A COBODO AL DUCKS OVERBOARD





2024 TEAM HANDBOOK Version 1.0 (October 2023)

Introduction

RoboBoat 2024

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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.





Table of Contents

Robol	Boat 2024			WV	vw.roboboat.org
SEC	FION 1: RoboBoat Over	view			4
1.1	Dates & Venue	4	1.3	Fligibility	4
1.2	Competition Structure	4	1.4	Point of Contacts	4
SEC	FION 2: Competition				5
2.1	Competition Schedule	5	2.4	Task Descriptions	13
2.2	Design Documentation	6	2.5	Qualifying Round	20
2.3	Autonomy Challenge	11	2.6	Finals Round	21
SEC	ΓΙΟΝ 3: Scoring & Awai	rds			22
SECT	FION 4: Rules & Requir	ements.			
4.1	Rules	24	4.3	Vehicle Requirements	27
4.2	Safety	24	4.4	Obstacle Avoidance	28
SEC	FION 5: How to Compe	te			29
5.1	Register to Compete	29	5.4	Logistics	30
5.2	Pre-Competition Requirements	29	5.5	Communications	32
5.3	Timeline	30	5.6	Data Sharing	32
SEC	FION 6: Glossary & Acro	onyms			33
Δnn	endix A: Competition S	chodulo			2/
- hh	endix A. competition 5	incuale	••••		
Арр	endix B: Technical Desig	gn Repo	rt (TDR)	



Version Updates

RoboBoat 2024

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Version	Changes	Date
V1	First release of RoboBoat 2024 Team Handbook.	25 October 2023

Table 1. Document Version Log



SECTION 1: RoboBoat Overview

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1.1 Dates & Venue

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

1.2 Competition Structure

RoboBoat 2024 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. *

***First-year teams** are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representatives on-site at the event as a learning experience. First-year teams are expected to indicate this option in their <u>registration form</u>.

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 Point of Contacts

RoboBoat Questions: roboboat.org/discord autonomy@robonation.org Registration Questions: support@robonation.org On-Site Logistics/Safety: events@robonation.org 850.642.0536



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SECTION 2: Competition

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This section includes general competition details including competition schedule, design documentation, and autonomy challenge.

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.

See <u>Appendix A: Competition Schedule</u> for the detailed competition schedule.

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

Table 2. RoboBoat 2024 Schedule

2.1.1 Daily Team Meeting

Each competition day starts and ends with a mandatory team meeting for all teams, conducted by the Technical Director. Team leads are required to attend all meetings. All participants are strongly encouraged to attend.

The Technical Director summarizes the day's events, describes any course changes for the following day, and teams are encouraged to provide feedback.



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.

Scoring Considerations

To be eligible for full points, the design documentation must be submitted in accordance with the requirements below and the deadlines listed in <u>Section 5.3 Timeline</u>. Judges will evaluate each category against the scoring rubrics outlined below. The total scores will be combined to determine the overall standings in the design documentation portion of the competition. See <u>Section 3.1 Scoring</u> for the summarized design documentation scoring breakdown.

2.2.1 Delivered Prior to On-Site Competition

The following design documentation is delivered prior to the on-site competition. How to submit deliverables can be found in <u>Section 5.2 Pre-Competition Requirements</u>. The deliverable deadlines can be found in <u>Section 5.3 Timeline</u>.

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. Below are the scoring metrics the judges are provided to evaluate teams' websites.



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Team Information Scoring Metrics (Maximum Points: 40)

31-40 points	Team website includes all required team information, including the team's name and contact information, and a list of team members and sponsors. All mentions of the vehicle are relevant to the current competition year.
16-30 points	Team website provides a brief introduction to the team, team members and sponsors. There is limited supporting media on the vehicle.
1-15 points	Team website introduces the team. There is no mention of the vehicle.
0 points	The required team information is not included on the website.

Vehicle Design Documentation Scoring Metrics (Maximum Points: 70)

	Vehicle development and testing process is thoroughly documented with instructional and informative supporting media and historical recording. This could
51-70 points	include photographs, diagrams, videos, procedures (text + images), design
	documentation (text + images + video), or blogs for historical records.
26-50 points	Vehicle development and testing process is briefly documented. Limited
20-30 points	supporting media is accessible.
1-25 points	Few pictures or videos of the vehicle, but no instructional or informative
1-25 points	documentation included.
0 points	No visuals or documentation of the vehicle is available on the website.

Website Quality Scoring Metrics (Maximum Points: 70)

51-70 points	Website places a heavy emphasis on human factors. Layout is visually appealing, easily maneuverable, and does an excellent job of drawing user's attention to relevant content.
26-50 points	Website considers some user experience. Layout does an acceptable job of drawing user's attention. Users can navigate the site to find most information.
1-25 points	Layout and/or design makes it difficult to find information. Website does not have a user-friendly display.
0 points	Website is busy and difficult to read; no guidance on maneuvering site.

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 for this report are available in <u>Appendix B: Technical Design Report</u>.

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:

OPTION 1: Hosted on team's YouTube Channel.

- Videos shared on the <u>RoboNation YouTube Channel.</u>
- Must follow <u>YouTube Rules & Policies</u>, including appropriate music copyright management. OPTION 2: Host/Embed on Team Website.

The team introduction video submission is worth a total of 120 points. Below are the scoring metrics the judges are provided to evaluate teams' videos.

Formatting Scoring Metrics (Maximum Points: 10)

10 points	All formatting guidelines are followed. Video is conducted in English or includes English subtitles, video is no more than 3 minutes in length, and video is hosted on
	the team's website or YouTube channel.
0 points	Video does not follow formatting requirements.

Video Quality Scoring Metrics (Maximum Points: 25)

21-25 points	Visuals immediately draws attention. Overall, the video is solid in frame (not shaky), correctly lighted, in precision focus, appropriately segmented, and visually clear in all respects. Transitions between segments are clear and smooth. The video is less than 3 minutes total runtime.
11-20 points	Good visual impression. Majority of video is clear, adequately lit, and places people and objects in recognizable scale and perspective. Video segments are generally of the appropriate length, transition well, and are related to each other. Use of video effects is good. Runtime is less than 3 minutes.
1-10 points	Frames and segments are shaky, distracting or poorly lit. Some segments are out of focus. Some heavy shadows are obscuring viewpoint. Visual effects are distracting rather than informative. Video exceeds 3 minutes in length.
0 points	No focus on visual quality. Video exceeds 3 minutes in length.

Information Organization Scoring Metrics (Maximum Points: 30)

21-30 points	Video is a complete introduction of the team makeup including team members, sub-teams, activities, mentors, and major sponsors. Organization of video information is logical and compelling.
11-20 points	Video information is scattered throughout video, leaving the viewer lacking complete understanding of project.
1-10 points	Video provides incomplete information regarding the team members, activities, or progress. The information presented is extraneous, confusing, or low quality.
0 points	No organizational strategy is apparent.



Clear and Effective Communication Scoring Metrics (Maximum Points: 30)

21-30 points	Effective and compelling use of video medium to communicate the introduction of the team. Easy for non-technical viewer to understand and support. [You're left wanting to learn more.]
11-20 points	Exhibits moderately compelling use of video medium to communicate the introduction of the team. Strong potential, moderately compelling, mostly understandable to non-technical viewer. [You're left strongly considering to learn more.]
1-10 points	Exhibits some ability to use video to attempt to introduce team and project overview. Difficult for viewer to understand and/or was not compelling. [You're left unenthused.]
0 points	Poorly used video medium to convey team introduction. Information was as not clearly understood and was not compelling. [You're left with little information.]

Creativity Scoring Metrics (Maximum Points: 25)

21-25 points	Team creativity and enthusiasm is clearly evident in the video. Appropriate use of humor is understated and well done. Video captures user's attention without diminishing or obscuring the information delivered. Effects of careful post- production editing are clear.
11-20 points	Some creativity has been used throughout video. The visual style and tone are consistent throughout video.
1-10 points	Little attempts made to include creative or imaginative ideas in video. Poor visual effects and enthusiasm for the project.
0 points	Little imagination or creativity is evident in production. Information is presented lacking enthusiasm.

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: <u>roboboat.org/2024</u>.

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

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.

Scoring Metrics (Maximum Points: 180)



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

Vehicle Transit

Teams must provide a cart to move the vehicle around the competition site and launch the vehicle into the water.

- Cart must be manually propelled on site, no motorized carts.
- Cart's handle must be solid, no rope or chain.
- Cart's width must be less than thirty-six (36) inches.
- Carts are recommended to have six (6) inch (or more) diameter rubberized wheels.
- Carts must be able to get wet with minimal impact to function.



Figure 2: Example Vehicle Carts

Suggested carts: garden cart, available at homedepot.com; or dump cart, available at homedepot.com.

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)
 - o 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 <u>scaleline.com</u>) 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 3: Weight and Thrust Scoresheet

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



Figure 4: Navigation Channel Demonstration

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Model No.	Color	Ht. Above Waterline	Base Diam.
Port Marker Buoy	Taylor Made Sur-Mark Buoy	950410	Red	39in	18in
Starboard Marker Buoy	Taylor Made Sur-Mark Buoy	950400	Green	39in	18in
Buoys are supplied from Taylor Made, www.taylormadeproducts.com.					

Table 4. Task Elements for Navigation Channel



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.

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.



Figure 5: Follow the Path Demonstration

Task Elements

Task elements for this task are detailed in the table below.

Task Flomont	Description	Model	Color	Ht. Above	Base
Idsk Element		No.		Waterline	Diam.
Gate Buoy	Polyform A-0	A-0	Classic Red	0.5 ft	20.3 cm
Gate Buoy	Polyform A-0	A-0	Green	0.5 ft	20.3 cm
Obstacle Buoy	Polyform A-0	A-0	Yellow	0.5 ft	20.3 cm
Obstacle Buoy	Polyform A-0	A-0	Black	0.5 ft	20.3 cm
Buoys are supplied from Polyform US, shop.polyformus.com.					

Table 5: Task Elements for Follow the Path



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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.

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.

Design files and specifications of the banners printed for each docking bay is available for download in the Data Sharing Task Design folder.



Figure 6: Docking Demonstration

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Dimensions	Color
Floating Dock	Large dock cubes Item code: C000000008	Dock: 40 in. W x 10 ft. L x 16 in. H Tines: 4-7 ft. L Individual Cube: 20 in. x 20 in. x 16 in. H	Beige
Color/Shape Display	Vinyl banner	24 in. x 24 in. Design files and specifications can be found in the <u>Data Sharing Task Design folder</u> .	Red, Blue, Green, Yellow Shapes
Dock units are supplied from Jet Docks, <u>www.jetdock.com</u> .			

Table 6: Task Elements for Docking



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.

Design files and specifications of the banners printed for each docking bay is available for download in the Data Sharing Task Design folder.



Figure 7: Duck Wash Demonstration

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Dimensions	Color
Color/Shape Display	Vinyl banner	24 in. x 24 in.	Yellow
Design files and specifications can be found in the Data Sharing Task Design folder.			

Table 7: Task Elements for Duck Wash



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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.

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)

Figure 8: Speed Challenge Demonstration

of the ASV crosses the gate buoys (entry) and stops when the bow (front) of the ASV crosses the gate buoys (exit).

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Model No.	Color	Ht. Above Waterline	Base Diam.
Gate buoy	Polyform A-2	A-2	Classic Red	1 ft	36.8 cm
Gate buoy	Polyform A-2	A-2	Green	1 ft	36.8 cm
Mark buoy	Polyform A-2	A-2	Yellow	1 ft	36.8 cm
Mark buoy	Polyform A-2	A-2	Blue	1 ft	36.8 cm
Buoys are supplied from Polyform US, shop.polyformus.com.					

Table 8: Task Elements Speed Challenge



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 9: Collection Octagon Demonstration

Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Color	Base Dimensions
Octagon	½ inch PVC Pipe	White	~ 6 feet diameter
Color/Shape Display	Vinyl banner	Black	24 in. x 24 in.
This task is still under development.			

Table 9: Task Elements for Collection Octagon



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 (<u>Task 6</u>) 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.



Task Elements

Task elements for this task are detailed in the table below.

Task Element	Description	Color	Base Dimensions
Octagon	½ inch PVC Pipe	White	~ 6 feet diameter
Color/Shape Display	Vinyl banner	Yellow, Black	24 in. x 24 in.
This task is still under development.			

Table 10: Task Elements for Delivery Octagon



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.

See Figure 11 below for the preliminary course layout.

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.

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



Below is a preliminary course configuration for the Qualifying Round.

Figure 11: Preliminary Qualifying Course



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 <u>Navigation Channel task</u>.
- attempt the remaining Tasks 2-7 of their choice, in any order.
- return to home (<u>Task 8</u>) at the end of the run.

The requirements for the Finals Round are at the judges' discretion on-site at the competition. The scoring breakdown can be found in <u>Section 3.1.2</u>.



SECTION 3: Scoring & Awards

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3.1 Scoring

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 outlined in <u>Section 2.2</u> and the deadlines listed in <u>Section 5.3</u>., to be eligible for full points. After the competition, the judges will issue overall standings in the design documentation portion of the competition.

The design documentation scoring breakdown is summarized in the table below.

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 occurs in three rounds: Qualifying Round, Semi-Finals, and Finals. 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 Semi-Final and Final Rounds points are awarded, as outlined in this section. Upon completion of the Semi-Finals Round, the judges will announce the top-scoring teams 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 <u>Table 3</u>	Vehicle	
Thrust measurement	Generate pounds of thrust (in lbs) (Th)	100*(Th / W)	Dependent	
Task 1 – Navigation Channel	ASV navigates through both gates		0,200	
	ASV maneuvers through gates (G), without striking buoys (S) (maximum buoy strikes: 5)	25*G – 25*S	0-250	
Task 2 – Follow the Path	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	
	ASV enters any docking bay (points awarded once)		0,50	
	ASV enters correct docking bay on first attempt		0,150	
Task 2 - Docking	ASV remains in dock for 30 seconds		0,150	
Task 5 - Docking	ASV style points			
	50 for entering in any direction, other than forward		0-150	
	50 per turn in place, while remaining in dock (max: 2)			
	ASV shoots water near task platform		0,100	
Task 4 – Duck Wash	ASV delivers water on duck banner		0,150	
	ASV delivers steady stream of water on duck banner for		0 300	
	5 seconds continuously		0,500	
	ASV navigates through gate, without touching any buoy		0,50	
	ASV circles yellow buoy, without touching any buoy		0,100	
Task 5 – Speed Challenge	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	
	ASV makes contact with item from collection octagon		0,50	
Task 6 – Collection Octagon	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	Nolimit	
Task / = Delivery Octagoli	ASV delivers items (i) to correct nest	50*i		
Task 8 - Poturn 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 BonusMultiplier applied to overall points earned, based on number of seconds remaining on the timeslot clock.Up to 40 score p remaining		Up to 40% bo score propor remaining on	nus on overall tional to time 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 firstplace 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 onsite to nominate teams for special awards.



SECTION 4: Rules & Requirements

RoboBoat 2024

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4.1 Rules

- 1. Teams must build an ASV to compete and only enter one vehicle in the competition. (Section 4.3: <u>Vehicle Requirements</u>)
- 2. Teams that arrive at the competition failing to meet the vehicle requirements will not be permitted on the course, until the vehicle is modified to meet all requirements. (Section 4.3: Vehicle Requirements)
- 3. No combustion engines of any type may be used on the ASV.
- 4. Teams must be comprised of 75% or more full-time students. (Section 1.3: Eligibility)
- 5. First-year teams are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representation on-site at the event as a learning experience. First-year teams are expected to indicate this option in their <u>registration form</u>.
- 6. One student member of the team must be designated as the "team lead". The team lead must be conversationally fluent in English. The team lead, and only the team lead, will speak for the team during the competition runs.
- 7. Teams must have at least one representative present for the team orientation. Teams who miss orientation will not be permitted to deploy their ASV. (Appendix A: Competition Schedule)
- 8. Team leads are required to attend daily team meetings conducted by the Technical Director. (Section 2.1: Schedule)
- Teams must have at least one representative present onsite at the competition venue during the competition hours (8:00 am 5:30 pm) to be eligible for prizes. If teams cannot be onsite, they must notify RoboNation staff in a timely manner. (Appendix A: Competition Schedule)
- 10. Prior to entering the Autonomy Challenge courses, teams must demonstrate the ability to operate their ASV safely. (Section 2.3.1: Mandatory Activities)
- 11. At any point, the Technical Director Team may require a team to repeat the ASV Demonstration to re-deploy. (Section 2.3.1: Mandatory Activities)
- 12. Course boundaries are clearly identified. The ASV must stay within the course or task boundaries while attempting any tasks.
- 13. An Autonomy Challenge run will be terminated if the ASV interferes with course elements or crosses through a different course. This includes entangling, dragging, pushing, or damaging course elements or landscape.
- 14. All decisions of the judges are final.
- 15. RoboBoat organizers are not responsible for any damage to a team's ASV as a consequence of participating in the competition.

4.2 Safety

Safe operations are a priority for the RoboBoat staff. All considerations to maintain safety for operators and the surrounding environment must be made. These guidelines are the minimum requirements for all teams and their systems during the competition.

- 1. All Radio Frequency (RF) equipment must be operated within the rules and regulations of the host country. This includes, but is not limited to, frequency, transmitting power, antenna height, etc.
- 2. ASV power systems must follow the safety rules and regulations of the host country as well as the team's home country.



3. RoboBoat staff may suspend team operations at any time for safety considerations. The staff is not required to advise the team prior to the decision to terminate the run attempt. In all matters of safety, the decisions of the RoboBoat staff are final.

4.2.1 Safety Inspections

Before operating in the water, all systems must pass a safety inspection. This includes, but is not limited to:

- 1. A Safety Inspector completes a safety checklist, verifying successful operation of all safety features at each unmanned system launch.
- 2. Teams demonstrate compliance with all the requirements, to include identifying all actuators, and moving parts and their associated protection mechanisms (shrouds, etc.).
- 3. Verification of both kill switches' operation (remote and physical). This is repeated each time a team enters the water.

Safety Checklist

- Demonstrate On-board Kill Switch
- Demonstrate Remote Kill Switch
- Vehicle killed when transmitter loses link?
- Verify tele-operation link (remote control)
- Vehicle have forward and/or aft tow line?
- Any safety issues related to the propellers?

- Any potentially dangerous protrusions?
- Is everything properly secured to the system?
- Is system properly protected from rain? (recommended)

4.2.2 Battery Safety Requirements

Teams are required to understand and follow battery safety best practices on the battery chemistry selected by the team. Lithium-ion chemistry batteries may become damaged and create a hazard if misused/abused, representing the greatest risk to people, facilities, and the environment. The following safety rules and requirements must be followed:

- 1. Teams will be required to attend a mandatory battery safety briefing prior to the start of the competition.
- 2. Teams must submit battery specifications, Material Safety Data Sheets (MSDS), and proper disposal procedures, sourced from the battery manufacturer for all batteries.
- 3. Teams must keep a hard copy of the battery safety documentation for all batteries in Team Village (onsite) at all times, for reference.
- 4. Teams must bring a LiPo safe bag(s) adequate for the lithium batteries used. LiPo bag(s) must be available at the competition and the hotel.
- 5. Li-Po (Lithium Polymer) battery packs need cell level safety and balancing circuits.
- 6. Batteries must be shipped according to required shipping regulations based on battery weight/type. Note that most batteries are considered HAZMAT and must be shipped using HAZMAT regulations.
- 7. Each team must understand and follow their own country's regulations as well as those of the host nation.
- 8. All batteries must be stored, used, and maintained in accordance with manufacturer guidelines.
- 9. Teams are required to inspect their batteries daily for signs of swelling, heat, leaking, venting, burning or any other irregularities.
 - a. Lithium batteries that become too warm during use or have become swollen or malformed must be removed from use and reported to the Technical Director.



peroboboat

- b. Lithium batteries that do not hold a charge must be removed from use and reported to the Technical Director.
- 10. A team member must be present at all times to monitor charging batteries.
- 11. At the competition site, if any of the above battery conditions are observed, students must immediately notify the Technical Director or RoboBoat staff and provide the battery specifications and safety information.
- 12. At the hotel, if a battery irregularity occurs at any time, students must notify RoboNation's Senior Events Manager, Cheri Koch immediately by phone at 850.642.0536 and provide the battery specifications and safety information.
- 13. Failed or failing Lithium-ion batteries must be handled in accordance with manufacturer's safety and disposal guidelines. In the absence of specific guidelines, batteries must be placed in a LiPo safe bag, which must then be placed in a bucket, covered with sand, and placed in a designated safety zone.
- 14. Teams cannot change or replace batteries when ASV is in the water or while standing on floating docks.

4.2.3 Kill Switch (Emergency Stop) Requirements

The ASV must comply with the kill switch requirements detailed below. The ASV must have two emergency stop systems, also known as 'kill switches' or 'E-Stops'.

- On-Board: A hard-wired, on-board, emergency stop system.
- Off-Board: A wireless remote emergency stop, located off-board and on its own frequency and link.

Both systems must operate in a failsafe fashion (if any part of the system fails, the battery dies or is removed, the system must enter emergency stop) and upon activation of either system (on-board or off-board), the switch must instantaneously disconnect power from the vehicle's thruster units. An example of how to implement this is shown in Figure 12. System should be designed such that power, to the thrusters, cannot be restored until the emergency switch is reset.

The Technical team will conduct a detailed engineering and safety inspection including a team demonstration of the proper operation of all emergency systems. This includes the removal of the remote kill switch battery to



Figure 12: Example Emergency Stop Circuit

prove it fails safe. Teams must be prepared to discuss the design and implementation of their fail-safe systems in detail, if requested.

Onboard Emergency Stop System

All ASVs must have an onboard emergency stop capable of being actuated by personnel from a support craft. For personnel safety, the switch may be triggered from a distance by a wooden or plastic pole/paddle. Keeping this in mind, teams should select rugged and reliable components for their safety system.



Emergency Stop Button

A large, red button should be installed in such a way that safety personnel, from the support craft can easily actuate the button. The engage/disengage button should be red in color and have a 'press to activate and twist/pull to reset' feature. This button, momentary contact switch or not, should cut power to the thrusters immediately on actuation. The thrusters must remain in a powered-down state until the judge gives permission for the team to reinitialize the system. An example of a suitable button is shown in Figure 13 and can be found at <u>www.mcmaster.com</u>.



Figure 13: Example Kill Switch

Wireless Emergency Stop

All ASVs must be equipped with a portable, handheld, Wireless Emergency Stop controller. This controller must immediately (less than 2 seconds) disconnect power to the vehicle's thruster units when activated. This system must also meet the host country RF guidelines for frequency and transmit power.

4.3 Vehicle Requirements

The following is a list of minimal requirements for a vehicle to be permitted access to a course. **Teams** that arrive at the competition failing to meet the vehicle requirements will not be permitted on the course, until the vehicle is modified to meet all requirements.

4.3.1 ASV Requirements

- **Autonomy**: Vehicle shall be fully autonomous and shall have all autonomy decisions made onboard the ASV.
- **Buoyancy**: The vehicle shall be positively buoyant.
- **Communication**: The vehicle cannot send or receive any <u>control</u> information while in autonomous mode (to and from Operators Control Station).
- **Towable**: The vehicle must have a multi-point tow harness installed at all times to allow staff to attach a rope and tow the vehicle through the water. Underslung harnesses will <u>NOT</u> be permitted.
- **Energy source**: The vehicle must be battery powered. All batteries must be sealed to reduce the hazard from acid or caustic electrolytes. The open circuit voltage of any battery (or battery system) may not exceed 60Vdc.
- **Kill Switch**: The vehicle must have at least one 1.5 inch diameter red button located on the vehicle that, when actuated, must instantaneously disconnect power from all motors and actuators. (Section 4.2.3 Kill Switch Requirements)
- Wireless Kill Switch: In addition to the physical kill-switch, the vehicle must have at least one remote kill switch that, when actuated, must instantaneously disconnect power from all motors and actuators. If the remote kill switch system is powered off, vehicle must default to a state in which power is disconnected from all motors and actuators. (Section 4.2.3 Kill Switch Requirements)
- **Propulsion**: Any propulsion system may be used (thruster, paddle, etc.). However, all moving parts must have protection. For instance, a propeller must be shrouded.
- **Remote-controllable**: The vehicle must be remote-controllable (tele-operated) to be brought back to the dock. If the remote controller is turned off (or power is interrupted), vehicle must default to a state in which power is disconnected from all motors and actuators. Driving the vehicle through a laptop is STRONGLY discouraged.
- **Safety**: All sharp, pointy, moving or sensitive parts must be covered and marked.



- **Size**: The vehicle must fit within a six feet, by three feet, by three feet "box". (Any extensions from the hull can exceed these dimensions during a run.)
- **Surface**: The vehicle must float or use ground effect of the water. Mostly submerged/flying vehicles are forbidden for use as primary autonomous platform.
- Weight: The entire maritime system shall weigh less than 140 lbs.

4.4 Obstacle Avoidance

The ability to avoid obstacles is a core capability for unmanned systems. Each buoy on the course represents an object to be avoided or approached in some way. In addition, obstacle buoys may be placed throughout the operating areas in an effort to provide a more representative real-world challenge.



Figure 14: Obstacle Avoidance



SECTION 5: How to Compete

RoboBoat 2024

www.roboboat.org

5.1 Register to Compete

All teams are required to register to compete using the Registration form found on the RoboBoat website, <u>RoboBoat.org/2024</u>. This registration collects each team's point of contact information, demographics, and the Pre-Competition Requirements outlined in <u>Section 5.2</u>.

Registration Fees

To complete the RoboBoat 2024 registration, teams must pay the registration fee of \$850 USD.

First-Year Teams

First-year teams are eligible to participate in RoboBoat without an ASV. These teams are expected to participate in Design Documentation and send representation on-site at the event as a learning experience. First-year teams are expected to indicate this option in their registration form.

5.1.1 Data Sharing Access Requirements

During the registration process, teams must provide a generic email account and a team acronym that is used in the Data Sharing project (Section 5.6). The generic email can be associated with any email provider. An example of the Generic Email is: roboboat-team@outlook.com. The team acronym must be within 2-10 characters, abbreviating the team's school or organization. Examples of the team acronym are: RN or ROBOTEAM.

Access is given to teams that complete the Registration form. Only official registered teams maintain access to the Data Sharing project for the RoboBoat 2024 season.

5.2 Pre-Competition Requirements

These requirements are collected prior to participation on-site at the competition, during the registration process.

5.2.1 Team Information Package

Teams are required to submit a team roster including all participants that support the RoboBoat 2024 effort, liability waivers, forms, and other contact information.

5.2.2 On-Site Requirements

All teams are required to submit the following required documentation prior to participation on-site at the competitions.

Battery Safety Requirements

Teams are required to submit battery specifications, Material Safety Data Sheets (MSDS), and proper disposal procedures, sourced from the battery manufacturer for all batteries. More information can be found in <u>Section 4.2 Safety</u>.

Shipping Plan

Teams are required to submit a shipping plan to facilitate shipment receipt/handling at the competition hotel. Shipping guidelines can be found in <u>Section 5.4.3 Shipping</u>. This shipping plan must include:



- 1) Organization name
- 2) Team name
- 3) Shipping POC
- 4) Shipping POC mobile number
- 5) Shipping POC e-mail
- 6) Number of crates
- 7) Dimensions for each crate
- 8) Estimated shipping date
- 9) Shipping Company
- 10) Type of shipment Air, ground, ocean
- 11) Has initial pick-up or drop off been scheduled include date of pick-up or drop off
- 12) Is this a dangerous good shipment? If so, has a dangerous goods shipment been arranged?
- 13) Have you scheduled your outbound shipment pick-up or drop off? Provide pick-up details (date/time) for any pick-up from the hotel.
- 14) Additional information for shipment, if needed.

5.2.3 Design Documentation Package

Teams are required to submit the team website, report, and video of their Design Documentation prior to being on-site at the competition. Guidelines can be found in <u>Section 2.3 Design Documentation</u>.

5.2.4 Optional Community & Outreach

Teams are invited to outline their educational outreach efforts. This activity is not scored; however, it will be shared online for the community and can be eligible for special awards and recognition. Teams may submit a description (500 word limit) of their activities and any supporting documents.

5.3 Timeline

Date/Deadline	Event
01 October – 01 November 2023	Registration Open
20 November 2023	Full Refund Cancellation Deadline
11 December 2023	Pre-Competition Event Submission Deadlines:
	Team Information
	On-Site Requirements
18 December 2023	Pre-Competition Design Documentation Deadlines:
	Design Documentation
	 Optional Community & Outreach
18 December 2023	50% Refund Cancellation Deadline
05-11 February 2024	RoboBoat 2024

5.4 Logistics

5.4.1 Travel + Lodging

Teams are responsible for coordinating their own lodging and travel plans.

Lodging—Event Hotel

RoboNation has contracted with a local hotel to provide a special rate for RoboBoat teams. Teams are responsible for booking their own lodging for the event. More information to be released at a later date.





Travel Considerations

Invitation Letter – During the registration process, teams are given the opportunity to request an invitation letter issued by RoboNation.

VISA Process – It is recommended for international students to acquire a B-1 Visitor VISA to attend the competition. However, if the student has plans for any other activities besides the competition, they may choose to investigate other types of visas. Explore the different types of visas: <u>travel.state.gov</u>.

5.4.2 Shipping

Teams are responsible for coordinating the necessary shipping to ensure arrival of ASV and equipment. Any shipping questions can be directed to Cheri Koch at ckenglobolic.com / 850.642.0536. More shipping instructions to be released at a later date.

5.4.3 On-site Logistics

Team Village

Each team is provided with a 10' x 10' working area in a tent that includes two tables / seven chairs, one electrical outlet (120V 60 Hz 15A), and a wireless internet connection. The Team Village is a tent with sidewalls that resides on a flat grassy field surface. Although the covered workspace is weather resistant, teams are discouraged from leaving sensitive electronics/equipment exposed in the tent.

Teams should conduct development, maintenance, and repair of their systems in their designated area in Team Village. Batteries may be charged during the day at the Team Village but may not be left charging overnight.

Team Course Operating Areas (Shoreline)

Teams are provided with an area along the shoreline near the course areas where they are able to set up their shore equipment. Each course has a 10' x 10' tent-covered area with a single table per tent, 120V 60Hz 15A power, and a hard-wired Ethernet connection to the Technical Director network. The power provided is for Operator Control Station (OCS) use only and shall not be extended to any platforms on the beach. This space is shared between all teams utilizing the course.

Power

The United States uses a 120V 60Hz 15A electrical outlet plug. Usually three pins, two parallel blades (one wider than the other), and an offset semi-round pin. The wider blade is Neutral, the shorter blade is Hot/Line and the third pin is Ground. Teams will only get one 15A service and should not connect more load than that.





Figure 15: US electrical outlets

Vehicle Deployment and Recovery

Vehicles are deployed and recovered in the water on the <u>required cart provided by each team</u>, using a portable rollout mat. The temporary walkway is similar to the Mobi-mat, available at <u>shop.mobi-mat.com</u>. The cart will get wet as it's submerged during deployment and recovery. RoboBoat staff are responsible for recovering any lost vehicles. All reasonable efforts to recover a lost vehicle will be made, but the recovery of a lost vehicle cannot be guaranteed. All teams recognize by entering the competition, they risk damage to, or the loss of, their vehicle.



Open to the Public

This event is open to the public. Consider the possible attendance from future employers or sponsors.

5.5 Communications

5.5.1 Pre-Competition Communications

RoboBoat teams have a variety of opportunities to interact with each other and the RoboBoat staff.

TeamTime Meetings

Leading up to the on-site competition, there are regularly held virtual meetings where teams are asked to have a team representative join. These TeamTime meetings are hosted by the RoboBoat organizers and technical team to provide teams with competition updates and the opportunity to ask questions.

RoboBoat Discord

All questions, comments, and suggestions should be posted on the <u>RoboBoat Discord</u>. Teams are encouraged to actively participate in the online community and monitor it for the latest news and updates regarding all things RoboBoat.

5.5.2 On-site Communications

Team Lead

Each team must designate a student team member as their team lead. The team lead is the only person allowed to speak for the team. The team lead is the only person permitted to request vehicle deployment, run start, run end, or vehicle retrieval. The team lead must be conversationally fluent in English to communicate with RoboBoat staff. Teams who do not have members fluent in English should contact RoboBoat staff as soon as possible.

Technical Director Team

The RoboBoat Technical Director Team consists of a Technical Director, Safety Inspectors and Course Managers.

Other RoboBoat Staff

The RoboBoat Staff are identified with "Staff" shirts.

5.5.3 RoboBoat Website

The official competition website is <u>www.RoboBoat.org/2024</u>. This website includes all official documents and a detailed list of the registered RoboBoat teams. Helpful resources, past competition results, and other engagement opportunities can be found on this website. Information and documents are updated regularly, and it is the team's responsibility to check the website for updates.

5.6 Data Sharing

A Data Sharing project has been established for registered teams competing in RoboNation's RoboBoat, RoboSub, and RobotX competitions. This project aims to increase collaboration between teams and to provide access to shared resources and test data to validate and debug the reliability and robustness of teams' machine vision algorithms. Access information is provided in the team registration process, outlined in <u>Section 5.1 Register and Intent to Compete</u>.

For more information on Data Sharing: <u>RoboBoat.org/data-sharing</u>.



SECTION 6: Glossary & Acronyms

RoboBoat 2024

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6.1 Glossary

Phrase	Definition
Practice Courses	These courses are designed to provide opportunities to demonstrate proficiency in one task at a time. They contain an instance of each task.
Team Lead	Designated spokesperson for each team.
Technical Director	Technical team that runs the courses, safety inspections, set-up, and tear-
Team	down.
RoboBoat Staff	RoboBoat support personnel.
Judge	Subject Matter Experts that observe and score the Autonomy Challenge and
	Design Documentation.
Sponsor	Organizations that provide support to RoboBoat.

6.2 Acronyms

Acronym	Definition
ASV	Autonomous Surface Vehicle
N/A	Not available
OCS	Operator Control Station
RGB	Red, Green, Blue
RF	Radio Frequency
TD	Technical Director
TDR	Technical Design Report



Appendix A: Competition Schedule

RoboBoat 2024

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LOCATIONS	Nathan Benderson Park (NBP)	5851 Nathan Benderson Circle Sarasota, FL 34235
	Hotel – TBA	

DATE	ТІМЕ	EVENT	LOCATION
Sunday, February 4	All Day	Team Travel Day & Hotel Check-in	
	All Day	Team Travel Day & Hotel Check-in	
	1:00 pm – 1:30 pm	Team Check-in	NBP
Monday,	1:30 pm – 2:30 pm	Team Orientation	NBP – Team Village
February 5	2:30 pm – 5:00 pm	Safety Inspections / Team Village – Team Move-in	NBP – Team Village
	5:30 pm – 6:00 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	8:00 am – 12:00 pm	Safety Inspections & Autonomy Challenge Practice	NBP – Competition Courses
	10:00 am – 2:00 pm	Media Day	NBP
Tuesday,	12:00 pm – 1:00 pm	Break / Lunch	NBP
February 6	1:00 pm – 5:30 pm	Safety Inspections & Autonomy Challenge Practice	NBP – Competition Courses
	2:00 pm – 4:00 pm	Judges' Training	NBP – Finish Tower
	5:30 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	8:00 am – 12:00 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	9:00 am – 4:00 pm	Design Presentations & Team Photographs	NBP – Finish Tower
Wednesday, February 7	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP - Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool



DATE	TIME	EVENT	LOCATION
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	8:00 am – 12:00 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	9:00 am – 4:00 pm	Design Presentations & Team Photographs	NBP – Finish Tower
Thursday,	10:00 am – 3:00 pm	RoboNation's STEM Demo	NBP – Team Village
February 8	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	8:00 am – 12:00 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	9:00 am – 12:00 pm	Design Presentations & Team Photographs	NBP – Finish Tower
Friday	10:00 am – 3:00 pm	RoboNation's STEM Demo	NBP – Team Village
February 9	12:00 pm – 1:00 pm	Break / Lunch	
	1:00 pm – 5:30 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	5:30 pm – 6:00 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
	8:00 am – 12:00 pm	Autonomy Challenge Practice & Qualifying	NBP – Competition Courses
	12:00 pm – 1:00 pm	Break / Lunch	
Saturday,	1:00 pm – 5:30 pm	Autonomy Challenge Finals Round 1	NBP – Competition Courses
February 10	4:30 pm – 5:30 pm	VIP Welcome & Tour	NBP
	5:30 pm – 6:00 pm	Daily Team Meeting (Mandatory: 1 team representative)	NBP - Team Village
	5:30 pm – 7:00 pm	VIP Reception	NBP – Finish Tower
	7:30 pm	Facility Closed to Teams	NBP
	10:00 pm – 2:00 am	Overnight Pool Testing	Hotel Pool
	7:30 am	Facility Open to Teams	NBP
	7:45 am	Daily Team Meeting (Mandatory: 1 team representative)	NBP – Team Village
Currelau	8:00 am – 12:00 pm	Autonomy Challenge Finals Round 2	NBP – Competition Courses
Sunday, February 11	12:00 pm – 1:00 pm	Break / Lunch	
· Cordary II	1:00 pm – 5:00 pm	Autonomy Challenge Finals Round 3	NBP – Competition Courses
	7:30 pm – 10:00 pm	Awards	NBP
	10:00 pm – 12:00 am	Team Pool Party	Hotel Pool





Appendix B: Technical Design Report (TDR)

RoboBoat 2024

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B.1. Paper Preparation Overview

Each team is required to submit a TDR that describes the design of their vehicle, strategies for their approach to the competition, and rationale for design choices. Teams must follow the TDR instructions provided below.

The deadlines for the TDR and other Design Documentation submissions can be found in <u>Section 5.3</u>. To be eligible for full points, teams must submit their TDR by the deadline.

The outline of each section of the paper includes a scoring metrics table with guidance on scoring considerations that are provided to the judges during evaluations.

B.2. Format

The format of the written paper shall adhere to the following guidelines:

- 6 page limit (excluding References and Appendices)
- 8.5 x 11 in. page size
- Margins ≥ 0.8 in.
- Font: Times New Roman 12pt
- Header on every page including team name and page number
- Submitted in .pdf format

RoboNation Tip: It is recommended that papers be peer-reviewed prior to submission. For example, teams can utilize resources at their institution, fellow students, or professional editing services.

Optional Formatting: Teams may choose to follow the two-column format, editorial style for IEEE Conference Proceedings: <u>www.ieee.org/conferences/publishing/templates.html</u>.

Formatting Scoring Metrics (Maximum Points: 10)

10 points	Paper follows page limit, and all formatting guidelines are followed. The document is professionally organized. All required sections are included and easy to identify. All grammar, punctuation, and spelling are correct. The style follows that expected of a scientific paper submitted for publication.
0 points	Formatting guidelines are not followed and the layout is unorganized.

B.3. Paper Contents

The TDR consists of the following mandatory sections: abstract, technical content, acknowledgements, references, appendix A, and appendix B.

B.3.1 Abstract

The abstract is a short summary of the main points in the paper. The abstract should summarize the linkage between overall competition strategy and system architecture, design, and engineering decisions.



17-20 points	Abstract is engaging, lists the scope of the work, and provides a thorough summary of the paper.
13-16 points	Abstract provides an explanation on the scope of the work and provides an adequate summary of the paper.
9-12 points	Abstract provides an explanation on the scope of the work and provides a limited summary of the paper.
5-8 points	Abstract provides a basic summary of the paper.
1-4 points	Abstract section is included but does not serve the intent of an abstract. The abstract is treated as an introduction and provides no summary of the paper.
0 points	No abstract is included.

Abstract Scoring Metrics (Maximum Points: 20)

B.3.2 Acknowledgements

Participating in the competition, as in all research projects, involves leveraging resources and support beyond the efforts of individual team members. This support can take many forms such as technical advice, labor, equipment, facilities, and monetary contributions. Acknowledging those who have supported efforts is important.

9-10 points	Acknowledgements detail supporting personnel and their contributions as well as resources. Sponsors and their contributions are acknowledged.
7-8 points	Acknowledgements mention supporting personnel and their contributions as well as resources. Sponsors are mentioned.
5-6 points	Acknowledgements mention minimal supporting personnel and sponsors.
3-4 points	Acknowledgements indicate sponsors only.
1-2 points	Acknowledgements provide a general thank you but do not specify particular contributions.
0 points	No acknowledgements are included.

Acknowledgements Scoring Metrics (Maximum Points: 10)

B.3.3 References

As with any technical publication, original ideas and content not generated by the paper's authors should be properly cited. The references should follow the <u>IEEE Conference Proceedings citation style</u>.



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9-10 points	All sources are thoroughly documented. The IEEE citation style is correctly utilized.
7-8 points	Some sources are noted and documented. The IEEE citation style is utilized.
5-6 points	Limited sources are documented and the IEEE citation style is utilized.
3-4 points	Minimal sources are documented and/or citations are not correctly listed.
1-2 points	Limited sources are documented but there is no adherence to the IEEE citation style.
0 points	No sources or citations are documented.

References Scoring Metrics (Maximum Points: 10)

B.3.4 Technical Content

The technical content of the paper outlines the goals determined for the competition, and strategy for the system design and the testing approach. This portion of the paper should not include detailed descriptions of components as it can distract from understanding the team's underlying strategic thinking, design and engineering decisions, or novel contributions.

B.3.4.1 Competition Goals

The paper must include details on the team's goals for the competition, including the plans for approaching the course and how the vehicle design relates to this approach. The course consists of multiple tasks with associated points for accomplished behaviors. The only required task is navigating through the start gates. Teams may choose to attempt the other tasks and complete the tasks in any order. The more tasks a vehicle is designed and engineered to accomplish, the more complex the overall vehicle system will be.

Consider the trade-offs between system complexity and reliability. For example, teams have a limited number of working hours to prepare for the competition; this time could be spent adding additional capabilities or testing and improving the reliability of an existing capability. As system complexity grows, changes in subsystems can propagate in unmanageable ways when time is limited. Based on history and the system engineering talents of the team, include a description the team's strategic vision.

41-50 points	Detailed description of the team's strategic vision and how the vehicle design compliments their goals. Detailed discussion on trade-off studies between system complexity and reliability during design development process.
31-40 points	The team's goals are clearly evident but not discussed in detail. Trade-off studies evident but lacking details.
21-30 points	Brief mention of team's strategic goals and/or trade-off studies.
11-20 points	Document hints at a goal for competition and/or trade-off studies.
1-10 points	Discussion of the team's vision is incoherent; rationale for competition goals is not discussed.
0 points	No mention of competition goals.

Competition Goals Scoring Metrics (Maximum Points: 50)



B.3.4.2 Design Strategy

Given the strategy for success at the competition and the approach to managing complexity, the paper must include a description of the system design to meet the goals they established for the competition. Justification for design choices should be clear. Discuss how components and sub-systems were selected and integrated on the vehicle. For teams that are working with a previously designed vehicle, discuss how the design meets the current competition strategy and any modifications needed at the component, subsystem, and/or integrated system levels. Describe the experience in making both architectural/design decisions and system engineering decisions.

This section should **not** include detailed component descriptions and/or specifications not of original design. The latter should be described in Appendix B.

36-50 points	Provides in-depth explanations on design strategy and clearly identifies creative aspects of system. Creative design methodology is justified with required calculation steps and visual aids. Content clearly exhibits a Systems Engineering approach.
21-35 points	Provides explanations on design strategy and identifies creative aspects of system. Creative design methodology is justified with calculation steps and visual aids. Content hints at a Systems Engineering approach.
11-20 points	Provides some information on design strategy and creative aspects of system. Creative design methodology is supported with a few calculations. Content could be justified as a Systems Engineering approach.
1-10 points	Provides limited information on the creative aspects of system. Creative design methodology is hypothesized. No evidence to support application of Systems Engineering principles.
0 points	Creative aspects of design are not described.

Design Strategy Scoring Metrics (Maximum Points: 50)

B.3.4.3 Testing Strategy

Testing and experimentation is a crucial step to preparing and innovating a system design that strongly correlates with a competitive performance in the arena. The paper must include the approach to a testing strategy, including various test plans, both in-water and in simulation. There is a strong correlation between in-water testing time and competitive performance in the arena.

Consider the time needed to thoroughly test to meet the determined goals. Additionally, consider the demands of design and engineering with those of testing and experimentation.



Testing Strategy Scoring Metrics (Maximum Points: 50)

36-50 points	Testing approach is presented in great detail, to include test strategy and plans. Component testing, sensor and control systems testing (bench tests and in-water) done in accordance with a test plan.
21-35 points	Testing approach is presented with sufficient detail, to include test strategy and plans. Documentation shows limited components, sensors and control system testing (bench tests and in-water).
11-20 points	Testing approach is presented but not in detail. No mention of components or sensors testing.
1-10 points	Testing is done to a certain degree. No components and sensors are tested independently. There are no test plans.
0 points	No mention of testing or connection with the system design.

B.3.5 Appendices

B.3.5.1 Appendix A: Component List

This appendix documents a list of all components utilized in the system design. In cases where components were developed by the team versus purchased off the shelf, this information should be included. Additionally, if commercial off the shelf equipment were significantly modified this should be noted. Under the column marked "Specs" a web link to the manufacturer's specifications may be provided. This standardized table will help document and track trends in component (hardware and software) usage and team metrics.

Component	Vendor	Model/Type	Specs	Custom/Purchased	Cost	Year of Purchase
ASV Hull Form/Platform	9 M M M M M M M M M M	81. H.		24 Martha Harllo Harlto Harlto Martha Martha Martha Martha Mart		la l
Waterproof Connectors						
Propulsion						
Power System						
Motor Controls						
CPU						
Teleoperation						
Compass						
Intertial Measurement Unit (IMU)						
Doppler Velocity Logger (DVL)						
Camera(s)						
Hydrophones Algorithms		9 16 16 16 16 16 16 16 16 16 16 16 16 16		ANN		
Vision						
Localization and Mapping						
Autonomy Open-Source Software						1. M.



B.3.5.2 Appendix B: Test Plan & Results (Optional)

Based off the testing approach outlined in the paper, this appendix showcases the test plan that was developed and the detailed results that came out of testing. Teams should present their plans for testing, including algorithm testing in a virtual environment, component testing in a laboratory setting, sub-system testing in a relevant environment, and full system testing in a pseudo-competition environment. Test set up should be included and results presented. Any design modifications or changes in competition strategy as a result of testing should be discussed.

While this appendix is not required, excellence seen in this section can be eligible for a special judges' award.

The appendix may include detailed documentation covering the following areas:

- *Scope:* Objectives and test cases (this may also specify what was not included in tests)
- Schedule: Start/end dates and deadlines
- Resource and Tools: Resources and tools needed to conduct tests and assess results
- Environment: Description of the test environment, configurations, and availability
- *Risk Management:* Outline potential risks that could occur throughout testing
- *Results:* Detailed outcomes of test cases

