigate the fentanyl smuggling crisis?</i>
<b>Research Importance to Homeland Security:</b> Resource allocation routinely presents obstacles to interdiction of illegal drugs. The use of adversarial simulation games can be used to better understand the methods and strategies drug smugglers may take to traffic drugs at ports of entry.
<b>Prospective End-User:</b> The game simulation was developed to be used as a potential interdiction training tool for CBP, HSI, and U.S. Coast Guard personnel.
<b>Project Abstract:</b> Resource allocation routinely presents obstacles to interdiction of illegal drugs at United States ports. The team investigated the possibilities to aid the Department of Homeland Security personnel to better react to the smuggling of drugs, specifically the synthetic opioid fentanyl. A simulation was developed to elevate the utilities of serious game play to train personnel and organize data retrieved from ongoing use. The adversarial game is played as a series of turns by two players with opposing goals. The red player is the smuggler and aims to transport illegal drugs into the port. The blue player is the defender and aims to interdict all illegal drugs entering the port. The multipurpose tool is to be used to identify strategic trends and target employee learning and adaptation to facility procedures. As a result, the game will produce insight into both infiltration and defense strategies by the Red (Smugglers) and Blue (Defense) teams.
<b>Methodology:</b> The team set off to create a deliverable of both an optimal fidelity simulation and an organized data collection service. To develop a game simulation, the team used JavaScript because of its superiority in game-making visuals and functionality. The team then recorded the data documented from game plays to deliver a service that tracks changes and trends.
<b>Research Outcomes:</b> The team designed a moderate fidelity adversarial game to analyze the resource allocation strategies of drug smugglers versus those of law enforcement. A database was created to track red team versus blue team player moves and graphic interpretations of the strategies were derived by the collected data.

A copy of the team's final research presentation slides and research poster can be found on the MSC website at: <https://www.stevens.edu/SummerResearchInstitute>.



Table 15 below identifies the student team, their academic majors and their university affiliations.

**Table 15. Red Team / Blue Team Exercises - Student Research Team**

<b>Student</b>	<b>Academic Discipline</b>	<b>School</b>
Liam Brew	Software Engineering	Stevens Institute
Tanner Chiamprasert	Engineering Physics	Stevens Institute
Caroline Corr	Biomedical Engineering	Stevens Institute
Ronald Estevez	Computer Science	Stevens Institute
Shreena Mehta	Computer Science	NJ Institute of Technology
Yousef Salaman Maclara	Electrical Engineering	Univ. of Puerto Rico-Mayaguez
<b>Faculty Mentor:</b> Dr. Jeffrey Nickerson, Stevens Institute of Technology		

### 3.3.8. SRI 2019 Student Survey

An assessment of the summer research program was conducted via a student survey (see Appendix E-1 for a copy of the student survey questions and format). Student participants were each asked to complete an online survey and to provide feedback on the program, the students learning gains, areas for program improvement and program impacts on student interest in advanced study and/or careers in homeland security. 24 students out of the 25 participants completed the program survey.

A majority of the student respondents rated the SRI Excellent in the following categories:

- Program Coordination/Administration (75%)
- Teamwork/Collaboration (66.7%)
- Field Visits and Stakeholder Engagement (62.5%)
- Research Project Outcomes (62.5%)
- Faculty and Guest Lectures (62.5%)
- Program Format and Curriculum (58.3%)
- Faculty Mentorship and Guidance (58.3%)

79% of the survey respondents stated that the SRI enhanced their interest in advanced academic study and careers in the homeland security domain, and 100% of the students reported that they would recommend the program to their peers and colleagues at their respective schools.

When asked to what extent the SRI enhanced or improved their skills, a majority of the students reported “Significant Improvement” in the following areas:

- Networking (50%)

- Teamwork and Collaboration (42%)

A majority noted Sufficient Improvement, in the following skill areas:

- Ability to Conduct Research (54%)
- Leadership Skills (50%)
- Communication Skills (46%)
- Oral Presentations (46%)
- Professional Confidence (46%)

When asked to identify their “top takeaways” from the program, the students commonly mentioned the following:

- Multidisciplinary teamwork, collaboration and group projects.
- Networking with stakeholders and field visits.

When asked to identify the strengths and weakness of the program, students frequently mentioned the following:

Strengths:

- Student diversity
- Program administration
- Field visit opportunities

Weaknesses:

- Program is not long enough
- Students would prefer to select the research projects they want to be on rather than being assigned to a project.
- Students mentioned the need for more faculty mentorship at the start of the program.

The students worked in collaboration with assigned researcher mentors and had the unique opportunity to interact and engage with homeland security practitioners. Through their experience in the summer research program, students gained a greater awareness of maritime and homeland security issues. Student survey responses show that participation in the SRI has effectively inspired student interest to pursue careers and academic study in the homeland security domain. Collectively, the SRI was effective in achieving the following outcomes:

- Student presentations and research reports demonstrated that the students gained knowledge and understanding of the maritime security domain and their respective research projects. 54% of the students stated that their understanding of their assigned research area improved substantially and they could apply what they learned, whereas 33% said that they had gained advanced knowledge and confidence in the research area.

- A majority of the students (79%) expressed enhanced interest in pursuing careers and/or advanced academic study in maritime/homeland security as a result of their participation in the SRI.

### 3.3.9. SRI Lessons Learned

MSC continuously strives to enhance the learning experiences of its students by modifying and tailoring the SRI program format according to the survey feedback. For this year's program, the Center continued to limit the number of in-class faculty and guest lectures in lieu of more time for the students to conduct their research. The program administrators also leveraged broader research engagement across its Stevens Institute of Technology network to include faculty participation from the following departments/schools: Electrical and Computer Engineering, Mechanical Engineering, and the School of Business. The Center also leveraged the assistance of Duro UAS, a commercial buoy maker to provide design guidance to the UAS Buoy student team.

## 3.4. Graduate and Undergraduate Research Assistantship Programs

Milestones	Performance Metrics	Status/Discussion
1. Homeland Security Research Assistantships 7/1/18 – 5/30/19	Confer a minimum of two Graduate Research Assistantships.	Completed: MSC provided tuition and stipend support for two Master's degree students. One student conducted research to advance the underwater mapping capabilities of ROVs and the other focused on developing models to detect anomalous vessel traffic.

### 3.4.1. MSC Research Students (2018-2019)

The following Undergraduate and Graduate-level students conducted research with the MSC during Year 5. The Graduate students were provided funding support through the MSC and the Undergraduate students were provided stipend support by Stevens Institute of Technology.

Table 16. MSC Research Students

Student	Award / Program	Research / Activities
<b>GRADUATE</b>		
John Martin	Homeland Security and Mechanical Engineering Fellowship / Mechanical Engineering Doctoral Program	Conducted research focused on enabling robust robot intelligence for underwater surveillance. Completed remaining re-

		search requirements toward a doctoral degree in Mechanical Engineering. Submitted two conference papers and participated in a 12-week internship with Google Brain.
Chance Petersen	Graduate Research Assistantship / Applied Artificial Intelligence Master's Degree	Conducted research to develop new models for detecting anomalous vessel traffic. Briefed CBP Officers at the National Targeting Center on his work and presented his Master's thesis to MSC and Stevens researchers. Completed degree requirements in May 2019.
Helen Walter Cardinal	Graduate Research Assistantship / Mechanical Engineering Master's Degree	Conducted research to create algorithms to advance the autonomous mapping and path finding capabilities of underwater ROVs.
<b>UNDERGRADUATE</b>		
Dominic Alberella	Undergraduate Research Support Assistant/ Mechanical Engineering SRI 2018 program alumni	Provided support to rebuild and operationalize an infrared camera as part of the Maritime Security Laboratory suite of assets.
Liam Brew	Undergraduate Research Support Assistant / Software Engineering SRI 2018 program alumni	Provided MSC Lab support and served as a peer mentor leading up to and during the COE Summit Grand Challenge.
Patricia McKiever	Undergraduate Research Support Assistant / Systems Engineering	Provided MSC Lab support and assisted in documenting the Lab equipment specs and use cases.
Herb Zieger	Undergraduate Research Support Assistant / Software Engineering SRI 2018 program alumni	Assisted in the development of course materials for a new Drone Applications course. Provided technical and operational support to the MSC Lab.

### **3.4.2. Doctoral Fellowship – DHS Career Development 2015 Supplement Award**

Mr. John Martin was selected to receive the Center's Mechanical Engineering and Homeland Security Doctoral Fellowship in the fall of 2015. During the 2018/2019 academic year, he completed his remaining coursework and research requirements and was invited to join Google Brain, the deep learning artificial intelligence research team at Google, for a twelve-week summer internship. At Google Brain, John applied his research in developing core methods for underwater robot learning and optimization to broader contexts in reinforcement learning.

Prior to his internship, John submitted and presented conference papers at the 2018 Conference on Robot Learning and the 2019 International Conference on Machine Learning.

### **3.4.3. Graduate Research Assistantships**



*Figure 14. MSC Graduate Research Assistants Chance Petersen and Helen Walter Cardinal.*

At the start of the 2018/2019 academic year, the MSC awarded Graduate Research Assistantships to Chance Petersen and Helen Walter Cardinal. Competitively selected based on their academic qualifications, research interests and faculty recommendations, the Assistantships included tuition and stipend support to facilitate the students research engagement with the Center. Details regarding each of the student's research and assistantship activities are provided below.

#### **Chance Petersen – Graduate Research Assistant**

Chance Petersen's research conducted during the Graduate Research Assistantship program focused on the detection of vessel traffic anomalies using machine learning and recurrent neural networks. An abstract of his research project is as follows:

Abstract: In the maritime environment, vessels of certain types and sizes are required to use the Automatic Identification System (AIS). This system requires the vessels to be equipped with specialized radio transponders that regularly broadcast messages about themselves, including identification information and navigational data. The messages can then be received by any interested parties in range, notably other vessels and coastal authorities. The primary purpose of AIS is to assist in navigation to reduce congestion and

prevent accidents. The effectiveness of this system is well known and has been adopted across the globe. One of the largest suppliers of AIS data, MarineTraffic records approximately 520,000,000 messages from around 180,000 vessels each day. With this plethora of data, the system has also been used extensively in the maritime security domain.

This project presents a method for identifying anomalous behavior in vessels using the data from AIS messages. This can be used to tag vessels to be further investigated to determine if there was malicious activity, such as smuggling, illegal off-loading of cargo, or fishing in restricted waters. The method involves the use of a variational recurrent neural network, which is a type of generative machine learning model, to reconstruct trajectories of the vessels. The model was found to be effective at learning how certain vessels behave normally in order to identify vessels that are potential anomalies, even when AIS messages are not received for some time.

Over the course of the academic year, Chance completed 18 credits towards the balance of his degree requirements and defended his master's thesis titled "*Trajectory Reconstruction Models for Maritime Vessel Anomaly Detection.*" In May 2019, Chance successfully fulfilled his degree requirements to receive a Master's of Science in Applied Artificial Intelligence from Stevens Institute of Technology. During his Assistantship, Chance engaged in the following courses and fellowship/research activities.

Semester	Course Title	Credits
Spring 2019	CPE 604 Analytic Methods for Networks	3
Spring 2019	CPE 695 Applied Machine Learning	3
Spring 2019	CPE 900 Thesis in Computer Engineering	3
Fall 2018	CPE 584 Web Systems Security	3
Fall 2018	EE 672 Game Theory for Wireless Networks	3
Fall 2018	CPE 900 Master's Thesis	3

#### Assistantship/Research Activities:

- Completed and defended Master's thesis
- Set up an AISHub data collection system in the Maritime Security Lab and prepared a corresponding user manual.
- Provided a briefing of his research in a conference call meeting with the CBP National Targeting Center.
- Presented his research at the 2019 Graduate Research Conference at Stevens Institute of Technology

Upon the completion of his degree program, Chance was offered a Junior Engineering position at the National Urban Security Technology Laboratory where he is currently employed.

## Helen Walter Cardinal – Graduate Research Assistant

Helen's research during the 2018/2019 academic year focused on the development of algorithms to advance the autonomous capabilities of underwater robots. An abstract of her project work is as follows:

**Abstract:** This research focuses on underwater path-planning for the BlueROV2 when following a pipeline. The primary research question focuses on the optimal spacing between waypoints when following a linear pipeline. The MSC's 2018 Summer Research Institute explored pipe detection through vision-based algorithms, however, the subjects of trajectory and path-planning were not as thoroughly explored. In the research, I modified an existing platform, *uwsim*, to analyze the effect that different spacing between waypoints can have on the accuracy and efficiency of a given trajectory when taking water current into account. The accuracy of the trajectory is important when monitoring pipelines for security purposes, as a shift from the desired trajectory could mean losing "sight" of certain lengths of a pipeline, especially when faced with underwater currents or disturbances."

Over the course of the Assistantship program, Helen completed 18 credits towards her Master's degree in Mechanical Engineering and participated in the following research activities:

Semester	Course Title	Credits
Spring 2019	ME 621 Intro to Modern Control Engineering	3
Spring 2019	ME 635 Simulation and Modeling	3
Spring 2019	ME 900 Thesis in Mechanical Engineering	3
Fall 2018	ME 598 Intro to Robotics	3
Fall 2018	ME 642 Engineering Analysis	3
Fall 2018	ME 651 Analytic Dynamics	3

### Assistantship/Research Activities:

- Conducted 20 hours per week of research as part of the Assistantship program.
- Participated in regularly scheduled faculty mentor meetings.
- Participated in a full-scale emergency response exercise coordinated by the Port Authority of New York/New Jersey.
- Represented the MSC at the Submerge Marine Science Festival.

At the culmination of her Assistantship program, Helen presented her research outcomes in a final report and presentation for MSC and Stevens Institute of Technology research faculty.

### 3.4.4. Undergraduate Research Assistant Support

During Year 5, Stevens Institute of Technology provided funding support for four undergraduate students to provide research support to the Maritime Security Center. Three out of the four students were alumni of the MSC 2018 Summer Research Institute. The tasks

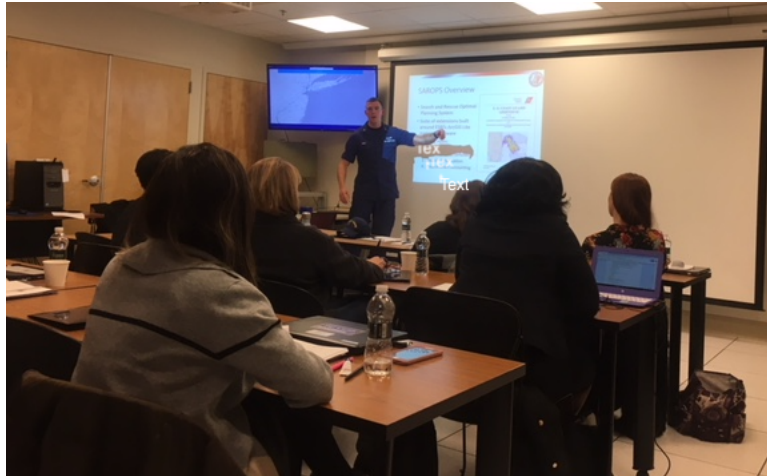
and research activities of the MSC undergraduate research assistants is described above in Table 16.

### 3.5. MSI Engagement

Milestone	Performance Metrics	Status / Discussion
1. Minority and women student participation in the Center's annual Summer Research Institute. SRI 2019 – outreach and recruitment (9/1/18 – 2/16/19)	Diversity in the SRI program will reflect a minimum of 50% of students from underrepresented communities. (e.g. minority students, women and MSI enrolled students.)	Partially Completed: The demographics for the 2019 SRI included 48% students from underrepresented communities and students from three MSIs.
2. MSI participation in MSC research activities/programs. Summer Research Team program YR 4 (6/3/19 – 8/9/19)	MSC will host a minimum of one MSI SRT team per summer. - Outreach efforts to recruit MSI SRT participation will be measured by the number of targeted email distributions and personal conversations had with MSI representatives.	Partially Completed: Effort was made across the MSC network to recruit MSI SRTP participants. Two MSI schools submitted proposals and one was selected for participation. A few short weeks prior to the start of the MSI SRTP, the MSI faculty mentor withdrew their participation due to personal reasons. The Center was able to provide funding support for the two MSI SRT students to attend the MSC Summer Research Institute for a tailored ten-week program.
3. MSI Workshop	MSC will host a STEM-focused workshop tailored to MSI faculty and educators from underserved communities.	Completed: MSC developed and delivered a Fundamentals of Sensing Technologies -STEM Education workshop on March 22, 2019 in conjunction with Stevens ACES program and the USCG Sector NY.



### 3.5.1. MSI Workshop – Fundamentals of Sensing Technologies



**Figure 15. LTJG Kloo, from USCG Sector NY discusses the Coast Guard’s use of sensor data during search and rescue missions in MSI STEM Educators Workshop.**

The MSC, in conjunction with the Accessing Careers in Engineering and Science (ACES) Program at Stevens Institute of Technology co-hosted a Fundamentals of Sensing Technologies Workshop on March 22, 2019 at the Stevens Institute of Technology campus in Hoboken, NJ.

The objectives of the workshop were to:

- Provide professional development, educational instruction and resources to STEM educators working within underrepresented and underserved communities.
- Provide workshop participants with the basic principles of sensor technologies and an understanding of data science techniques used to process and interpret data.
- Provide workshop participants with new perspectives on how the U.S. Coast Guard and other Department of Homeland Security component agencies utilize sensor technologies to support their missions.

The lead instructor for the workshop was Liesl Hotaling, affiliate instructor with Stevens Center for Innovation Engineering and Science Education (CIESE), and the co-PI on the National Science Foundation SenseIT project.

The agenda for the workshop includes the following five modules:

- Fundamentals of Sensor Technologies – What are they and how do they work?
  - Principles of sensing and examples
- Different Types of Sensors and their Applications.
  - Acoustic, Electromagnetic, Optical, Radar, and Infrared
- Sensor Technologies and Data Science in the context of real-world maritime and homeland security applications – Discussions with U.S. Coast Guard
  - Search and Rescue
  - Ship Traffic
  - Ocean Weather Forecast

- Hands-on activity – Build a temperature sensor system
- Workshop roundtable discussion and curriculum uses in teaching

Copies of the curriculum materials discussed in the workshop can be found on the MSC website at <https://www.stevens.edu/STEM%20Educators%20Workshop>.

To assess the effectiveness of the workshop in providing relevant and useable curriculum materials, the MSC asked the participants to assess the workshop in a participant survey (see Appendix E-2 for copy of the survey instrument). MSC received assessments from 9 out of the 10 participants. Overall, the assessments were overwhelmingly positive, 8 out of the 9 respondents rating the workshop Excellent in the Quality of Curriculum Materials and in Program Facilitation, and 90% reported that they are likely to incorporate all lesson plans pertaining to maritime search and rescue, vessel traffic, and ocean weather into their existing curricula. All the respondents gave the highest rating of five out of five to the inclusion of the Coast Guard representative in the workshop.

Suggestions to improve the workshop for future delivery included the need for more time conducting the hands-on activities and more time to learn about the NSF Sense IT curriculum.

Following the STEM teachers workshop, MSC was invited to hold a student-centric version of the Fundamentals of Sensing Technologies program at the Paterson Charter School for Science and Technology, in Paterson, NJ on May 13. Twenty students participated in the two-hour workshop, that included a discussion on the impacts of water temperature on vessel traffic in the New York Harbor, and the construction of a temperature sensor.

Positive feedback to both the teacher's and student's workshops has inspired the MSC to develop future offerings during the 2019/2020 academic year.

### **3.5.2. MSI Summer Research Team Program**

During the fall of 2018, the Center pursued its academic network to identify an MSI partner to collaborate with in the DHS MSI Summer Research Team Program (SRTP). MSC collaborated with two MSI schools to submit research proposals for the 2019 DHS MSI Summer Research Team Program. Following a review by the DHS Office of University Programs, the proposal submitted by the University of Puerto Rico Mayaguez (UPRM) titled "*A Multispectral Infrared Remote Vessel Emission Monitoring System*", was selected for funding and participation. A few weeks prior to the start of the ten-week summer program however, the UPRM faculty member withdrew their participation due to personal reasons. However, the Center was able to leverage remaining funds in its budget to extend summer research offers to the two UPRM students who were to have accompanied the visiting faculty member.

## 4. Other Related Activities

This section describes additional activities related to MSC that occurred during the reporting period. These include the Center's activities for soliciting projects, stakeholder engagement, communications and outreach, management, and guidelines and policies.

### 4.1. Project Solicitation

In Year 4, the MSC announced a Request for Proposals for Maritime Security Research to solicit projects that would be conducted in Year 5. The RFP solicited projects that addressed IPT gaps and FOA research questions, and that corresponded to one or more of the following research theme areas:

- Theme Area 1: Maritime Risk, Threat Analysis, and Resilience
- Theme Area 2: Maritime Domain Awareness (MDA) Research
- Theme Area 3: Maritime Technology Research
- Theme Area 4: Integration of Science and Engineering with Maritime Security Governance and Policy Research

MSC leveraged the OUP and COE networks, as well as its own academic and industry contact list to distribute the RFP announcement as broadly as possible. Eligibility requirements stated that only proposals from accredited U.S. colleges and universities, for-profit organizations and organizations that met the definition of non-profit.

Collectively, the RFP solicitation resulted in the receipt of 16 proposals overing a broad range of topics, from Unattended Remote Sensing Applications to Piracy and Maritime Crime to Predictive Port Resilience Tools. Each proposal underwent a two-part review to include a Scientific Merit Review conducted by independent peer reviewers (a total of 32 reviewers) and then a comprehensive assessment by the DHS Office of University Programs for Mission Relevancy.

Following an extensive review that concluded in April, two proposals were selected for funding by DHS. The two proposals are listed below and are described in Section 3 of this report.

1. *Predictive Port Resilience Tool to Assess Regional Impact of Hurricanes*,  
Dr. Manhar Dhanak Florida Atlantic University (FAU)  
Project Champion: LCDR Rachel Stryker, CG-FAC-1
2. *Social Media Analytics Research and Training for the US Coast Guard*,  
Dr. David S. Ebert, Purdue University  
Project Champion: Captain Howard Wright, USCG

For Year 6 projects, MSC conducted multiple meetings with the USCG representatives from various organizations, mainly from the Acquisition Directorate (CG-9) and from the Capabilities Directorate (CG-7). These meetings resulted in identifying 11 projects of interest to the USCG. Due to limited resources, four projects were identified to be pursued. MSC developed problem statements for the projects (one for each) that were reviewed by

the USCG. The USCG comments were incorporated in revised problem statements and work plans were developed. The work plans underwent a thorough review by DHS and the USCG. The four projects that are expected to be conducted in Year 6 are:

- Low Cost Sensors for Remote Locations
- Safety and Security for Remote Bridge Operations
- RF Surveillance of Ships with Illegal Activity
- VTS Radar for Small Vessel Detection

Problem Statements and detailed workplans for the four projects will be posted on the MSC website when each project is kicked off.

#### **4.2. Stakeholder Engagement, Communications, and Outreach**

MSC continued to engage visitors and partners from various key stakeholder organizations in a range of activities (e.g., Meetings, COE Summit, trainings and exercises). MSC personnel participated in various activities and has partnered with the USCG HQ, USCG RDC, USCG Sector NY, DHS S&T Borders and Maritime Division, Customs and Border Protection, National Urban Security Technology Lab, the DHS Office of Intelligence and Analysis, and others as described below.

##### **USCG HQ**

Through a coordinated effort with DHS OUP, representatives from MSC met several times with USCG representatives from the Acquisition and Capabilities Directorates as well as representatives from different areas in the USCG, including the Living Marine Resources Enforcement Policy, Sector Corpus Christi, and Office of Bridges Programs to identify projects of high importance and high priority to the USCG that MSC can conduct. The meetings were very productive and resulted in identifying a number of projects that MSC can undertake to help the USCG in their critical missions.

In addition, the MSC Director is serving as a member of the National Maritime Security Advisory Committee (NMSAC) that is chaired by USCG CG-FAC members to provide technical advice to the USCG Commandant. The NMSAC met once during Year 5 and discussed high priority issues to the USCG.

##### **USCG RDC**

Representatives from the USCG RDC have been routinely contributing to the Center's annual Summer Research Institute. This past summer, RDC's Executive Director, together with Ms. Grace Python, Senior Operations Research Analyst and former MSC Master's Degree Fellow, provided a guest lecture to the 2019 cohort of students. The guest lecture included a review of the USCG mission areas and briefings on field-based test and evaluation exercises and technology transitions into USCG field operations. In addition, MSC frequently coordinates with the RDC on workshops and activities of mutual interest.

## **USCG Sector New York**

MSC and USCG Sector New York have developed a strong partnership over the years. This past year, Mr. John Hillin, Division Chief Safety and Security championed a student research project as part of the Center's 2019 Summer Research Institute. The project engaged a team of students to develop a computer dashboard tool that can be used to visualize and conduct trend analysis of incidents occurring in the Sector New York Area of Responsibility (AOR). As part of the summer research project, Mr. Hillin hosted a field-visit for the summer research students to attend a morning briefing of the Captain of the Port and the Sector's Command Center and Vessel Traffic System.

In another MSC event, LTJG Alexander Kloo, Command Duty Officer participated in the Center's Fundamentals of Sensing Technologies MSI STEM Educator's Workshop to provide an overview of the Coast Guards Search and Rescue Optimal Planning System (SA-ROPS).

Throughout Year 5, MSC's Director of Education continued to serve as a co-Chair for the Sector NY Area Maritime Security Committee – Cybersecurity Subcommittee and assisted in the planning and coordination of a cybersecurity tabletop exercise held in the Port of NY/NJ in February 2019. The exercise included support by the DHS National Cybersecurity and Communications Integration Center (NCCIC) National Cyber Exercise and Planning Program (NCEPP).

## **S&T Borders, Immigration and Maritime and Tech Centers**

MSC PI and other researchers met with the Director of the S&T Borders, Immigration and Maritime Division to solicit input from their interactions with the DHS components (USCG, CBP, and ICE) on their operational needs. These discussions include the IPT gaps, existing projects, as well as potential new projects that can quickly fill in gaps that need to be addressed. MSC research PIs had multiple interactions with S&T's BIM Director as well as with Program Managers to discuss port resilience and maritime surveillance areas of interest to BIM, CBP, and USCG. In addition, the MSC PI routinely talks with Technology Center Subject Matter Experts about current research project ideas.

## **NUSTL**

MSC PIs participated in multiple meetings with NUSTL to discuss CUAS needs for the Coast Guard and other DHS stakeholders and assist them in formulating their test plans and reviewing requirements.

In May 2019, MSC Graduate Research Assistant, Chance Petersen was extended an offer of employment by NUSTL, where he is now a Junior Engineer.

## **CBP**

CBP's Office of Field Operations at the Port of NY/Newark hosted MSC students and faculty mentors from the 2019 Summer Research Institute for a tour of the agency's cargo

scanning equipment and operational facilities. This trip marked the Center's eighth annual visit to CBP over the course of the summer research program. Supervisory Officers from the Field Operations Division also attended the SRI student's final research presentations.

MSC PIs also participated in meetings with CBP representatives to discuss their needs for port agricultural security, cargo container security, maritime border security, and using VTS radars to detect small vessels. In addition, assistance was provided on the capabilities and limitations of underwater and surface sensors for maritime situational awareness.

### **CBP Laboratory and Scientific Services**

MSC research students met with and observed Customs and Border Protection Science Officers at work in a facilitated tour of CBP's New York Laboratory on June 23. Located in Newark, NJ, the Laboratory is part of the agency's Laboratories and Scientific Services Division and is responsible for forensics services to include the analysis of controlled substances and illicit narcotics, latent fingerprint lifting and analysis of commodities imported into the U.S., including inorganic products, organic chemicals and products and food products among other items.

### **DHS I&A**

MSC collaborated with the DHS Office of Intelligence and Analysis (I&A) Private Sector Engagement to host the New Jersey Corporate Security Symposium at Stevens Institute of Technology on May 23, 2019. The Symposium included a keynote address by The Honorable David J. Glawe, Under Secretary, Office of Intelligence and Analysis at DHS as well as by Mr. Jared Maples, Director of the NJ Office of Homeland Security and Preparedness, Mr. Robert Kolasky, Director of DHS's CISA National Risk Management Center and Mr. Robert Taylor, Commander and Chief Contingency Planning Force Readiness, USCG.

Panelists included State law enforcement personnel and Chief Security Officers from Johnson & Johnson, Verizon Communications, Bristol-Myers Squibb and PSEG Service. The symposium was attended by more than 200 participants.

### **PANYNJ**

MSC and Stevens students participated in two full-scale exercises coordinated by The Port Authority of New York/New Jersey's (PANYNJ) Office of Emergency Management (OEM). The exercises included a hypothetical plane crash at New Liberty International Airport and the other a series of simulated active shooter events during the embarkation and debarkation of a cruise ship at the Cape Liberty Cruise Terminal in Bayonne, NJ.

### **Other Activities**

In addition to the above activities, MSC conducted many targeted communications efforts. This included participation in the planning of the COE Summit that was held at George Mason University in Arlington, VA.

On July 31 – August 1, MSC administrators, researchers and students participated in the DHS S&T Centers of Excellence (COE) Summit held at George Mason University in Arlington, VA. The event brought together representatives from across the public and private homeland security enterprise with researchers and students to discuss technologies and new approaches to address security concerns. The Summit featured an Innovation Showcase where each of the COEs exhibited their respective knowledge products, tools and technologies, and a series of student activities that highlighted the talent and breadth of student research being conducted across the COE university network.

The MSC Director of Education served as co-chair the Education Planning Committee, including the coordination all student activities related to the student Grand Challenge, Poster Showcase and Workforce Development Roundtable. The Center also assisted in identifying panel speakers and the planning for the Summit reception at the Canadian Embassy.

The Center also generated a monthly email newsletter that was distributed to the Center's stakeholders. These updates proved to be an effective way to communicate MSC's activities with its government partners and generate discussions among DHS components on areas of interest.

The monthly update contains relevant information regarding the Center's research, stakeholder engagements and student achievements. An archive of MSC's update newsletters can be found on the Center's website at: <https://www.stevens.edu/research-entrepreneurship/research-centers-labs/maritime-security-center/center-newsletters>.

Due to the Government shutdown and with the approval of the Program Manager, MSC did not conduct an annual meeting this year. However, through the monthly updates and the meetings at the USCG headquarters, we were able to communicate our research and education activities and engage in discussions of topics of interest.

#### **4.3. Management Activities**

The main COE management activities not discussed earlier in this report are summarized in this section. The Center Director worked with the COE's Principal Investigators (PIs) to develop project work plans and discussed project content that will benefit DHS and its stakeholders. The Director also worked closely with the DHS Program Manager and spoke with him on a regular basis to understand DHS expectations from the Center and bring up any issues of concern and to adjust operations based on additional OUP COE requirements. Based on these discussions and meetings, the Director held regular meetings with individual PIs as well as coordinated conference call meetings with the Center's PIs as needed. The purpose of these meetings was to ensure that the individual projects are progressing according to the work plans and continue to be aligned with DHS OUP's expectations.

Members the Center Science and Education Advisory Committee (SEAC) have been engaged periodically throughout the year and were kept informed of the Center activities through phone conversations and Center email communications. In addition, they were

invited to Center activities including the Summer Research Institute.

In addition to the above activities, the Center Director continued to reach out to many DHS stakeholders at various levels and in different capacities to discuss their projects and how the Center can be a resource to them. These meetings included discussions with representatives from DHS Countering Weapons of Mass Destruction, NUSTL, CBP, and USCG. Also, worked closely with the USCG RDC and NUSTL regarding research in the area of counter-UAS systems, such as developing requirements, testing, and quantifying their performance. The Director also discussed transition ideas with the USCG RDC and CBP Air and Marine personnel to understand their needs and their limitations in preparation for transitioning projects when they are ready. In particular, many discussions were focused on current sensors for detecting and tracking underwater and water surface threats.

As part of its transition efforts, the MSC management has continued to conduct project evaluations and tracking of post-project developments. Discussions and meetings were conducted with Mr. Jon McEntee, Ms. Marilyn Rudzinsky, and Mr. Doug Maughan on the Year 5 projects.

In addition, MSC management worked closely with newly formed partnerships with ICE, DHS Intelligence and Analysis Directorate, DHS CWMD, and National Maritime Security Advisory Committee (NMSAC). With ICE, many discussions were conducted regarding the use of multiple sensors to protect the US Virgin Islands and Puerto Rico against illegal smuggling of humans and illicit material. With DHS I&A, we met several times and hosted a symposium at Stevens that was attended by many of MSC stakeholders as described in Section 4.2. Finally, MSC's Director attended multiple NMSAC calls/meetings, with one held with the public in Houston.

#### **4.4. Center Guidelines and Policies**

During Year 1, MSC administrators created a document for the Center's academic partners and research PIs containing general orientation information (e.g. partner contact information, reporting requirements, and DHS acknowledgement and disclaimer statements), and copies of the Center's policy and security requirements for handling sensitive material, as well as student safety and security guidelines. The MSC General Information and Guidelines for Academic Partners document was updated in Year 5 and shared with each of the MSC partner schools, with the requirement that they acknowledge receipt and confirm that they have reviewed and understand the policy and security requirements for handling sensitive material and the student safety and security guidelines.

### **5. Budget**

The budget breakdown is being provided separately as part of the Stevens financial reporting requirements. The table below provides a summary of the funds (actual and budget) per project and per object code (e.g., salary, fringe, travel, overhead, supplies, etc.). Please note that the numbers included below are based on numbers available in the financial reporting system at the time this document was prepared. Some expenses



and credits may not have posted when this report was prepared and will consequently be reflected in future financial reporting.

	Management ACTUAL	Management BUDGET	Education ACTUAL	Education BUDGET	FY2015 CDG Education Supplement ACTUAL	BUDGET	MSC MSI Workshop ACTUAL
Category							
Salary	\$202,020.41	\$194,255.00	\$226,314.81	\$193,697.00	\$0.00	\$0.00	\$8,131.03
Fringe	\$50,572.15	\$51,076.00	\$27,108.94	\$34,215.00	\$0.00	\$0.00	\$2,114.07
Other	\$1,235.59	\$21,587.00	\$1,291.86	\$81,432.00	\$9,038.00	\$0.00	\$14,733.78
Supplies	\$0.00	\$0.00	\$17.85	\$0.00	\$0.00	\$0.00	\$1,218.76
Travel	\$8,831.96	\$0.00	\$262.10	\$7,000.00	\$0.00	\$0.00	\$0.00
Equipment	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Participant Support	\$0.00	\$0.00	\$77,236.67	\$84,700.00	\$22,860.20	\$31,923.00	\$0.00
Overhead	\$131,330.21	\$138,273.00	\$91,537.89	\$121,205.00	\$0.00	\$0.00	\$13,098.85
Consultants	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Subcontracts	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Total	\$393,990.32	\$405,191.00	\$423,770.12	\$522,249.00	\$31,898.20	\$31,923.00	\$39,296.49
Year 5 Continuation Funding	\$0.00	\$105,798.00	\$0.00	\$484,273.00	\$0.00	\$0.00	\$0.00
Year 4 Carryover	\$0.00	\$299,393.00	\$0.00	\$37,976.00	\$0.00	\$31,923.00	\$0.00
Total Year 5 Budget	\$0.00	\$405,191.00	\$0.00	\$522,249.00	\$0.00	\$31,923.00	\$0.00
SIT Account Number	2102437		2102467		2102533		21
	Expense Notes	Budget Notes	Expense Notes	Budget Notes	Expense Notes	Budget Notes	Expense Notes
NOTES				This includes Research Assistantships (\$238,972), Research Fellowships (\$23,976) and SRI (\$259,301)			Expenses exceeded the budget amount but the account has enough funding to cover.

\$2,723,000	Continuation Funds
\$898,409	Carryover
\$3,621,409	Continuation + Carryover

MSC MSI Workshop BUDGET	FAU Predictive Port Resiliency Tool Research Project ACTUAL	FAU Predictive Port Resiliency Tool Research Project Budget	Purdue SMART Project ACTUAL	Purdue SMART Project Budget	Research Projects (Restricted)	ACTUAL Total	
\$10,021.00	\$0.00	\$114,275.00	\$0.00	\$54,379.00	\$0.00	\$436,466.25	
\$2,605.00	\$0.00	\$17,765.00	\$0.00	\$15,233.00	\$0.00	\$79,785.16	
\$600.00	\$0.00	\$8,789.00	\$0.00	\$6,020.00	\$0.00	\$26,299.23	
\$3,100.00	\$0.00	\$2,500.00	\$0.00	\$2,150.00	\$0.00	\$1,236.61	
\$0.00	\$0.00	\$4,000.00	\$0.00	\$8,810.00	\$0.00	\$9,094.66	
\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$100,096.87	
\$8,163.00	\$0.00	\$69,320.00	\$12,292.73	\$65,064.00	\$0.00	\$248,259.68	
\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	
\$0.00	\$77,389.39	\$0.00	\$151,574.65	\$15,000.00	\$0.00	\$228,963.95	
<b>\$24,489.00</b>	<b>\$77,389.39</b>	<b>\$216,649.00</b>	<b>\$163,867.38</b>	<b>\$166,656.00</b>	<b>\$0.00</b>	<b>\$1,130,211.81</b>	<b>Budget Totals</b>
<b>\$24,489.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$0.00</b>	<b>\$2,108,440.00</b>	<b>\$2,723,000.00</b>	
<b>\$0.00</b>	<b>\$0.00</b>	<b>\$216,649.00</b>	<b>\$0.00</b>	<b>\$166,656.00</b>	<b>\$145,812.00</b>	<b>\$898,409.00</b>	
<b>\$24,489.00</b>	<b>\$0.00</b>	<b>\$216,649.00</b>	<b>\$0.00</b>	<b>\$166,656.00</b>	<b>\$2,254,252.00</b>	<b>\$3,621,409.00</b>	
<b>02793</b>	<b>2102833</b>		<b>2102832</b>		<b>N/A</b>		
Budget Notes	Expense Notes	Budget Notes	Expense Notes	Budget Notes	Notes		
Note: In addition to the Year 5 (\$24,489) budget there remained \$10,732 in Year 4 funds	The final invoice for this task was received on 8/7/2019 and will be reflected in Stevens August 2019 invoice. The balance as of August 2019 on this task will be \$1,346.92.		The final invoice for this task was received on 7/23/2019 and will be reflected in Stevens July 2019 invoice. The balance as of July 2019 on this task will be \$0.				

\$0.00  
\$0.00

Expenditures by Functional Categories	Administrative	Research and Development	Education and Training	Customer Outreach and Communication	Transition	Total
Category						
Salary	\$202,020.41	\$0.00	\$226,314.81	\$8,131.03	\$0.00	\$436,466.25
Fringe	\$50,572.15	\$0.00	\$27,108.94	\$2,114.07	\$0.00	\$79,795.16
Other	\$1,235.59	\$0.00	\$10,329.86	\$14,733.78	\$0.00	\$26,299.23
Supplies	\$0.00	\$0.00	\$17.85	\$1,218.76	\$0.00	\$1,236.61
Travel	\$8,831.96	\$0.00	\$262.10	\$0.00	\$0.00	\$9,094.06
Equipment	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Participant Support	\$0.00	\$0.00	\$100,096.87	\$0.00	\$0.00	\$100,096.87
Overhead	\$131,330.21	\$12,292.73	\$91,537.89	\$13,098.85	\$0.00	\$248,259.68
Consultants	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00	\$0.00
Subcontracts	\$0.00	\$151,574.65	\$0.00	\$0.00	\$0.00	\$151,574.65
<b>Total:</b>	<b>\$393,990.32</b>	<b>\$163,867.38</b>	<b>\$455,668.32</b>	<b>\$39,296.49</b>	<b>\$0.00</b>	<b>\$1,052,822.51</b>

## APPENDIX E-1 SRI 2019 Student Survey



Copy of SRI 2019 Student Survey

Student Survey

This survey is designed to document the SRI's impacts on your knowledge and understanding of maritime safety and security tools, technologies and applications, and the challenges faced by the Department of Homeland Security in securing the Nation's ports, inland waterways, and coastal borders. We also want to assess the quality of the SRI program from your perspective.

Please take the time to provide us with as much detailed information as possible in the open-ended questions of this survey. All responses are anonymous. We thank you for your time and feedback!

\* 1. How would you describe your knowledge of the maritime domain/enterprise prior to the start of the SRI?

- ☐ 1=No prior knowledge
- ☐ 2=Minimal knowledge
- ☐ 3=Working knowledge
- ☐ 4=Advanced knowledge

\* 2. How would you describe your knowledge of maritime safety and security applications, tools and technologies (e.g., AIS, Risk management tools, ROVs, USVs, UASs, etc.) prior to the SRI?

- ☐ 1=No prior knowledge
- ☐ 2=Minimal knowledge
- ☐ 3=Working knowledge
- ☐ 4=Advanced knowledge

\* 3. How has your knowledge of your assigned research area (e.g., AIS anomaly detection, Adversarial game approaches, Risk management dashboard development, UAS buoy prototype, WAM-V simulator, BlueROV, etc.) improved over the course of the eight-week summer research program?

		2=Improved (I have a basic understanding of the concepts.)	3=Improved Sufficiently (I can effectively apply my knowledge.)	4=Improved Substantially (I have gained advanced knowledge and confidence in this area.)
Knowledge of research project area.	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* 4. To what extent has the SRI enhanced or improved your skills in the following areas?

	1=Not at all	2=Somewhat (Very little improvement in this area.)	3=Improved Sufficiently (My skills have improved and I can effectively apply what I have learned.)	4=Significantly Improved (I have significantly improved my skills and I feel confident in my capabilities in this area.)
Ability to Conduct Research	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Communication Skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Leadership Skills	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Networking	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Oral Presentations	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Professional Confidence	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teamwork/Collaboration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

Other (please specify)

\* 5. In your opinion, which of the skills above did you improve the most and what activities in the SRI helped you improve these skills?

\* 6. What new skills have you learned or enhanced during the SRI that you feel will be of most use to you in your academic programs and future careers?

\* 7. Rate the SRI with regards to the following items:

	1= Not good at all	2= Good	3= Very Good	4= Excellent
Faculty Mentor Guidance and Assistance	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Program Coordination/Administration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Program Format and Curriculum	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Faculty Lectures and Guest Speakers	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Teamwork/Collaboration	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Field-visits and Stakeholder Engagement	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>
Research Project Outcomes	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>	<input type="radio"/>

\* 8. What are your top takeaways from this summer's program?

\* 9. What would you say are the strengths of the SRI? (e.g., faculty mentorship, program administration, student diversity, team work, field-visits, etc.) Please provide as much detail as possible.)

\* 10. What are the program weaknesses and what can the Maritime Security Center do to improve the SRI for future student groups? (Please provide as much detail as possible.)

\* 11. How would you best describe your experience in the SRI?

\* 12. Has the SRI enhanced your interest in pursuing a career and/or further academic study in the field of maritime/homeland security?

- ☐ Yes
- ☐ No

\* 13. Would you recommend the SRI to your friends and colleagues at your university/school?

☐ Yes

☐ No



## APPENDIX E-2 Fundamentals of Sensing Workshop Survey

### Fundamentals of Sensing Workshop Survey



#### Workshop Survey

Name: \_\_\_\_\_ School: \_\_\_\_\_

Rate each of the following for today (circle one choice):

<b>Pacing</b>	Too slow	Just right	Too fast
<b>Enjoyment/fun</b>	Too much	Just right	Not enough
<b>New learning/content</b>	Too much	Just right	Not enough
<b>Interactions with colleagues</b>	Too much	Just right	Not enough
<b>Quality of facilitation</b>	Excellent	Good	Not very good
<b>Quality of materials</b>	Excellent	Good	Not very good

On a scale of 1 to 5, with 5 being the highest, how would you rate the speakers?

Speaker	1	2	3	4	5	NA
<b>LTJG Alex Kloo</b> , Command Duty Officer, Sector Command Center, USCG Sector New York						

On a scale of 1 to 5, with 5 being the highest, how interested are you to implement:

Activity	1	2	3	4	5	NA
<b>Maritime Search and Rescue</b>						
<b>Safe Harbor</b>						
<b>Ocean Weather</b>						
<b>SENSE IT</b>						

What did you like **BEST** about the activities you did today?

What was the most valuable thing you learned today?

How easy will it be to apply this information to your current curriculum?

Would you suggest we do anything differently if we offer this workshop again?