



Robotics Training and Competition as Novel Validation for the RxS Rating

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N00014-23-C-2015

**Manpower, Personnel, Training &
Education Information Sciences
Portfolio Review**

July 9-11, 2024

Objective

- The Robotics Warfare Specialist rating, established in February 2024, is aimed at developing expertise in autonomous and robotic technologies to support the Navy's hybrid fleet initiatives.
 - Specialists are trained to operate, maintain, and manage advanced robotic systems.



Project Objectives:

- Provide data to back training design decisions
- Shorten the time to stand up RW "A" School





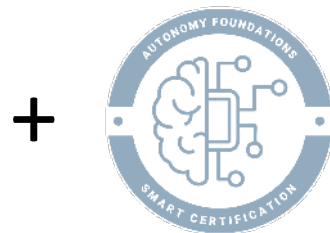
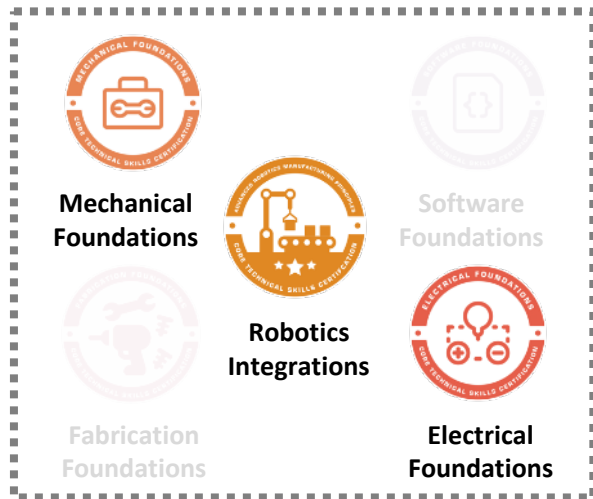
Motivation

- The importance of robotic and autonomous systems continues to increase.
- These systems advance and replace very rapidly
 - Specializing training around single-systems scales poorly
- Carnegie Mellon University (CMU) has Robotics Technician curriculum that targets core elements of the role across industries and platforms, as well as AI-focused offerings
- But we need to know:
 - **RQ1:** Does training with multiple small-scale robots accelerate future learning on larger, more capable robotic platforms?
 - **RQ2:** What are the role and impact of ML/AI training for RW?

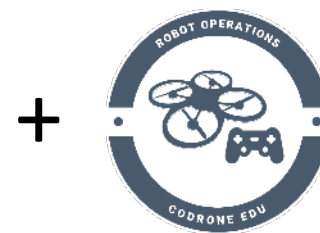
Methodology

- Using **Design-Based Research** methods, adapt existing robotics technician curriculum for automotive and manufacturing into an experimental RW curriculum

SMART Robotics Technician Curriculum



**Autonomy
Foundations**



**Robot
Operations**



**AI User w/ Robot
Applications**

Methodology

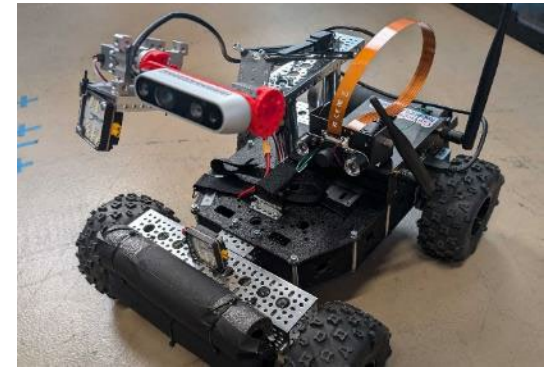
- Embed a **Competition-based assessment** for future platform learning potential
 - Measure ability to learn new platforms, not mastery of one now
 - Competition robotics platforms provided in collaboration with Dahlgren and Robotics/Autonomy SME's



Amphibious UGV / USV



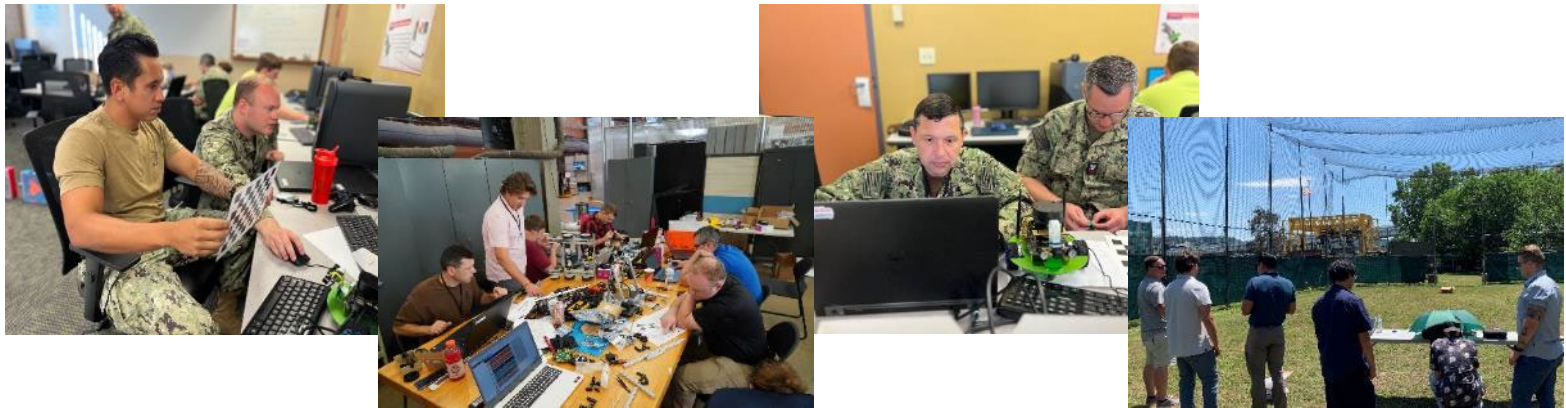
Kairos UAV



UGV w/ Advanced Perception

Methodology

- Run test groups through the training and competition
 - Training Cohort Alpha consists of 8 Civilians and 5 Sailors
 - Plus a Competition-only comparison group with incumbent single-system or other “A” school training (e.g., Electronics Technician [ET])

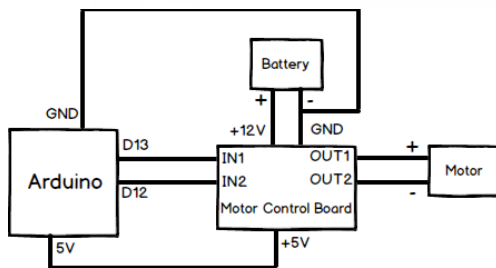
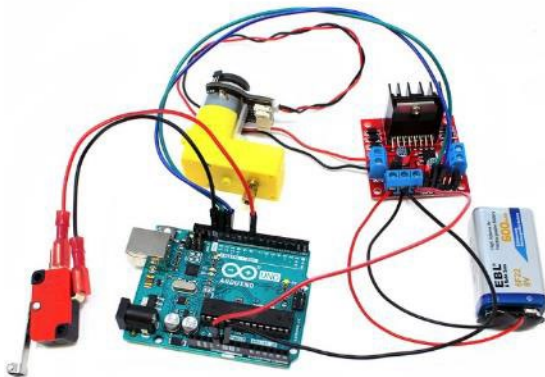


- To avoid bias, we use an arms-length 3rd party to design the competition events and platforms
 - At a minimum, require stakeholder consensus that the competition events represent valid applications

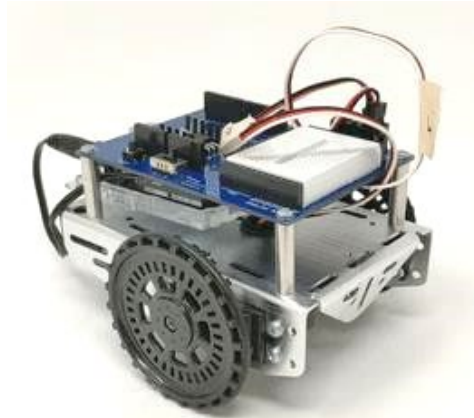
Results: Adapted Experimental Curriculum - Electrical Foundations

Electrical Foundations focuses on the foundational concepts around basic electricity and how circuits work. Participants use multimeters to troubleshoot electrical components.

- Unit 1: Wiring and Circuits
- Unit 2: Voltage – Parallel and Series Circuits
- Unit 3: Voltage and Current – Motors
- Unit 4: Controlling Signals
- Unit 5: Sensors
- Unit 6: E-Panel

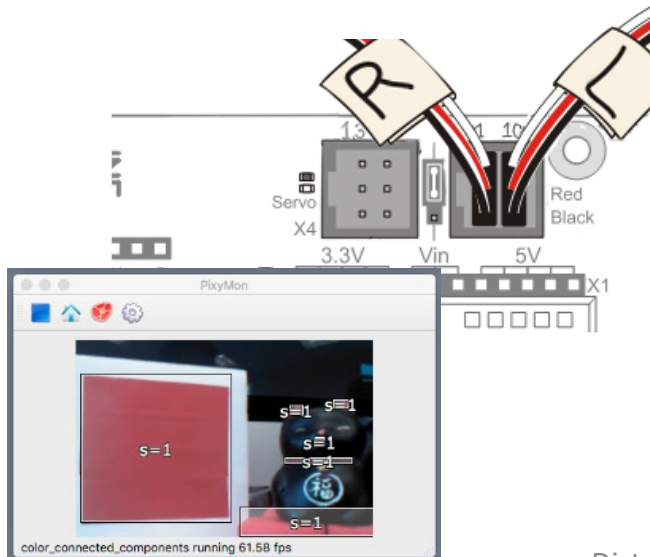


Results: Adapted Experimental Curriculum - Robotics Integration



Robotics Integration introduces participants to situations where technicians receive multiple components of a robotics system that require assembly, installation, and debugging. Participants integrate components such as a vision sensor, breadboard, servo motors, and microprocessor.

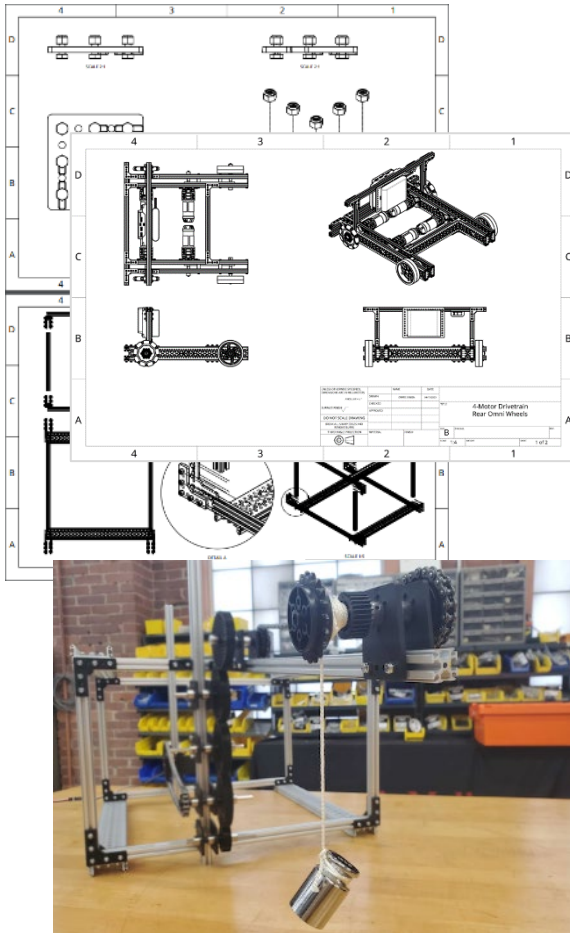
- Unit 1: Testbed with Arduino
- Unit 2: Open-Loop Navigation
- Unit 3: Camera Integration



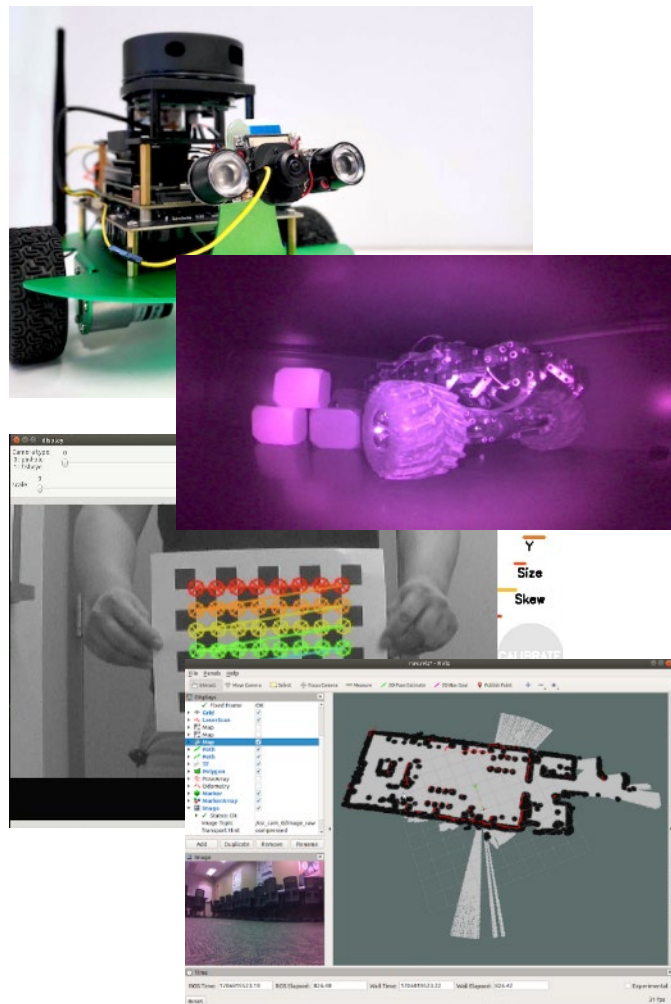
Results: Adapted Experimental Curriculum - Mechanical Foundations

Mechanical Foundations provides participants with knowledge and hands-on experiences with a variety of tools and hardware components. By understanding the foundational mechanical principles that underpin robotics, participants develop the ability to construct and maintain these systems with increased confidence and efficacy.

- Unit 1: Strength, Stability, & Balance
- Unit 2: Transmissions & Mechanical Advantage
- Unit 3: Drivetrains
- Unit 4: Payloads



Results: Adapted Experimental Curriculum - Autonomy Foundations



Autonomy Foundations equips learners with a practical understanding of how artificial shapes robotic perception and autonomy. This course provides a comprehensive foundation for operating and maintaining intelligent robotic systems.

- Unit 1: Setup
- Unit 2: Basic Navigation
- Unit 3: Basic IO and Sensing
- Unit 4: Collision Avoidance & Path Following
- Unit 5: AprilTag Navigation
- Unit6: SLAM

Results: Adapted Experimental Curriculum - Robot Operations



Robot Operations is a *longitudinal course* designed to foster depth-of-coverage within the Robotics Functional Tasks. Indoor and outdoor platforms are used which are pilatable, configurable, repairable, and programmable.

- Consists of daily ~30-minute tasks where participants perform missional operations, maintenance, troubleshooting, and reporting.
- Missional operations focus on Piloting, Setting waypoint navigation, Performing launch and recovery, Configuring sensors and payloads.

Results: Adapted Experimental Curriculum - AI User



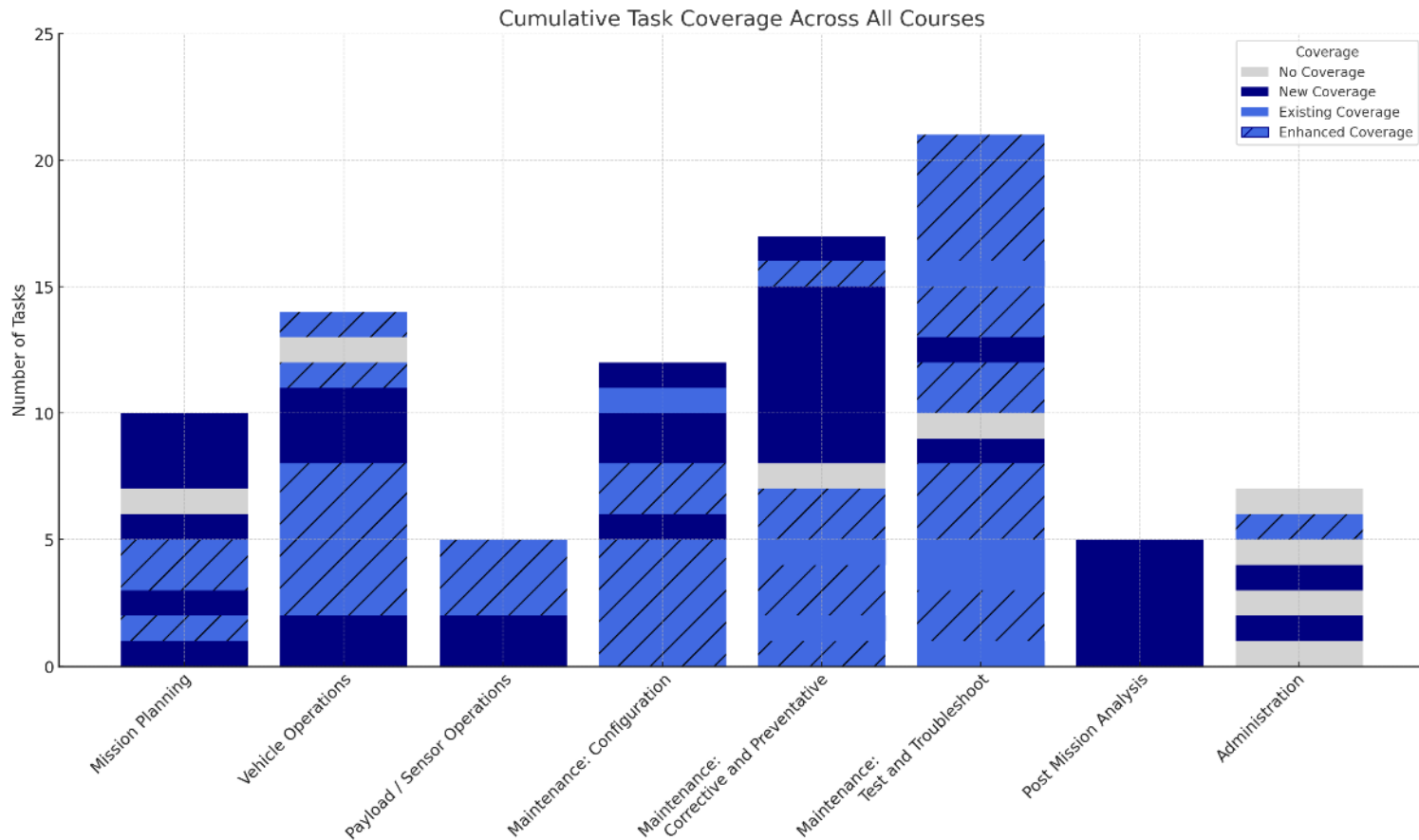
In **AI User**, participants gain knowledge and develop experience using AI/ML based systems. Participants are introduced to current applications, capabilities, and main components of AI/ML systems. Each unit is paired with an applied robotic exercise.

- Unit 1: AI Capabilities & Non-Capabilities
- Unit 2: The Role of Data
- Unit 3: Limitations, Bias, Evaluation & Troubleshooting
- Unit 4: Computing Devices and Environments
- Unit 5: Computer Vision



Results: Adapted Experimental Curriculum

- **Resulting Cumulative Course** coverage across E1-E4 Robotics Functional Tasks:

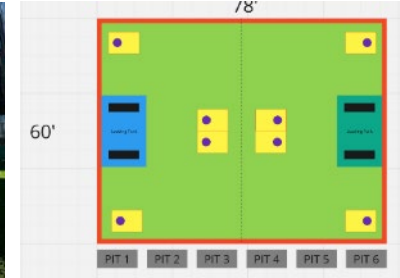


Source: Robotics Warfare Specialist Rating Establishment NEOCS Package

Results: Competition Design

- Competition Designed with 3 unique platforms and events:

1



2



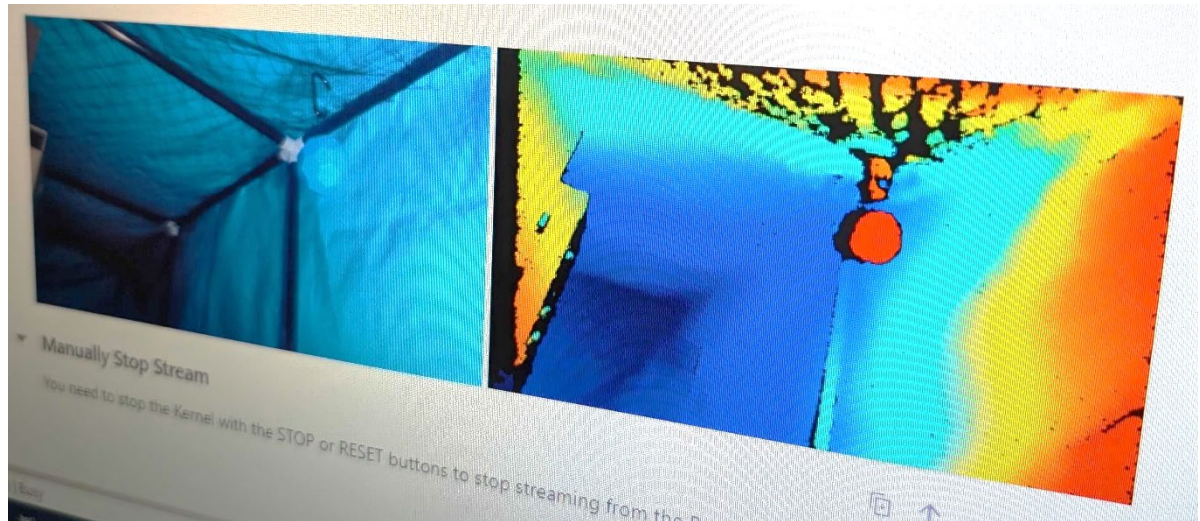
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- We will be streaming the first competition test July 17 – 19!
 - Contact me for access to the stream or to plan a visit.

UGV with Advanced Perception

- Jetson Orin Nano with Intel RealSense Depth Camera
- Inspired by EOD UUV tasks, but altered to include SLAM and Machine Vision capabilities in a non-underwater setting



Results: Study in Progress

- Currently in week 6 of 7 of Cohort Alpha!





Challenges

- Initial 3rd party Competition developers fell through
- Moving target on learning objectives prior to Q3'24
- IRB/HRPO delays (resolved)
- Recruiting/attrition of community college students
- Participant logistics for a 7-week training
- Classroom technology availability and durability



Project Plan

- Cohort Alpha is currently in progress
- Instrument and test curriculum revisions to follow
- Cohort Beta in planning – likely Jan 2025 (FY25 Q2)



Conclusions & Naval Relevance

- Testing is underway to determine the efficacy of small robot training on accelerating learning of future systems.
- Testing will also help determine the kinds of ML/AI training relevant to “optainer” roles (rather than data science ones).
- If successful, experimental curriculum could significantly shorten timeline for RW “A” school development.



Achievements

- Initial experimental curriculum and competition designs complete
- Achieved concurrence with key Naval stakeholders on curriculum alignment with E1-E4 RW Tasks
- IRB / HRPO Approval complete. Conducting Alpha cohort test through July 19
- Presenting at ONR Science of Autonomy Meeting (*pending*)



Questions & Contact Information

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