

Ship Maintenance “Robot Rodeo” Program Overview

09/16/2022

1. Introduction

This document describes the Competition Rules for the NSWC PHD Ship Maintenance Robot Rodeo Challenge. Teams are encouraged to carefully review the entire document. The intent of this document is to provide participants guidance on competition intent, provide an environment for innovation to flourish, and establish a fair process to objectively assess competitors.

While not anticipated, minor revisions to these Competition Rules may be required. The NSWC PHD Challenge Chief Judge has the final authority to make any decisions related to the rules or scoring. All decisions made by the Chief Judge are final.

The primary goal of the Ship Maintenance Robot Rodeo Challenge is to provide an environment where innovative solutions that emulate challenges found on the complex surroundings of a Navy ship including restricted passageways, a steep stairwell, and a heavy armored hatch. The challenge elements and the competition structure itself are intended to address the secondary goal of increasing the diversity, versatility, cost-effectiveness, and robustness of relevant technologies and systems capable of addressing the myriad needs of a wide range of anticipated Navy requirements rather than single-purpose or specifically tailored solutions. The third goal of the competition is to establish a collaborative community by bringing together multi-disciplinary teams and cross-cutting approaches across disparate fields to address the autonomy, perception, and mobility needs for shipboard use.

2. Overview

The Challenge course represents a sample shipboard environment and is set up at 1/3 scale to lower cost for team involvement (focusing on navigation and ability to move through a shipboard space vs. need for large actuators/motors for maneuverability). Teams can explore different avenues for development of innovative approaches to solve the challenges at a reduced cost, without creating solutions that would be inadequate in the real world.

Pre-test days allowing for at most three “build-test-improve” iterations for all participating teams is available. The course will generally be open and available for informal testing. The Final will be the only graded event.

3. Challenge Schedule

The Challenge is organized into three stages. In the Kick-off Stage, teams will be provided access to the course where they can take pictures, measurements and detailed notes. They can also tour NSWC PHD self-defense test ship to see the full scale article which was the bases of the 1/3 scale model. In the Development Stage, teams have approximately 5 months to develop their robots to meet the challenge course. At the end of this stage teams can try out their robots on the sub-scale course. In the Final Stage, 3 month long, teams will finish their development, refinement, and be graded against the competition Final Challenge Event.

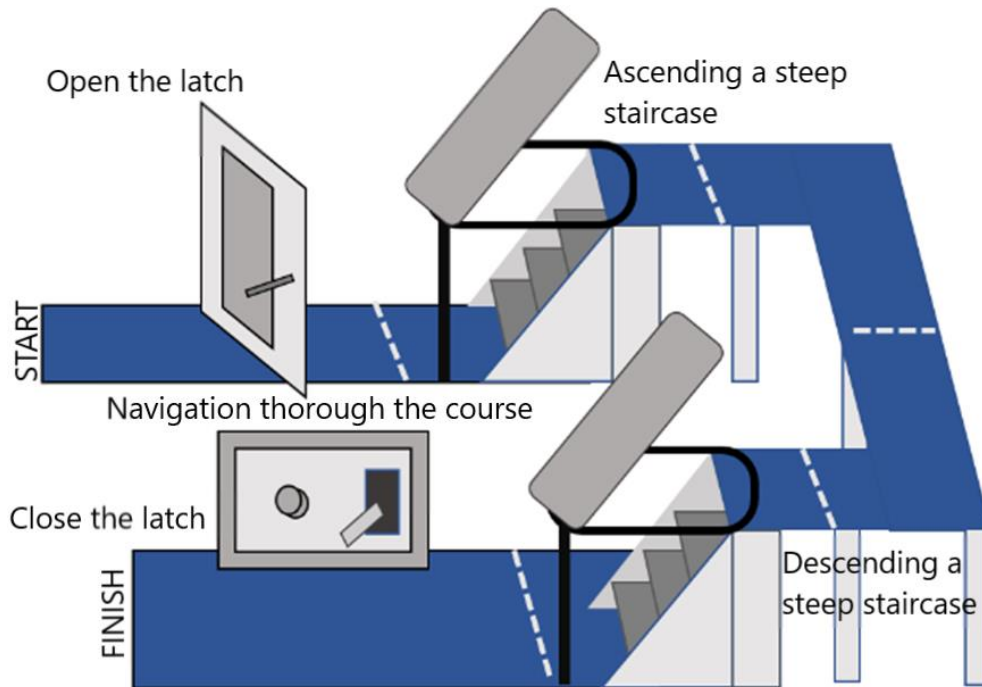
Final Event Competition Date May 30, 2023

4. Prizes and Funding

Teams are charged with pursuing high-risk, high-reward approaches to meet and exceed the objectives of the challenge events, and are motivated by the potential for winning against competitive teams from other academic institutions.

5. Competition Guidelines

The primary scenario of interest for the competition is successful movement of the robot through the shipboard environment. A rough outline of the course is shown below.



Note that this is intended to provide a concept of the course. It is intended to be modular, so the exact sequence in the Final Competition may vary in sequence, but the basic requirements will be the same. Walls and other structural supports will be added in final design. The entire course will be on a moving platform that will be used to simulate a shipboard environment in a sea state not to exceed level 3. Teams will be given 3 months of notice of the final configuration.

Each team is envisioned to deploy its robot to navigate through course. **The winning team will complete the course in the shortest amount of time.** Every time a wall is contacted, a 30 second penalty will be issued. At each obstacle, the robot is required to try for a maximum of 10 minutes. If the obstacle cannot be cleared, the team may hit the emergency off button on the robot and manually clear the obstacle such that the robot may continue. A bonus equal to a 2 minute reduction in the final time will be applied if the robot is fully autonomous for the full run. Autonomy is defined as having no human control when the robot is within the course. Each team may opt to try an autonomous run and a human-controlled (radio-controlled) run, scored separately if they choose to do so.

Obstacles include, but are not in any particular order:

1. Navigation through the course
2. Opening a latch
3. Closing a latch
4. Ascending a steep staircase
5. Descending a steep staircase

6.0.0 Rules

6.1.1. Course Access

Systems are allowed to enter, exit, or reenter the competition course at any time within the duration of the run, but only at the Starting Gate. All human operators and personnel that interface with the system must stay within the Staging Area and cannot enter the moving platform course area. No manual physical intervention or entry by any (human) team member on the course will be permitted. A system may only be handled or retrieved if it has crossed back into the Staging Area past the front face of the Starting Gate. Once a system has partially or completely crossed into the Staging Area, team personnel are permitted to handle the systems as long as the personnel stay within the Staging Area and do not pass the front face of the Starting Gate. The team may pause the timer to retrieve their system, but the system must then start the course from the beginning again with their overall time continuing from when they paused to retrieve the system. Only authorized Judging personnel are allowed to enter the course preceding, during, and following the run.

6.1.2. Run Termination

A scored run terminates upon any of the following conditions:

- Time Expiration: The scored run time expires before another termination criterion is met
- Run Completion: The deployed systems successfully report all artifacts, and successfully exit the course
- Run Cancellation: Competition Staff cancels the run due to an external factor such as weather, including lightning, rain, snow, or wind
- Emergency Stop: Competition Staff initiates an emergency stop because of an unsafe condition
- By Request: The Team Lead requests an end to the run

6.1.3. Terminated Runs

A team may be eligible for an additional attempt if a run is canceled or stopped due to an emergency or external factor outside of the team's control. The Chief Judge will review eligible cases and determine the course of action. The Chief Judge has the final authority to make any scoring-related decisions.

NSWC PHD reserves the right to disqualify any team that is found to violate either the rules or the intent of the rules. The Chief Judge has the final authority to make any rules-related decisions. All decisions made by the Chief Judge are final.

6.1.4. Score Disputes

Disputes are intended to provide teams a mechanism to submit a formal dispute or request for review by the Chief Judge. The Dispute must be delivered by the Team Lead to the Chief Judge. The Dispute must be submitted within 30 minutes of the completion of the run in question. All submissions will be reviewed by the Chief Judge. All decisions made by the Chief Judge are final.

6.1.5 Operator

The team is permitted to have a single operator at a Base Station external to the course but within the Staging Area. The Base Station is defined as one or more computers or controllers that serve as the interface between the systems and the operator. The Base Station is responsible, either automatically or with operator monitoring, for communicating with the deployed system and relaying reports back to the operator.

The operator is permitted to monitor and manage the communications with their deployed systems as they choose. With the exception of the Safety Officers described in Section 6.1.6, only the operator is permitted to use wireless communications with the systems during the competition run. The operator is permitted to view, access, and/or analyze both course data and status data. The operator is permitted to provide inputs to the deployed systems and/or to serve as a buffer between the deployed systems and the Chief Judge. Once a team's run has begun, the operator may not be substituted with other personnel.

For the Final Event, teams are expected to use the provided Base Station workbench located in the Operator Area. Once the team's run has begun, only the Operator is permitted to be in the Area.

In addition to cameras in the Staging Area, NSWC PHD intends to observe and capture the Base Station display(s) via HDMI screen capture devices. The captured footage is anticipated to be used as part of the live-stream broadcast.

6.1.6 Safety Review/Safety Officer

Teams must submit their robot design and support systems (i.e. base station, lifting equipment, transportation, etc) for safety review. This includes RF frequencies used, hazardous chemicals, lasers, heavy lifts, and any other items which are considered hazardous.

Teams need to identify specific members to serve as Safety Officer. The role of the Safety Officer is to preserve the safety of personnel and property. The Safety Officer will order an emergency stop for a system in an unsafe condition.

6.1.7 Size Limits/Weight

NSWC PHD does not expect to place explicit limits on the size of deployed systems, but teams should consider how their systems will operate in the space-constraints of the shipboard environments. System weight should be under 100 lbs.

6.1.8. System Cost and Quantity Constraints

NSWC PHD does not expect to place limits on the minimum or maximum number of deployed systems; However, the Navy is interested in solutions that are cost-effective and attrition-tolerant.

6.1.9. Emergency Stop

The emergency stop requirements are designed to ensure the safety of personnel, equipment, and the competition course environment. All systems participating in the Challenge will utilize a full proof emergency stop system that mechanically disconnects power between a battery and robot.

6.1.10 Dropped Components

Teams are permitted to make use of dropped components. However, all such components will need to be collected by their system during the run.

6.1.11 Course Alteration

The course may not be altered by any of the deployed systems.

6.1.12 Power Sources

All fuel and power sources must be approved by NSWC PHD safety. Teams may be required to submit safety protocols and Navy may require additional site-specific approvals which could require significant lead time. Most electric battery sources are expected to be approved. Teams are encouraged to address any potential concerns early.

6.1.13 Communications Frequency Spectrum and Power Limits

NSWC PHD is interested in novel networking solutions and will work with teams to get their approaches approved if possible. However, each competition event location may have frequency spectrum limitations, including applicable FCC guidelines. Teams are encouraged to raise any potential concerns about their planned approaches early.

Due to the possibility of interference from other teams, during the competition, all equipment will be powered down and batteries removed.

6.1.14 Cheating/Interference with other teams/Sabotage

NSWC PHD reserves the right to disqualify any team that is found to be cheating, or hindering other teams. The Chief Judge has the final authority to disqualify any team. All decisions made by the Chief Judge are final.