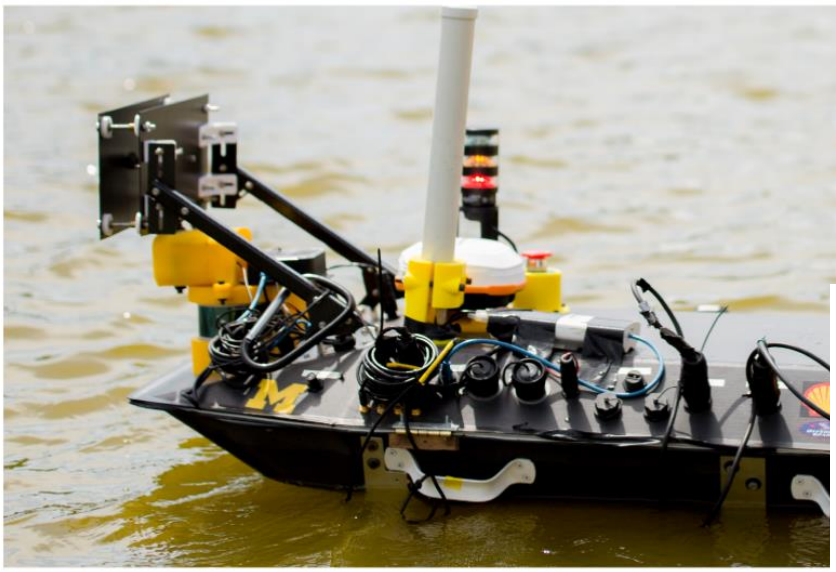
roboboat

DUCKS OVERBOARD



2024

JUDGE HANDBOOK

Introduction

Welcome to the frontlines of innovation at the 2024 RoboBoat Competition!
This Team Handbook contains information that teams need to compete at the 2024 RoboBoat Competition. It includes task descriptions, rules, and requirements, and other guidance and specifications. Teams are encouraged to read this document for a thorough understanding of what is necessary to compete effectively.

What is RoboBoat? RoboBoat is an international student program established to generate, cultivate, and enhance a community of innovators capable of making substantive contributions to the Autonomous Surface Vehicle (ASV) domain. The vision is achieved by providing a venue and mechanism, whereby practitioners of robotics and maritime autonomy come together at RoboBoat to share knowledge, innovate, and collaboratively advance the technology of ASV systems. Teams must also document their designs as described in this Team Handbook.

Why RoboBoat? The objective of RoboBoat is to build an international community of innovators – ranging from high school to higher education, capable of making substantive contributions to the maritime field and pushing development of small-scale (X-Class) Autonomous Surface Vehicle (ASV).

Why compete in RoboBoat? Participants of RoboBoat may expect to:

- Increase technical proficiency;
- Establish valuable professional connections; and
- Enjoy the satisfaction of learning and collaborating while advancing the technology of ASV systems.

The nominal winners are those teams that have scored the most points. The real winners are all those participants who have learned something lasting about working together to create an autonomous system that accomplished a challenging mission in a complex environment.

Maritime autonomous technology is critical to monitoring and healing our oceans. Developing the human resource to expand this effort is even more essential.

2024 ROBOBOAT ORGANIZERS

The 2024 RoboBoat Competition is hosted by RoboNation, in collaboration with the United States Office of Naval Research (ONR).

SECTION 1: RoboBoat Overview

RoboBoat 2024 *www.roboboat.org*

The 2024 RoboBoat Competition (RoboBoat 2024) will be conducted February 5-11, 2024, at the Nathan Benderson Park in Sarasota, Florida. Multiple courses will be used for the competition (Figure 1).

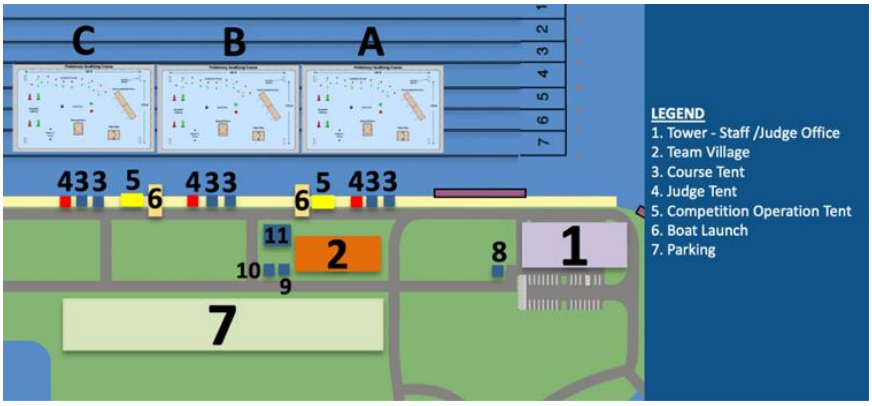


Figure 1: Preliminary Venue Layout

1.1 Judge Point of Contacts

RoboBoat Questions:
Julianna Smith
jsmith@robonation.org
571.239.9345

On-Site Logistics/Safety:
Cheri Koch
ckoch@robonation.org
850.642.0536

1.2 Competition Structure

RoboBoat 2023 includes the (1) Autonomy Challenge that demonstrates autonomous performance and safety; and (2) Design Documentation that presents each team's work and vehicle design.

1.3 Eligibility

Student teams from anywhere in the world are eligible to participate. All teams must build an ASV to compete and only enter one vehicle in the competition.

1.3.1 Eligibility Details & Team Composition

- Teams must be comprised of 75% or more full-time students. Student members are expected to make significant contributions to the engineering development cycle of their ASV.
- The majority of team members must be college or high school students. Teams may also include middle school students. Interdisciplinary teams are encouraged.
- Teams may be comprised of 25% or less alumni, industry, academic or government partners.
- A minimum of three (3) team members are required for safe operations on-site at RoboBoat.

1.4 Meet the 2024 Teams

1. AGH University of Krakow
2. Advancing Science, Technology, and Art / University of California San Diego
3. Cornell University
4. Gdańsk University of Technology, Science Club SimLE
5. Georgia Institute of Technology
6. Hagerty High School & University of Central Florida
7. Institut Teknologi Sepuluh Nopember
8. Istanbul Technical University
9. James Martin High School
10. Lake Superior State University/Florida Atlantic University
11. Memorial University of Newfoundland
12. Robotics Association of Embry-Riddle
13. South Dakota Mines
14. Tecnológico de Monterrey
15. United States Coast Guard Academy
16. Universitas Sebelas Maret
17. University of Michigan
18. University of Puerto Rico-Mayagüez
19. University of Strathclyde / Marine Robotics Society

SECTION 2: Competition

2.1 Competition Schedule

The competition includes:

- **Design Documentation:** Teams provide a variety of design documentation prior to and during the competition.
- **Autonomy Challenge:**
  - **Qualifying Round:** Teams assemble and test their ASV, participate in initial safety inspections, practice, and qualify for Finals in the water on the Practice Courses.
  - **Finals Round:** Teams complete runs on the Finals Course.

Date	Event	Location
18 December	Design Documentation (prior to on-site competition)	Online
05 February	Team Check-in / Orientation Vehicle Assembly + Safety Inspections	Nathan Benderson Park
06-09 February	Practice Course Open Qualifying Round Design Presentations	
10-11 February	Finals Round	
11 February	Awards	

Table 1. RoboBoat 2024 Schedule

2.2 Design Documentation

Prior to the on-site competition, teams provide multiple types of design documentation. During the competition, teams provide an oral presentation and their ASV is assessed by subject matter expert judges.

2.2.1 Delivered Prior to On-Site Competition

The following design documentation is delivered prior to the on-site competition.

Team Website (Total Maximum Points: 180)
Teams are required to submit a website in English that documents their team, vehicle design, and competition approach, addressing the following areas:

1) Website Content: Layout and detailed contents of the website are left for the teams to develop; however, the team website must include:

- Current team name and contact information
- Vehicle photos and/or videos
- Supporting media, which may include:
  - Instructional/Informative videos
  - Procedures (text, images)
  - Design decision documentation (text, images, videos)
  - Blogs for historical records of build progress
- List of sponsors with logos

2) Website Quality: Websites are often the first impression of a project. Potential supporters such as supervisors, sponsors, or advisors must find the website visually appealing and easy to navigate. Development of the website should include careful consideration of user experience, including:

- Written in English, or English translation provided
- Clear prioritization of key content
- Site search functionality
- Basic design elements: contrast, repetition, alignment and grouping to organize/highlight content
- User accessibility, as defined by the W3C Web Accessibility Initiative: www.w3.org/WAI
- Cross browser compatibility for modern web browsers (Chrome, Firefox, Safari, MS Edge)
- A mobile friendly display

The website submission is worth a total of 180 points. The scoring metrics can be found in the Team Handbook: roboboat.org/handbook.

Technical Design Report (TDR) (Total Maximum Points: 200)
Teams are required to submit a technical design report in English that describes the design of their ASV autonomy systems, propulsion system, and control systems, as well as strategies for their approach to the tasks. This paper should include the rationale for their design choices. Guidelines and scoring metrics can be found in the Team Handbook: roboboat.org/handbook.

Team Introduction Video (Total Maximum Points: 120)
Teams are required to create a video introducing their team members and highlighting their team personality. This video is meant to be a creative showcase of what makes each team unique, such as the mission of the team or the team culture. Teams should consider this video as an “elevator pitch” or project proposal for an opportunity to earn additional funding or support.

Format Requirements:

1. Video must be conducted in English or include subtitles in English.
2. Video must be no more than three (3) minutes in length.
3. Video may include graphics, vehicle performance, and/or simulation.
4. Videos must be hosted by team:

The team introduction video submission is worth a total of 120 points. The scoring metrics can be found in the Team Handbook: roboboat.org/handbook.

2.2.2 Delivered During On-Site Competition

Design Presentation (Total Maximum Points: 180)
Teams give a design presentation to a panel of subject matter expert judges. Each team must present what they plan to do on the course, and how that plan impacted their design and selections. This oral presentation must be conducted in English and may include visual aids. Teams must provide their own computer and adapters for an HDMI connecter to use the presentation display monitor. This presentation includes:

- Team Introduction Video (3 minutes)
- Presentation (15 minutes)
- Judge Question & Answer (5 minutes)

Teams receive an assigned 25-minute presentation time. After the presentation, teams should make themselves available for their system assessment. Please find the latest schedule here: roboboat.org/2024.

The design presentation submission is worth a total of 180 points. Below are the scoring metrics with guidance provided to the judges during evaluations.

Scoring Metrics (Maximum Points: 180)

Competition Strategy 0-55 points	The team demonstrates a good understanding of rules, requirements, and autonomy challenges, and explains how the team developed their competition strategy. Team effectively describes metrics of success for the competition.
Design Rationale 0-55 points	The team's design approach clearly relates to their competition strategy. System, subsystem, and component testing as well as lessons learned are applied throughout the system development process.
Effective Communication & Professionalism 0-35 points	Presentation materials and team member knowledge effectively support the team's message. Team members are engaging, respectful, and professional while interacting in a positive manner with the judges and each other.
Judge Questions & Dialogue 0-35 points	The team effectively uses evidence, experience, and research from project to inform responses to all questions and discussion.

System Assessment (Total Maximum Points: 180)
Judges inspect the team's ASV and assess technical design, technical innovation, and craftsmanship of the design. Team members should be present to answer technical questions posed by the judges during this inspection and be prepared to explain their design strategy and how decisions made impacts on the technical design, functionality, and craftsmanship.

Teams receive an assigned 15-minute slot. After the assessment, teams should make themselves available for a team photo and optional video interview. Please find the latest schedule here: roboboat.org/2024.

The system assessment submission is worth a total of 180 points. Below are the scoring metrics with guidance provided to the judges during evaluations.

Scoring Metrics (Maximum Points: 180)

Technical Design 0-80 points	Design and implementation of systems and subsystems are well aligned with team's strategy, design decisions, and sound engineering principles. For example, consideration has been given for ease of troubleshooting and operation.
Innovation 0-60 points	System demonstrates creative and innovative solutions. Innovation may include applying existing technology in novel ways within the system, using existing technology in a previously unintended way, or creating new technology or products incorporated into the system.
Craftsmanship 0-40 points	System is assembled with care and attention to detail and aesthetics. Construction and improvisations are neatly executed to maintain high levels of functionality, durability, and adherence to the team's design philosophy. Any vehicle adornment demonstrates creativity, originality, etc.

2.3 Autonomy Challenge

These challenges showcase ASV performance through autonomous behaviors designed to represent research and real-world applications.

2.3.1 Mandatory Activities

To participate in the Autonomy Challenge, teams must demonstrate the following mandatory activities.

Static Safety Inspection
Prior to deploying in the water, the ASV must meet all safety requirements. At a minimum, the following areas are checked:

- Emergency Stop System (location of switches, on-board and remote functionality)
    - Including a demonstration on correct function of the Emergency Stop System
- Safety issues related to a propeller or hazard
- All systems are properly secured
- Towing points and tow harness is present and secure

More details on system requirements are available in Section 4.3.1 ASV Requirements.

Weight and Thrust Measurements

Vehicles are weighed at the start of every day of the competition. Teams transport the vehicle on their cart to the scale (similar to a veterinary scale, available at scaleline.com) for weight measurement. The stable scale reading weight is recorded. Thrust is measured after the vehicle is deployed in the water either in manual or autonomous mode. The thrust value used is the highest scale reading that is stable for at least two seconds. Teams may opt to repeat their thrust measurement at each deployment.

During Finals runs, the vehicle must be re-weighed, and re-thrust tested every time it is launched into the water. If the vehicle stays in the water between finals runs, teams may forgo the weight and thrust test a second time. However, if a team is observed to be switching significant parts or working on their boat, the judges or TD staff may ask for a remeasurement.

Parameters	Points
ASV weight > 140 lbs.	**Disqualified!!!**
140 lbs > ASV weight > 110	-250 - 5*(w - 110)
110 lbs > ASV weight > 70	2*(110 – w)
ASV weight ≤ 70 lbs	80 + (70 - w)
Dimensions greater than: - three feet of width or - three feet of height - six feet of length	**Disqualified!!!**
Thrust (t) vs weight (w)	*100*(t / w)*

Table 2: Weight and Thrust Scoresheet

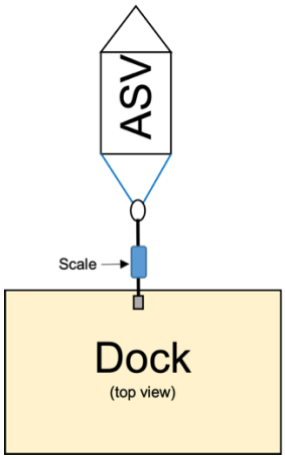


Figure 2: Thrust Measurement

2.3.2 Qualifying Round

Practice Courses are available for teams to practice, demonstrate proficiency, and qualify for the Finals Round. During this round, multiple courses are available, and each course includes all tasks. Teams may schedule times to practice or qualify on these courses. Multiple teams may be on a Practice Course at the same time. (Section 2.5 Qualifying Round)

2.3.3 Finals Round

Teams who qualify for the Finals Round are assigned a time slot and a course to conduct their scored Finals run. (Section 2.6 Finals Round)

2.4 Task Descriptions

This section provides details of the RoboBoat 2024 Autonomy Challenge tasks. Teams are encouraged to develop a strategy approaching these tasks that best suits their ASV.

Ducks Overboard Theme: The tasks your boats will be challenged with this year have been inspired by the “Friendly Floatee” event of 1992, when 28,800 rubber toys, including ducks and other animals, spilled overboard a cargo ship.

2.4.1 Task 1 – Navigation Channel

The Navigation Channel task is a navigation demonstration showcasing the basic autonomous control and sensing capabilities. The ASV must autonomously navigate through two pairs of red and green buoys. The entire ASV must pass through both sets of the gates, without touching the buoys. The ASV must start its autonomous navigation a minimum of 6 ft. before the first set of gates.

During Finals Round: This task is mandatory for all teams to qualify for finals and is required to be completed first during each scored run.

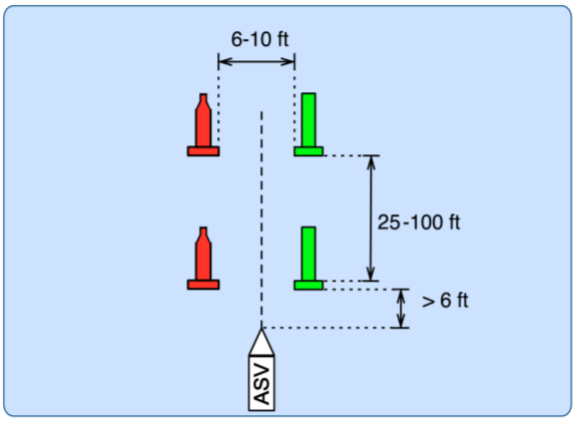


Figure 3: Navigation Channel Demonstration

2.4.2 Task 2 – Follow the Path

The Follow the Path task demonstrates the ability for the ASV to sense and maneuver through a complex path, staying within the defined pathway, and avoiding contact with obstacles along the way. The task consists of multiple sets of gates designated by pairs of red and green buoys. The ASV passes between the sets of gates without touching the buoys and avoids intermittent yellow buoys and black buoys, which may be various sizes, placed within the pathway.

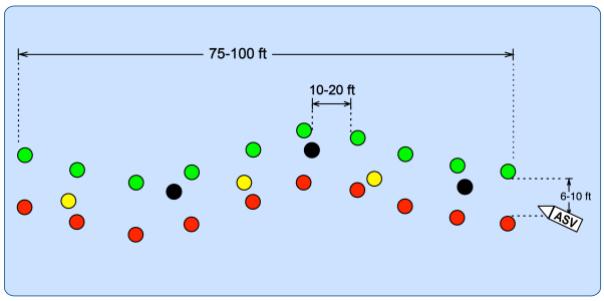


Figure 4: Follow the Path Demonstration

While maneuvering the pathway, the ASV counts the duck sightings (yellow buoys). Once the ASV exits the pathway, the ASV circles in place for the number of duck sightings collected during the task, for additional points.

2.4.3 Task 3 – Docking

The Docking task demonstrates the ability for the ASV to correctly sense, locate and maneuver into an assigned docking bay. Teams are assigned a color/shape before their time slot begins. The ASV must locate the bay matching this color/shape and attempt to enter the bay. The ASV may make contact with the dock and will not be penalized.

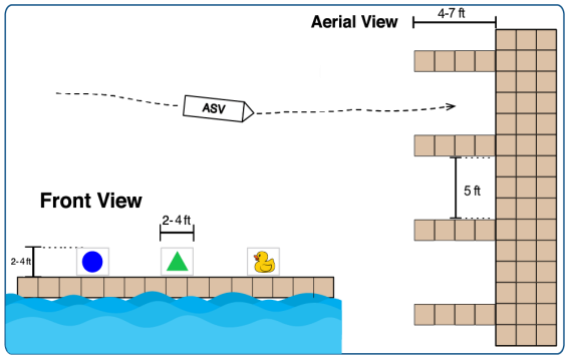


Figure 5: Docking Demonstration

The docking bays could have banners with any of the following:

- Shapes – circle, triangle, square, plus sign
- Colors – blue, green, red
- One docking bay will always be occupied by an image of a duck, also used for Task 4.

2.4.4 Task 4 – Duck Wash

The Duck Wash task demonstrates the ability for the ASV to sense and interact while demonstrating precise control and aiming. The ASV must locate the duck banner in one of the docking bays on the docking task
and shoot water on the printed duck. The ASV may pump the water from the environment versus storing it on board the vehicle. The ASV may make contact with the dock and will not be penalized.

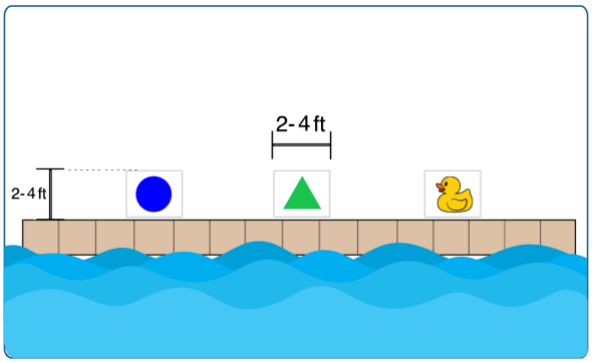


Figure 6: Duck Wash Demonstration

2.4.5 Task 5 – Speed Challenge

The Speed Challenge task demonstrates the ability for the ASV to sense the task elements with object recognition and decision making. This task demonstrates hull form efficiency coupled with its propulsion system, and the resulting maneuverability.

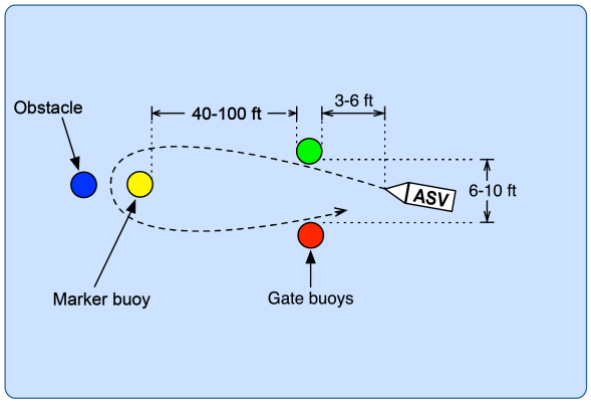


Figure 7: Speed Challenge

As quickly as possible, the ASV enters through gate buoys, circumnavigates around the yellow marker buoy (counterclockwise or clockwise), avoids the blue obstacle buoy, and exits through the same gate buoys. The gate buoys are moored 6 to 10 ft apart, and the marker buoy is placed 40 to 100 ft, from the gate buoys. The obstacle buoy may be positioned anywhere within the task.

This is a timed task. Time starts when the bow (front) of the ASV crosses the gate buoys (entry) and stops when the bow (front) of the ASV crosses the gate buoys (exit).

2.4.6 Task 6 – Collection Octagon

The Collection Octagon task demonstrates the ability for the ASV to detect the collection octagon that contains floating rubber ducks and racquetballs. The octagon floats on the surface of the water and is approximately 6 feet in diameter. A 3-dimensional cube is located at the center of the octagon that aids the ASV to detect the location of the task and items to collect. The panels on each side of the cube are black triangles.

The items the ASV collects in this octagon are to be delivered in the Delivery Octagon (Task 7).

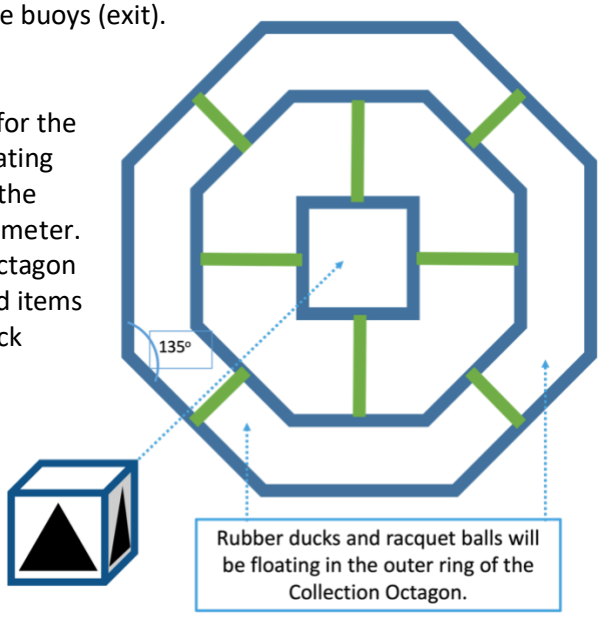


Figure 8: Collection Octagon Demonstration

2.4.7 Task 7 – Delivery Octagon

The Delivery Octagon task demonstrates the ability for the ASV to detect the delivery octagon that is identifying various "nests" to deliver items. The ASV delivers the collected items from the Collection Octagon (Task 6) in the corresponding nest areas. The delivery area floats on the surface of the water and is approximately 6 feet in diameter. A 3-dimensional cube is located at the center of the octagon that aids the ASV to detect the location of the task and nests to deliver items to. The panels on two sides of the cube are duck images to represent the duck nests and the panels on the remaining two sides are black plus signs.

The ASV may be preloaded with racquetballs prior to launching on the course to attempt this task.

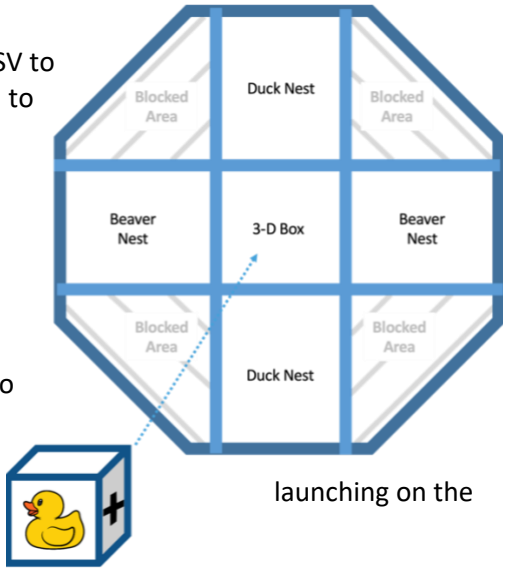


Figure 9: Delivery Octagon Demonstration

2.4.9 Task 8 – Return to Home

The Return to Home task demonstrates the ability for the ASV to navigate back to the launch point while avoiding interaction with any obstacles. The ASV returns through the gate created with two black buoys in autonomous mode after attempting Autonomy Challenge tasks. The ASV avoids all obstacles and task equipment (buoys, floating docks, etc.) on the way back. The "First Duck Gets the Worm" time bonus will be awarded based on the number of seconds remaining on the timeslot clock and overall points earned during run.

2.5 Qualifying Round

Three Qualifying and Practice Courses are available for teams to practice, demonstrate proficiency, and qualify for the Finals Round. These courses consist of all eight (8) tasks. Multiple teams may be on a Qualifying and Practice Course at the same time. Teams may schedule times to practice or complete individual tasks on these courses with the Technical Director. Teams may attempt completion on individual tasks in any order.

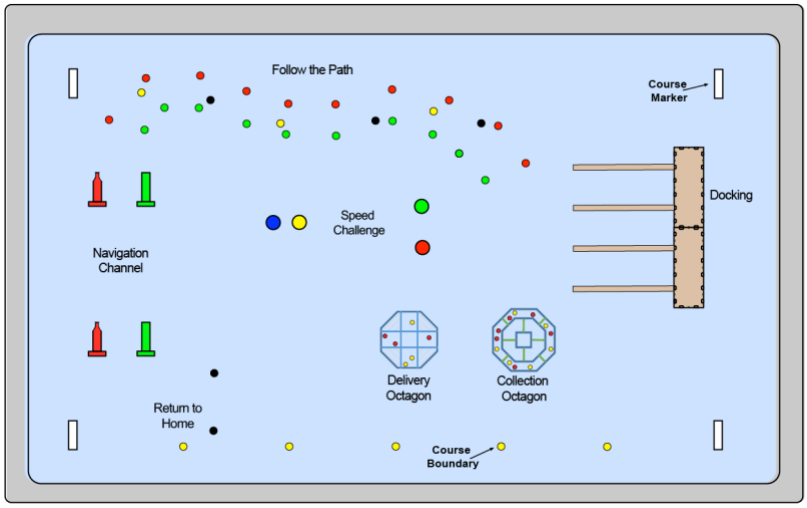


Figure 10: Preliminary Qualifying Course

Qualifying Round and task completion requirements is at the judges' discretion on-site at the competition.

2.6 Finals Round

Teams that qualify will have access to the Finals Course. These courses consist of eight (8) tasks: the mandatory navigation channel and tasks 2-8. Only one team may be on a Finals Course at a time. Note that teams may not know what course they are assigned until right before the start of their time slot.

During a Finals run the ASV must:

- operate autonomously throughout the entire run; no remote-controlled survey runs allowed.
- enter the course through the gates in the Navigation Channel task.
- attempt the remaining Tasks 2-7 of their choice, in any order.
- return to home (Task 8) at the end of the run.

SECTION 3: Scoring & Awards

Scores are calculated by the judges; all decisions of the judges are final.

3.1.1 Design Documentation Scoring

Design documentation must be submitted in accordance with the requirements and deadlines to be eligible for full points. After the competition, the judges issue overall standings in the design documentation portion of the competition.

Design Documentation	Potential Points
Website	180
Technical Design Report	200
Team Introduction Video	120
Design Presentation	180
System Assessment	180
Total Potential Points	**860**

3.1.2 Autonomy Challenge Scoring

The Autonomy Challenge is split across the Qualifying Round and the Finals Rounds. For the Qualifying Round minimum performance criteria is specified and no points are awarded. Qualifying Round and task completion requirements are at the judges' discretion on-site at the competition.

For the Final Rounds points are awarded, as outlined in this section. Upon completion of the Qualifying Round, the top-scoring teams are announced who will progress to the Finals Round. The judges have the discretion to select the number of teams advancing to the Finals Round. After the competition, the judges will issue Autonomy Challenge overall standings. Any team accepted into the Finals Round will be ranked ahead of all teams that did not participate in the Finals Round.

Task/Measurement	Performance Measures	Points	Potential Points
Weight measurement	Weight (W)	See Table 2	Vehicle Dependent
Thrust measurement	Generate pounds of thrust (in lbs) (Th)	100*(Th / W)	
Task 1 – Navigation Channel	ASV navigates through both gates		0,200
Task 2 – Follow the Path	ASV maneuvers through gates (G), without striking buoys (S) (maximum buoy strikes: 5)	25*G – 25*S	0-250
	ASV maneuvers through gates, in one sequence	25*G	0-250
	ASV exits pathway and circles in place, equivalent to number of yellow buoys in task		0,50
Task 3 – Docking	ASV enters any docking bay (points awarded once)		0,50
	ASV enters correct docking bay on first attempt		0,150
	ASV remains in dock for 30 seconds		0,150
	ASV style points *50 for entering in any direction, other than forward* *50 per turn in place, while remaining in dock (max: 2)*		0-150
Task 4 – Duck Wash	ASV shoots water near task platform		0,100
	ASV delivers water on duck banner		0,150
	ASV delivers steady stream of water on duck banner for 5 seconds continuously		0,300
Task 5 – Speed Challenge	ASV navigates through gate, without touching any buoy		0,50
	ASV circles yellow buoy, without touching any buoy		0,100
	ASV circles blue buoy, without touching any buoy		0,50
	ASV exits through gate, without touching buoy		0,100
	Task completion time (T)	250-T	0-250
Task 6 – Collection Octagon	ASV makes contact with item from collection octagon		0,50
	ASV collects items (i) from collection octagon	50*i	0,50,100,150
	ASV collects ducks (d) from collection octagon	50*d	0,50,100,150
Task 7 – Delivery Octagon	ASV delivers items (i) to any nest	50*i	No limit
	ASV delivers items (i) to correct nest	50*i	
Task 8 – Return to Home	Return to home after attempting tasks (#t)	100*#t	0-700
	Bonus for attempting all tasks and returning to home		0,100
"The First Duck Gets the Worm" Time Bonus	Multiplier applied to overall points earned, based on number of seconds remaining on the timeslot clock.	Up to 40% bonus on overall score proportional to time remaining on timeslot clock.	

3.2 Awards

3.2.1 Final Standings

Teams are awarded prize money reflective of their overall ranking after scores are calculated. The first-place teams receive a RoboNation champion banner.

3.2.2 Special Awards

Throughout the competition, teams, judges, and staff are asked to be on the lookout for exemplary behavior from teams to acknowledge with special awards. A digital nomination form will be shared on-site to nominate teams for special awards.