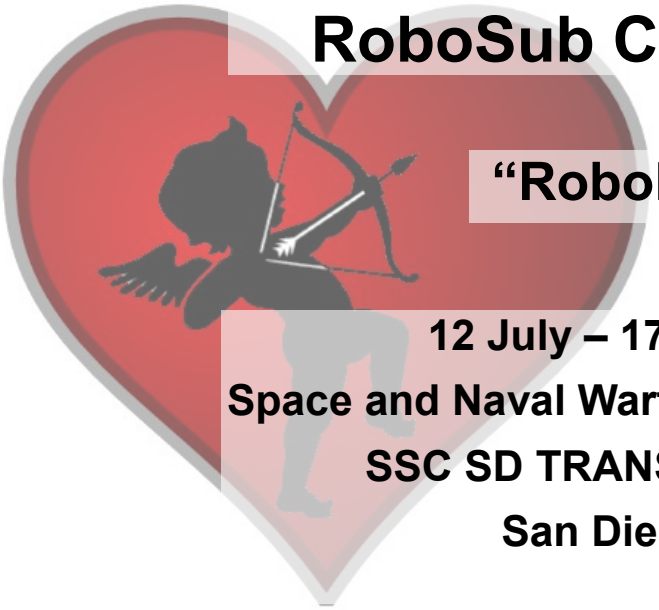
Official Rules and Mission

AUVSI & ONR's 14th Annual RoboSub Competition



"RoboLove"

12 July – 17 July 2011

Space and Naval Warfare Systems Center

SSC SD TRANSDEC Facility

San Diego, CA

Goals

The goals of the AUVSI student competitions are to provide opportunities for students to experience the challenges of system engineering, to develop skill in accomplishing realistic missions with autonomous vehicles and to foster relationships between young engineers and the organizations developing and producing autonomous vehicle technologies.

The primary emphases of the AUVSI student competitions are learning and outreach. These events are not grand challenges designed explicitly to progress the state-of-the-art. The objective is to produce the people who will push the envelope in the future. Major innovations may be spawned in these events, but this is a by-product, not an objective. Most important are gaining an appreciation for the trade offs inherent in any system design and the lessons learned in transitioning from a working bench prototype to operating reliably in the real world.

When competitiveness and collegiality are in balance, learning is maximized. The AUVSI competitions strive to maintain this balance. 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 accomplishes a challenging mission in a complex environment.

The legacy of the student competitions can be found today throughout government and industry. Employers and venture capitalists seek out prospects with the kind of resourcefulness and team management experience that former competitors offer.

Points of Contact:

Dr. David Novick	**Sandia National Labs**, *Technical Director* – rules, procedures, specifications
Karissa Bingham	**AUVSI**, *Competition Logistics* – logistics, housing, team registration, general information
Daryl Davidson	**AUVSI Foundation**, *Competition* – coordination, sponsorship
Melanie Hinton	**AUVSI**, Media Requests

Schedule*:

Event		Due Date
Intent to Compete Form and Payment Due	Friday	May 6, 2011
Journal Paper, Resume and Website Due	Monday	June 27, 2011
Team Check-in & Orientation	Tuesday	July 12, 2011
Safety Inspections and In-water Practice Time	Wednesday	July 13, 2011
Safety Inspections and In-water Practice Time	Thursday	July 14, 2011
Static Judging / Semi-final Runs	Friday	July 15, 2011
Semi-final Runs	Saturday	July 16, 2011
Finals	Sunday	July 17, 2011
Awards Party (evening)	Sunday	July 17, 2011

*subject to change

SCHEDULE

Teams will register on the afternoon at the mandatory Team Check-in & Orientation meeting. Practice time will be all day on both practice days (and both sides of the pool will be set-up for practice runs). Safety inspections will be conducted when a vehicle is brought up to the staging area to be lowered into the water. Depending on the number of competitors, a vehicle may need to autonomously pass through the gate once during the practice days in order to advance to the semi-final rounds. (see Drawing 6). Three to five (or more) teams will be selected to compete for the Finals round. As usual, the Awards Party will take place Sunday evening after the finals.

1. MISSION & ARENA

You are on your way to your sweeties house for a Valentines mission. Your usual path is laid out in orange. You'll collect flowers (touch a buoy), then follow the path and through lovers lane (a PVC bar to pass over). From there you have 2 choices. To the left you can drop off love letters (drop markers in bins), to the right, you can help cupid by firing an arrow through a heart (fire a torpedo through a heart cutout). Finally, pass over another section of lovers lane and grab a vase to place the flowers in (grab a PVC structure and surface within the octagon, with the option of dropping the structure).

1.1 Splitting the Arena

As in the past, we will operate vehicles in both halves of the arena at once. The layout in the two halves will be quite similar, as shown in Drawing 4 (however, there will be only one vase on the practice side). To increase the number of teams at any given time, we will operate vehicles in both halves of the arena at once.

During the practice days, both sides will be arranged in the practice configuration. For the qualifying rounds and final round, the competition side of the arena will be changed, first for the qualifying rounds and again for the final round. If our staffing permits, teams that are not making their qualifying run will be allowed to practice during the qualifying runs.

1.2 Starting Point

Each vehicle will be launched from the launch platform, whose approximate location is indicated on the arena plan.

2. DESCRIPTION OF TASKS

The tasks will be placed in such a way as to not have any three elements along a single line.

2.1 Path

This task consists of line segments constructed from flat PVC sheet snaking its way from the Gate to the Flowers, to the Lovers Lane, to the Letters and Cupid, to a second Lovers Lane and finally to the Vase/Sweeties House.

The "path" will be constructed of 6 inch (15 cm) wide by 4 feet (1.2 m) long sections of flat PVC sheet. It will be painted **ORANGE**. The "path" is raised off the floor of the pool 1-2 feet (0.3-0.6 m) and each segment will not have a relative angle between two pieces of more the 90° (except for the segments which point between the path split). The segments are situated in such a way that if you follow a heading along the line segment you will (eventually) meet with the next task. The next segment will be located on the "far side" of the obstacle 1-3 ft (0.3-0.9 m). Distances between segments will vary depending on the positioning of the tasks. The order of the tasks will always be: Flowers, Lovers Lane, [Letters or Cupid], Lovers Lane and Vase. You may complete the tasks in any order (with the Gate required to be first before starting anything else).

2.2 Flowers

This tasks consists of three moored 9" (23 cm) diameter buoys (**RED**, **GREEN**, **YELLOW**). The buoys will stay moored to the floor of TRANSDEC. The goal is to strike two of the three buoys in the given order. If you are told to strike **GREEN**, then **RED**, you must strike them in that order to get the full amount of points. The last two buoys that are touched are counted as your attempt at the task. The three buoys will be separated by 4ft (1.2m) from each other, and will be contained within a box that is a minimum of 7ft (2.1m) off the bottom to 10ft (3.0m) off the bottom (the heights of the buoys can vary by 3ft (0.91m)), and within a 3ft (0.91m) width along the bottom.

The buoys will be constructed so that they can take a decent blow. The mooring "line" will be nylon webbing to minimize chances of the vehicle becoming entangled. You may hit the buoy from any direction.

2.3 Lovers Lane

The task consists of two 2" (5.1 cm) diameter, 6ft (1.8 m) long PVC with 4 ft (1.2 m) PVC riser on one end. The PVC is colored using **GREEN** colored Duck Tape. and suspended 4-6 ft (1.2 – 1.8 m) above the floor. The vehicle must cross within the "box" (the bottom and side, plus the imaginary top and second side) to get points. If the vehicle midline (or more) passes inside the rectangle (side and bottom composed of the PVC pipe), you will receive more points.

2.4 Letters

This task consists of a **BLACK** bin surrounded by a white border. The bins will be 1-2 feet (0.3-0.6 m) off the bottom. The four bins will be positioned side-by-side (along their longest side). In each bin, there will be one **RED** letter (X, x, O, o). One letter in each bin. They will be centered within the bin. One size of the letter X, and one size of the letter O will be designated as the correct one. The other two will be extra.

A vehicle may carry up to two markers to drop within the bins. One marker must have an "X" on it, and one marker must have an "O" on it. The most points are awarded for dropping the "X" marker into the proper "X" bin, and for dropping the "O" marker in the proper "O" bin.

2.5 Cupid

This tasks consists of a two sided board with heart cut-outs. One side will be **RED**, the other side will be **BLUE.** There will be 2 different sized heart cut-outs on each side, a larger one and a smaller one. More points will be awarded for firing the torpedo through the smaller cut-out.

A vehicle may carry up to two torpedoes to fire. One must be marked as **RED**, and one as **BLUE.** The most points will be awarded for firing the red torpedo through the smaller red heart, and the blue torpedo through the smaller blue heart.

2.6 Vase & Sweeties House

This task consists of an acoustic pinger located 2 ft (0.6 m) off the floor. Floating above the pinger, on the surface will be a single octagon representing your Sweeties house. The octagon will be constructed from ½" PVC pipe and have a "diameter" of 9 ft (2.74 m). On the competition side, there will be two octagons placed in different locations. At the start of each run, one of the two pingers will be turned on.

Positioned directly above each pinger will be a fixture which holds a 3" x 3ft (7.63cm x 0.91m) PVC "Vase". This fixture will constrain the "Vase" from movement and rotation in such a way that you have to lift it up from the fixture to remove it. The "Vase" will be colored **ORANGE** using Duck Tape. The Vase will be laying on it's side, so from above, you will see an ~3in x 3ft (7.63cm x 0.91m) area. The weight of the vase will be adjusted so that it is just slightly negatively buoyant.

In order to obtain full points for surfacing, your vehicle must surface fully inside the octagon (no portion of the sub touching the structure). In order to obtain full points for recovery, the "Vase" must be captured by the vehicle when it surfaces. A capture consists of constraining the object in at least 3 degrees of freedom (grabbing the object with a dangling line does not count). In order to obtain full points for the drop off, once the vehicle has surfaced, the "Vase" must be released from the vehicle and sink back down (the object must first be properly recovered in order to drop it). No part of the object can be hung up on the vehicle.

The team captain can choose to switch the active pinger, after the vehicle as recovered the Vase, but before the vehicle has surfaced. The vehicle can then transport the Vase to the second octagon, surface, and drop the Vase.

The competition and practice side will ping at a rate of 0.5 Hz (2 seconds), and will be separated by 0.9 seconds. The pingers will be synchronized. The schedule will be:

Unit 1 (Competition)	ping t = 0s
Unit 2 (Practice)	ping t = 0.9s
Unit 1 (Competition)	ping t = 2.0s
Unit 2 (Practice)	ping t = 2.9s
Etc.	

This give the reverbs from each pinger (near) maximum time to die out. Note that for the final runs, the competitors will have the choice to keep the practice pinger on, or turn it off.

The ping duration is 1.3ms with a sound level of 187 dB.

2.7 Interference

Vehicles that interfere with competition elements may be disqualified at the judges' discretion. "Interference" does not include cases where, in the opinion of the judges, a vehicle is attempting to complete one of the tasks. If a vehicle becomes entangled in an objective, the run will be declared completed. Teams may keep the points earned on that run, or may have the AUV returned to the launching platform and start another new run. If a new run is begun, all points for the previous run are lost. See "Official Rules, Submissions and Fees" for more information on interference.

2.8 Acoustics

The pingers that we will least will be ORE model 4330B transponder/responder units (http://www.ore.com). They will be operated in responder mode, and each unit will be preset to one of the following frequencies: 22, 23, 24, 25, 26, 27, 28, 29 or 30 kHz. Since we cannot specify the frequency settings of the units we will receive, we will not be able to report the frequencies used to the teams until the start of the practice runs.

3. Weight and Size Constraints

3.1 Vehicle

For the International AUV Competition, each entry must fit within a six-foot long, by three-foot wide, by three-foot high “box” (1.83m x 0.91m x 0.91m). Table 1 shows the bonuses and penalties associated with a vehicle's weight in air.

Table 1: Size and weight constraints on AUVs entered into the competition.

	Bonus	Penalty
AUV Weight > 110 lbs (AUV Weight > 50 kg)	N/A	**Disqualified!!!**
110 lbs ≥ AUV Weight > 84 (50 kg ≥ AUV Weight > 38 kg)	N/A	**Loss of** 250 + 5(lb 110) 250 + 11(kg-50)
84 lbs ≥ AUV Weight > 48.5 (38 kg ≥ AUV Weight > 22 kg)	**Bonus of** 2(84 – lb) 4.4(38-kg)	N/A
AUV Weight ≤ 48.5 lbs (AUV Weight ≤ 22 kg)	**Bonus of** 80 + (48.5 – lb) 80 + 2.2(22-kg)	N/A

3.2 Markers

Each marker must fit within a box 1.5” square and 6” long (3.81 x 3.81 x 15.24 cm). Each must weight no more than 1.5 lbs (0.68 kg) in air. Any marker that exceeds these limits by less then 10% will result in a 500 point penalty. Any marker that exceeds these limits by more then 10% will be disqualified. Each marker must bear the team name or an emblem. Markers will be cleared from the arena after each run. A reasonable amount of time will be spent looking for lost markers, however consider them expendable and have back ups.

3.3 Torpedoes

The torpedoes size, weight, markings and potential “loss” are identical to the Markers. The torpedoes must travel at a “safe” speed. A “safe” speed is one that would not cause a bruise when it strikes a person.

4. OFFICIAL RULES, SUBMISSIONS AND FEES

1. The official source for all information concerning rules, interpretations, and information updates for the International Autonomous Underwater Vehicle Competition is the World Wide Web home page at: AUVSI AUV Competition
2. An Intent to Compete form, available on the website, and the entry fee must be completed. The submission must be in English and is not considered official until the entry fee has been received by AUVSI. As the competition format cannot handle an unlimited number of entries, the organizers reserve the right to limit the total number of entries that are allowed to compete by declaring the competition closed to new entries before the due date above. As with all official information, this announcement (should it be necessary) will appear on the official website.
3. During the competition, the vehicle must operate autonomously, with no control, guidance, or communication from a person or any off-board computer. The vehicle and any parts connected to the vehicle must submerge and remain submerged. No item may break the surface or be left floating while

the vehicle is underway.

4. Teams may comprise a combination of students, faculty, industrial partners, or government partners. Students may be high school, undergraduate and/or graduate students. Interdisciplinary teams are encouraged. Members from industry, government agencies, or universities (in the case of faculty) may participate, however, full-time students must compose at least 75% of each team. Participants must be enrolled at their schools as a full time student per quarter/semester during winter and spring to be considered "students." The student members of a joint team must make significant contributions to the development of their vehicle.

5. One student member of the team must be designated as the "team captain". The team captain, and only the team captain, will speak for the team during the competition run.

6. Only the student component of each team is eligible for the cash awards.

7. No team member is allowed to enter the arena at any time (this includes wading, swimming, and diving as well as floats, boats, etc.). Competition officials will be responsible for recovering lost vehicles. Officials will make all reasonable efforts to recover a lost vehicle but cannot guarantee that they will be able to do so. All teams recognize that by entering the competition, they risk damage to or the loss of their vehicle. The judges, officials, hosts, and sponsors can take no responsibility for such damage or loss.

8. The officials will suspend the competition at any time they deem that it is required by safety or security considerations.

9. There will be a semi-final round that most/all teams will compete in. After the semi-final round, the judges will convene and tally their scores. The judges have the discretion to select the number of teams entering the finals that they deem appropriate. Teams will be accepted into the final round in rank order from the semi-final round. We anticipate that three to five teams will be accepted into the finals.

10. Depending on the number of contestants, in order to be considered for selection in the semi-final round, a vehicle must show that it can submerge and pass through the gate during the practice days. A vehicle that autonomously passes through the gate is guaranteed a position in the semi-final round. If this requirement is necessary, it will be announced on the official website.

11. After the competition, the judges will issue overall standings. Any team that is accepted into the final round will be ranked ahead of all teams that are not accepted into the final round.

12. Each team will have 20 minutes on competition time. The first 5 minutes constitute the *preparation period*. During this time, the vehicle may not be deployed in the water. The 15-minute-long *performance period* immediately follows. **These times are subject to change depending on the number of contestants.**

    Preparation period: The vehicle may remain on the crane, or be placed on the dock, but not in or touching the water. A team may waive any portion of the 5-minute-long preparation period and start the 15-minute-long performance period. Once the performance period starts, the team loses any unused time in the preparation period.

    Performance period: When the officials signal the start of the performance period, the team may ask to have the vehicle deployed into the water and released to perform the mission. Only tournament officials may deploy and recover the vehicle. The time required to deploy and/or recover does not count against the 15-minute limit (see: **Ending a run and retrieving a vehicle**). This is to prevent unsafe actions in an attempt to speed the recovery and deployment process.

13. Multiple runs: A team may attempt multiple runs during the performance period. Once a team has the officials re-deploy their vehicle, all points earned in previous runs are lost.

14. Ending a run and retrieving a vehicle: At any time while the vehicle is running, the team captain can signal the end of the run and request the retrieval of the vehicle. Only officials may retrieve a vehicle and return it to the dock. The countdown clock for the performance period stops when the official touches the vehicle to recover it. The clock continues it's countdown once the team establishes communication with the vehicle, or the vehicle is safely back at the dock, whichever is first (i.e. if a team

has wireless communication with the sub, the countdown clock continues while the diver is returning the sub to the start).

15. Depending on the time, a team may use any of their 15-minute-long performance period time to survey the arena. The survey, however, must be completed autonomously. Unlike performing a competition run, the clock will continue to run while retrieving a vehicle. **This is subject to change depending on the number of contestants.**
16. If a vehicle experiences a significant interference from a piece of equipment, line, cable or diver deployed in support of the competition, the team captain may ask, at that time, to have the clock stopped, the vehicle returned to the dock, and for the judges to add back to the clock their best estimate of the time used in that run up to the point of interference. If the team captain does not make this request in a timely manner (as determined by the technical director or his designee) then the option is lost. Interference with a gate, light, or target object does not qualify for this option, and a vehicle interfering with those items may be disqualified at the judges' discretion.
17. The mission ends when any of the following occur:
    - The performance period time limit ends.
    - The judges order the end of the mission.
    - The team captain requests the end of the mission.
    - The vehicle breaches the surface (as determined by the judges, see: **Breaching** for more details).

4.1 Onsite Expectations

1. The organizers have made every attempt to provide the competitors with maximum resources at the Competition site, including electrical power, test pools, Internet access, and practice time in the main pool. This event is not only open to the public, but there is a very high possibility that a potential future employer or sponsor may also be observing the event.
2. It is expected that **ALL** teams will be present during **ALL** days of the competition. If your team does not make it into the finals, it is expected that your team will display your vehicle and be present in the team tent during this time(**All** teams, **ALL** days!)

4.2 Vehicles

1. Each team may enter only one vehicle into the competition. Each vehicle will be physically-inspected by the competition judges. The judges may disqualify any vehicle that they deem to pose an unreasonable safety hazard.
2. The judges will confer with representatives of the host facility, and any vehicle that, in the opinions of the judges or the representatives of the host facility, pose an unreasonable risk to the integrity of the host facility will be disqualified. The AUVSI and the host organization, their employees and agents, as well as the organizing committee, are in no way liable for any injury or damage caused by any vehicle, nor for any damage or injury caused directly or indirectly by the disqualification of a vehicle.
3. Each vehicle must operate autonomously during its dive. While carrying out the mission, no communication is permitted between the vehicle and any person or off-board computer. Vehicles must operate solely on their ability to sense and maneuver in the arena using on-board resources.
4. The weight of each vehicle must be less then the maximum allowed. Note that bonus points are awarded to vehicles that are below a certain value, and penalties assessed for those that exceed it (Table 1). The entire vehicle must fit within a box that is 6 feet long, 3 feet wide, and 3 feet deep (1.83m x 0.91m , 0.9m).
5. All vehicles must be battery powered. All batteries must be sealed to reduce the hazard from acid or caustic electrolytes. Batteries may not be charged inside of sealed vessels at any time while on the site

of the competition and/or while engaged in the competition. The open circuit voltage of any battery (or battery system) in a vehicle may not exceed 60 VDC. If a team has any questions or concerns, they are encouraged to contact the organizing committee.

6. No Materials (except for the markers/torpedoes and compressed air used to blow ballast) may be released by the vehicle into the waters of the arena.
7. For the safety of your vehicle, we require it to be slung on a harness or sling of some type. Even if the vehicle is light enough to hand carry, we wouldn't want anyone to slip and destroy their vehicle. Also, we need to weigh the vehicle, and require that the vehicle be slung somehow for the measurement. Please see the document *Harnessing the Submarine* for hints and ideas on how to accomplish this.
8. All vehicles must bear a clearly marked kill switch that a diver can readily activate. The switch must disconnect the batteries from all propulsion components and devices in the AUV. Note, this does not have to kill the computer. Upon reactivation, the vehicle must return to a safe state (props do not start spinning).
9. All props must have shrouds. The shrouds must surround the prop and have at least a 2" (5.08 cm) distance between the spinning disk of the prop and the edges of the shroud (front and back). If you have a guard across the opening, this distance can be minimal. Commercial thrusters qualify as is, as long as they are shrouded.
10. A vehicle will not be allowed in the water without a properly working kill switch and prop shrouds.
11. All vehicles must be buoyant by at least one half of one percent (0.5%) of their mass when they have been shut off through the kill switch.
12. The officials will suspend the operation of a vehicle at any time they deem that it is required by safety or security considerations. Teams may be required to submit technical descriptions of their vehicle to the officials in advance of the competition, with the goal of identifying potential safety concerns well in advance. When required, such technical information submitted to the judges will be held in confidence until the end of the competition.

4.3 Journal Paper

1. Each team is required to submit a journal paper that describes the design of their vehicle and the rationale behind their design choices. This paper may be no more than 10 pages long (including all figures, reference, and appendices). Additionally, each journal paper must include an abstract of no more than 250 words. The journal paper and abstract must be "printed" on standard 8.5 x 11-inch paper, with margins of at least 1 inch on all sides, and all text must be 12-point or larger font. Each page must bear a footer with the page numbering and the team name. The journal paper will be evaluated as described below in the section on scoring.
2. The journal paper must be received in pdf format via email. Teams that do not meet the deadline may be disqualified from the competition.
3. **NEW!** Along with the paper, each team will also submit a 3-5 minute video. The video will introduce the team and their approach to the event. This video will be scored and will be used online and onsite during the webcast. It will not be used for the oral persentation.

4.4 Resumes

1. One goal of the competition is to foster links between young engineers and the companies, universities, and government agencies involved in AUV development. To advance that goal, we request that each team provide resumes of each team member, along with class year and expected graduation date. These resumes (when submitted) will be circulated to our sponsors and employers who will be considering opportunities for full-time employment, internships and co-op programs. Your participation in this program is strongly encouraged.
2. Electronic versions of team member resumes should be zipped together with the journal paper.

3. Students are also encouraged to use AUVSI's Online Career Center at http://careers.auvsi.org

4.5 Static Judging

1. Each vehicle will be subject to static judging during the competition.
2. During the static display time, each team will be visited by the judges, and by the public, the press, and representatives of other organizations.
3. The judges will evaluate each vehicle for technical merit, safety, and craftsmanship as described below in the section on scoring. Teams are strongly encouraged to make a poster describing the vehicle. The posters can be set up next to the vehicle during the static display period.
4. Each team is required to have at least one member attending their vehicle throughout the static display period (not just during the judges' scheduled visit).
5. Representatives of the press and of other organizations will be encouraged to visit each team during this period.

5. SEQUENCE OF EVENTS DURING THE COMPETITION

5.1 Static display period

Each team will receive a visit from the judges during this period for the static judging. Additionally, members of the public, the press, and representatives of other organizations will be encouraged to view the vehicles and talk with team members. The judges may all work together or break apart into small groups resulting in multiple judge visits per team.

5.2 Practice runs

Practice time slots will be scheduled on an ad-hoc basis by the technical director or the designee during the practice days. It is our intent to provide as much practice time in the arena as is practical and to ensure minimal idle time for the arena. Each vehicle must be approved by the technical director or the designee before it will be allowed into the arena.

If required, this is the time for the vehicle to pass through the gate autonomously to be eligible for time slots for the qualifying rounds.

5.3 Time slots announced for competition runs

Competition time slots will be awarded based on standings after the static judging. The team that is in first place will have first choice, etc. Ties will be broken by a coin toss or random draw.

5.4 Semi-final round of the competition

Each qualifying team will be assigned a time slot to perform the mission. Twenty minutes before the beginning of their time slot, the team may enter the staging area near the launch site. At the beginning of their time slot, the team may move to the launching site on the dock.

The first 5 minutes are for preparation. During this period, the vehicle may not be deployed in the water. When the 5-minute limit has expired (or the team has waived the balance of the preparation time), the judges will begin the **performance time** clock. These competition minutes are for the vehicle to perform the mission. Once this period has begun, the team may ask to have their vehicle placed in the water to begin it's mission.

Vehicles will be put into and taken out of the water by tournament officials. The time required to do so will not count against the **performance time** limit. If a vehicle is in the water, the team may request that it be lifted onto the dock. Tournament officials will move the vehicle onto the dock and (when requested) re-deploy the AUV into

the water. Again, the time required to move the vehicle into and out of the water will not count against the **performance time** limit. However, time spent by the team on the dock does count against the **performance time** limit. The exception is when the vehicle is performing an autonomous survey, the clock will continue to run while the vehicle is retrieved.

The mission will continue until the **performance time** limit has expired, or the team captain requests the end of the mission, or the judges order the termination of the mission, or the vehicle breaches the surface. The judges may order termination of the mission at their discretion. Once the judges order the end of the mission, no further points may be scored. The judges' decisions on the termination of the run are final.

5.5 Final round of the competition

After the semi-final round, the judges will tally their scores. Teams will be accepted into the finals in rank order from the preliminary round. The judges have the discretion to select the number of teams entering the finals that they deem appropriate. We anticipate three to five teams competing in the finals. The finals round will be conducted in the same manner as the qualifying rounds.

6. SCORING

6.1 Breaching

When completing the sequence of tasks, a team may choose to complete the surfacing task first. In this case (and only this case) a vehicle may breach the surface and then submerge again to complete the remaining tasks without risking disqualification. For a vehicle to continue after breaching, it must surface inside of, or touching the octagon. A breach outside of the octagon would end the run.

6.2 Final Round

After the semi-final round, the judges will rank-order the teams based on their scores from the semi-final round, and select the top teams (as deemed by the judges) to compete in the final round. The point totals and ranking for the teams not selected are frozen. For the final round, all point totals are set to zero. The final standing of teams selected for the finals will be determined by the points their vehicle score in the final round based on the Performance Measures along. Any team that is selected to be in the finals will finish ahead of the remaining teams which where not selected.

6.3 Point Breakdown

Subjective Measures	Maximum points
Utility of team website	50
Technical merit (from journal paper)	50
Written style (from journal paper)	50
Technical accomplishments (from static judging)	75
Craftsmanship (from static judging)	75
Team uniform (from static judging)	10
Team Video	50
Discretionary static points (awarded after static judging)	40
Total	400
Performance Measures	**Maximum points**
Weight	See Table 1
Marker/Torpedo exceeding weight or dimensional specifications by < 10%	-500 per marker
Pass through the validation gate	100
Maintain a fixed heading through gate	150
Follow the “Path”	50/segment
Find the Flower (any one, correct two)	500, 1500
Pass over Lovers Lane (>½ above, <½ below)	600, 800
Marker: Correct marker in correct bin	1400
Marker: incorrect marker	700
Cupid (incorrect large, small, correct large, small)	400, 600, 1400, 1800 / torpedo
Surface within an Octagon	500
Surface within the correct Octagon	2000
Surface with the Vase	1200
Transport Vase to second Octagon	800
Drop the Vase	500
Finish the mission with T minutes (whole + fractional)	T x 100

6.3.1 “Subjective Measures” description

Technical accomplishment and Craftsmanship: These considerations will exclude any components of the design that are or could be (in the opinion of the judges) commercially available or do not include a significant contribution by team members. In other words, if you use a well-built, well-designed, off-the-shelf computer, your team does not get points for the computer's good technical design. You will get points for selecting a computer that is, in the opinion of the judges, well suited to the engineering needs of the vehicle.

6.3.2 “Performance Measures” description

Passing through the validation gate: The judges discretion will determine whether nor not the vehicle satisfactorily passes through the validation gate.

Maintain a fixed heading through the gate: Did the sub travel in a straight line through the validation gate?

Follow the “Path”: How well did the vehicle find/follow the segments?

Pick up Flowers: Full points for touching the buoys. Partial points are awarded if you track the buoy but you brush by instead of a head on bump.

Pass over Lovers Lane: Did the vehicle pass over the PVC without touching it? What percentage of the vehicle passed over the top of the object?

Love Letters: There is only one correct X and one correct O, two markers in either one only counts once. There are two secondary choices Two markers in a secondary choice will count twice.

Cupid: Full points for each torpedo that passes through the heart. Partial points are awarded if the torpedo touches a side. Partial points may be awarded if the torpedo passes close to the heart.

Surface within the Octagon: The sub must fully surface within the octagon to obtain full point value. Partial points may be awarded with judges' discretion. If a sub surfaces within both octagons, only points for “Surfacing within an Octagon” will be awarded.

Grabbing the Vase: The structure must be captured and constrained by the vehicle to obtain full points. Partial points may be awarded for a partial capture.

Transporting the Vase: The structure can be carried from one octagon to the other. It must remain constrained by the vehicle during the transport.

Releasing the Vase: The structure must be free to fall from the vehicle to obtain full points. The structure hanging on the vehicle may be awarded partial points with judges' discretion.

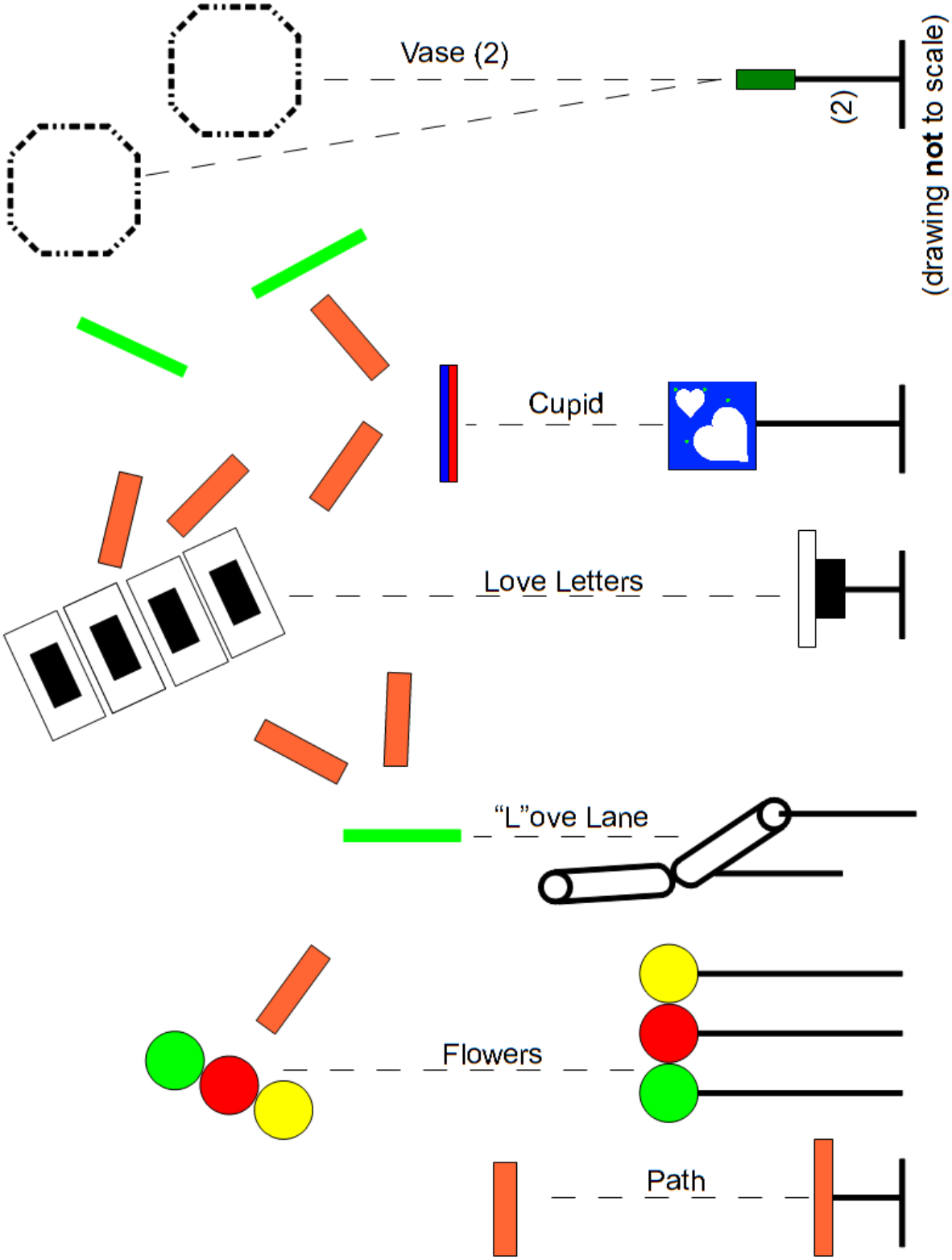
Time Bonus: At a minimum, a sub must touch the buoy, pass over Lovers Lane, drop at least one marker “in” the bin (or fire one torpedo through the window), and fully surface within one of the octagons to obtain the time bonus. These tasks can be completed in any order.

The time bonus is a calculation of whole minutes remaining plus fractional seconds. For example, with a remain time of 7:13, a team will receive (7+13/60)*100 = 721.667 points (approximately).

7. AWARDS

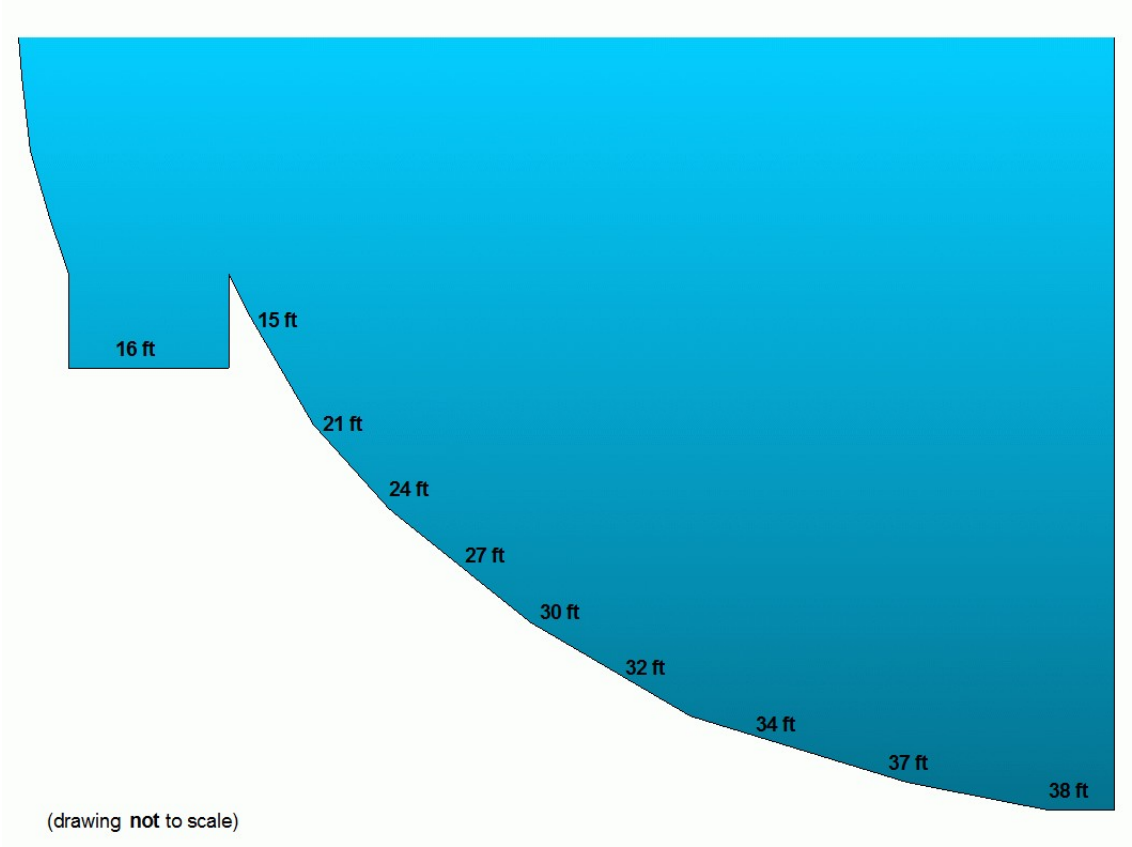
Cash prizes (and serious bragging rights) will be awarded at the discretion of the judges.

8. Diagrams

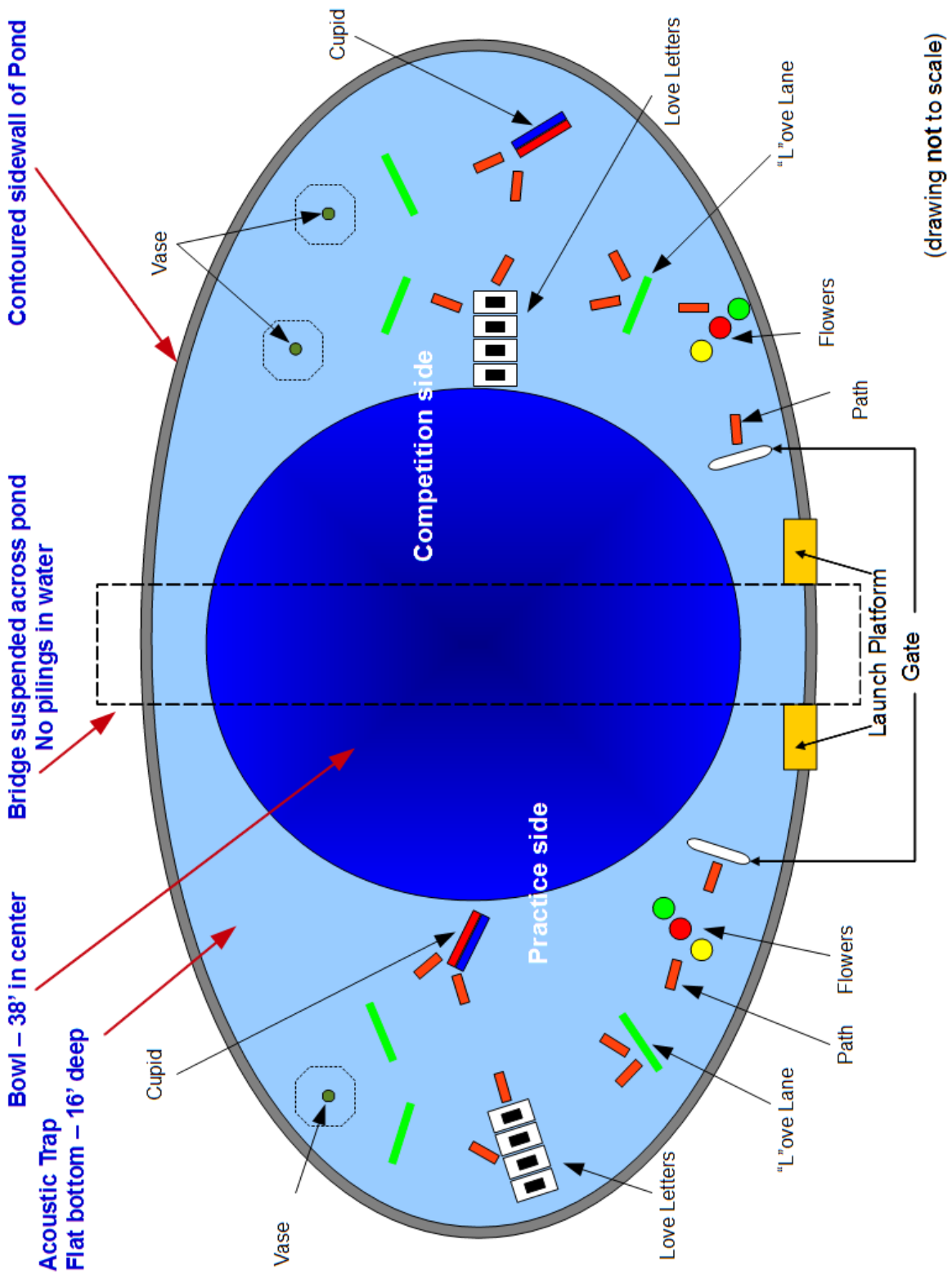


Drawing 1: Path to your Sweeties House

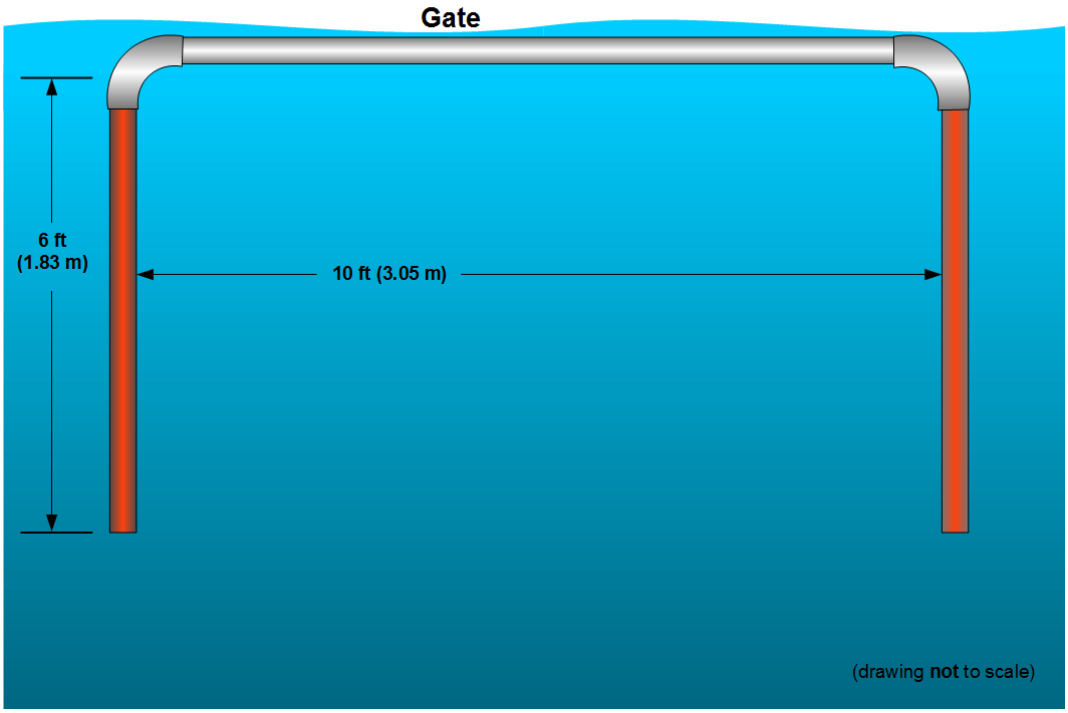
Drawing 2: Aerial photo of facility. The bridge structure has no piers or supports in the pond.



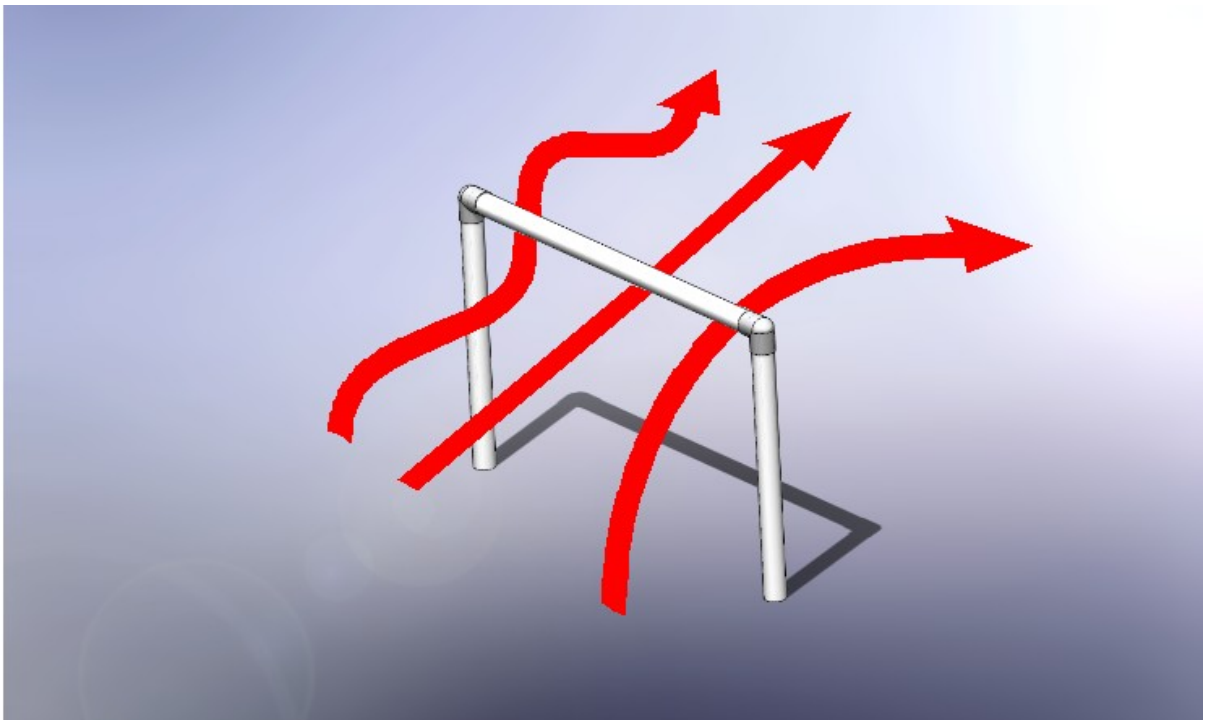
Drawing 3: Cross section of arena showing the depth profile in feet. Note that the acoustic trap (the 16ft deep section around the perimeter) varies in width around the pond.



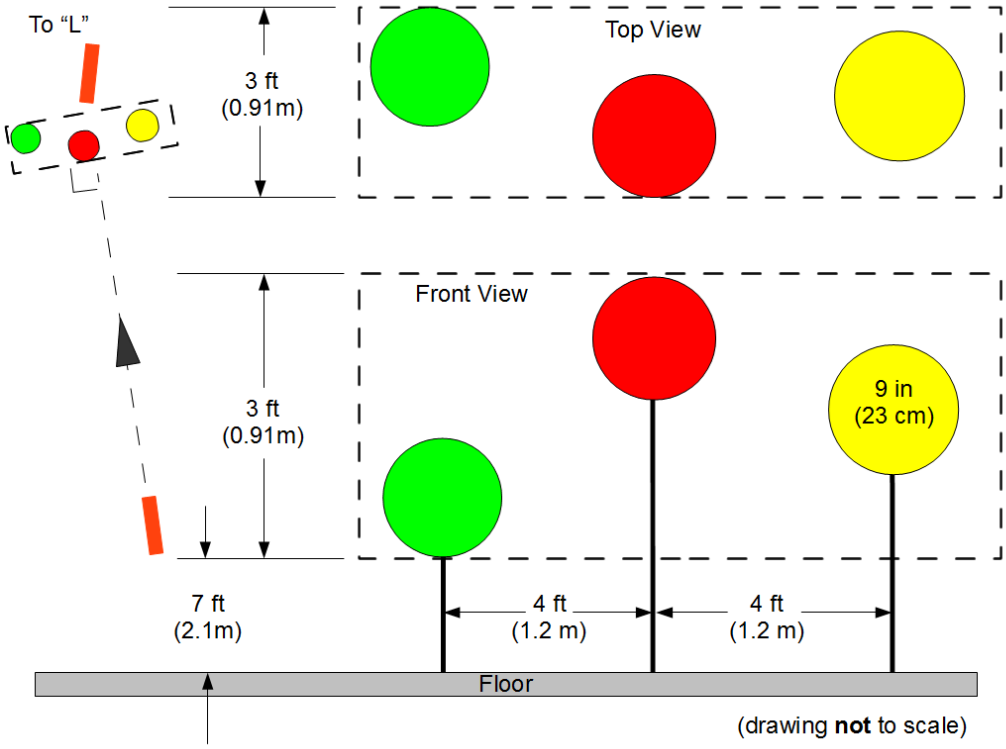
Drawing 4: General layout of the arena. The arena is split into a competition side (right half of this view) and a practice side (left half).



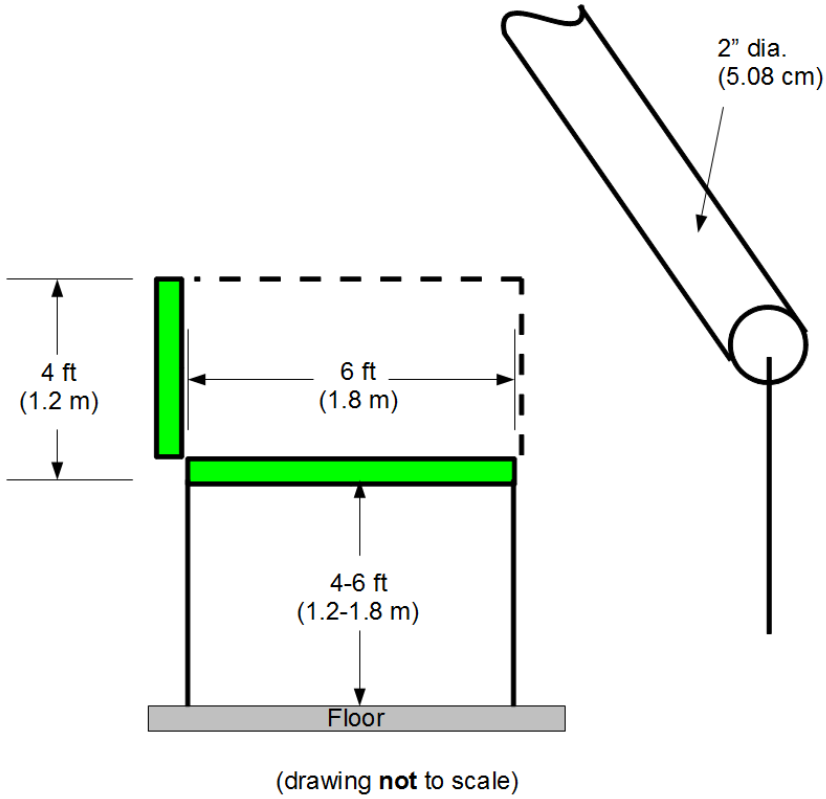
Drawing 5: Validation gate. The gate is constructed of 4 inch diameter PVC pipe. It may be white or black. It will be buoyant, and will be moored to the bottom. The vertical legs will be masked with orange Duck tape.



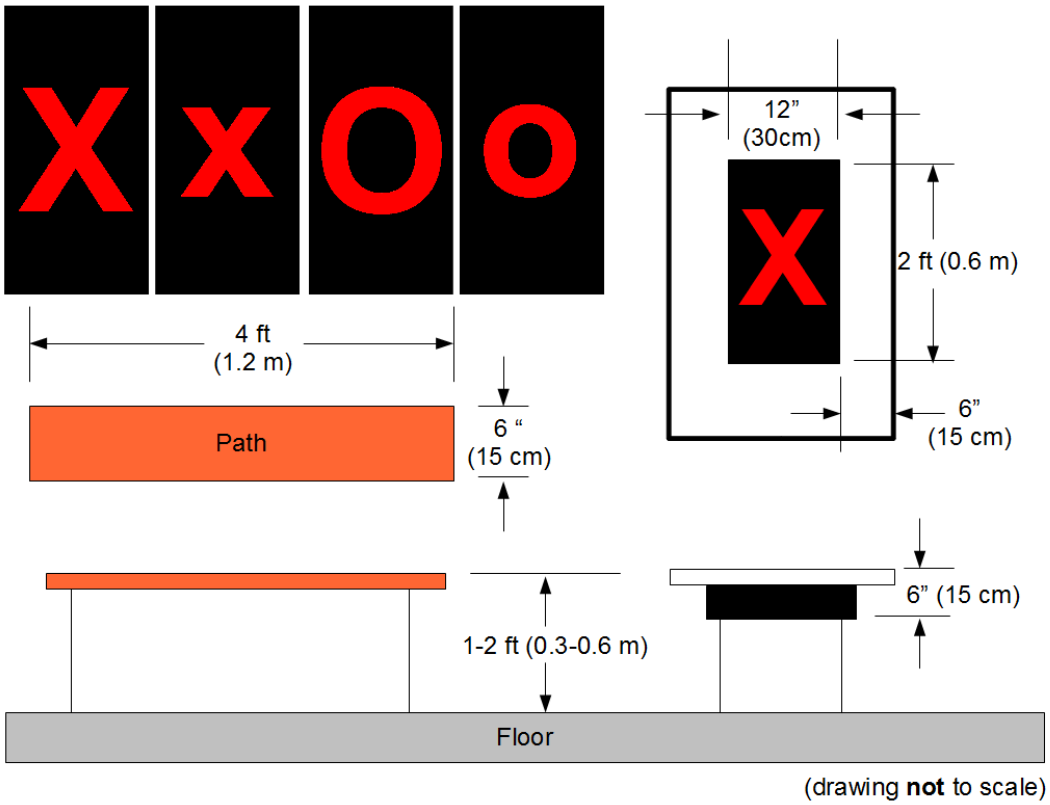
Drawing 6: Valid ways to pass through the validation gate during the practice days.



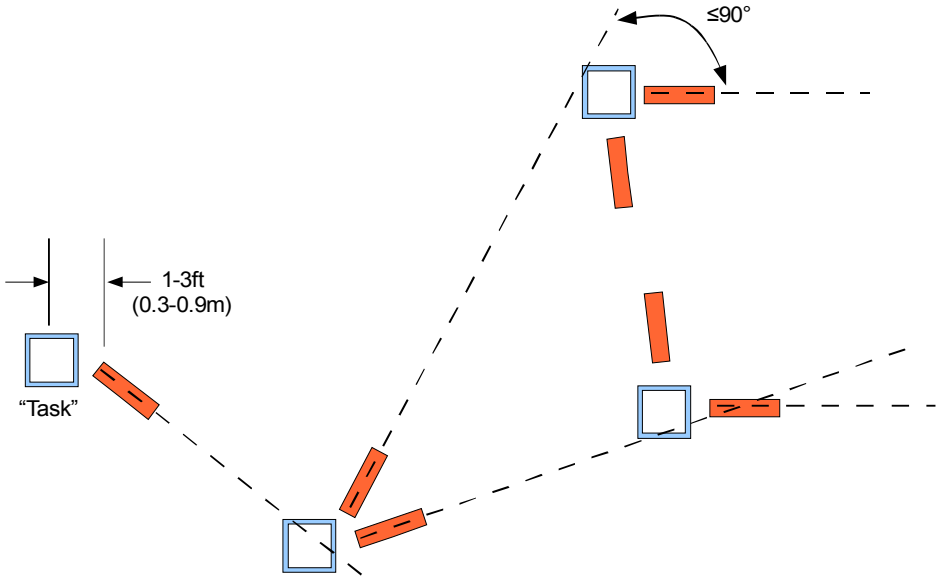
Drawing 7: Flowers (buoy), mooring line and base.



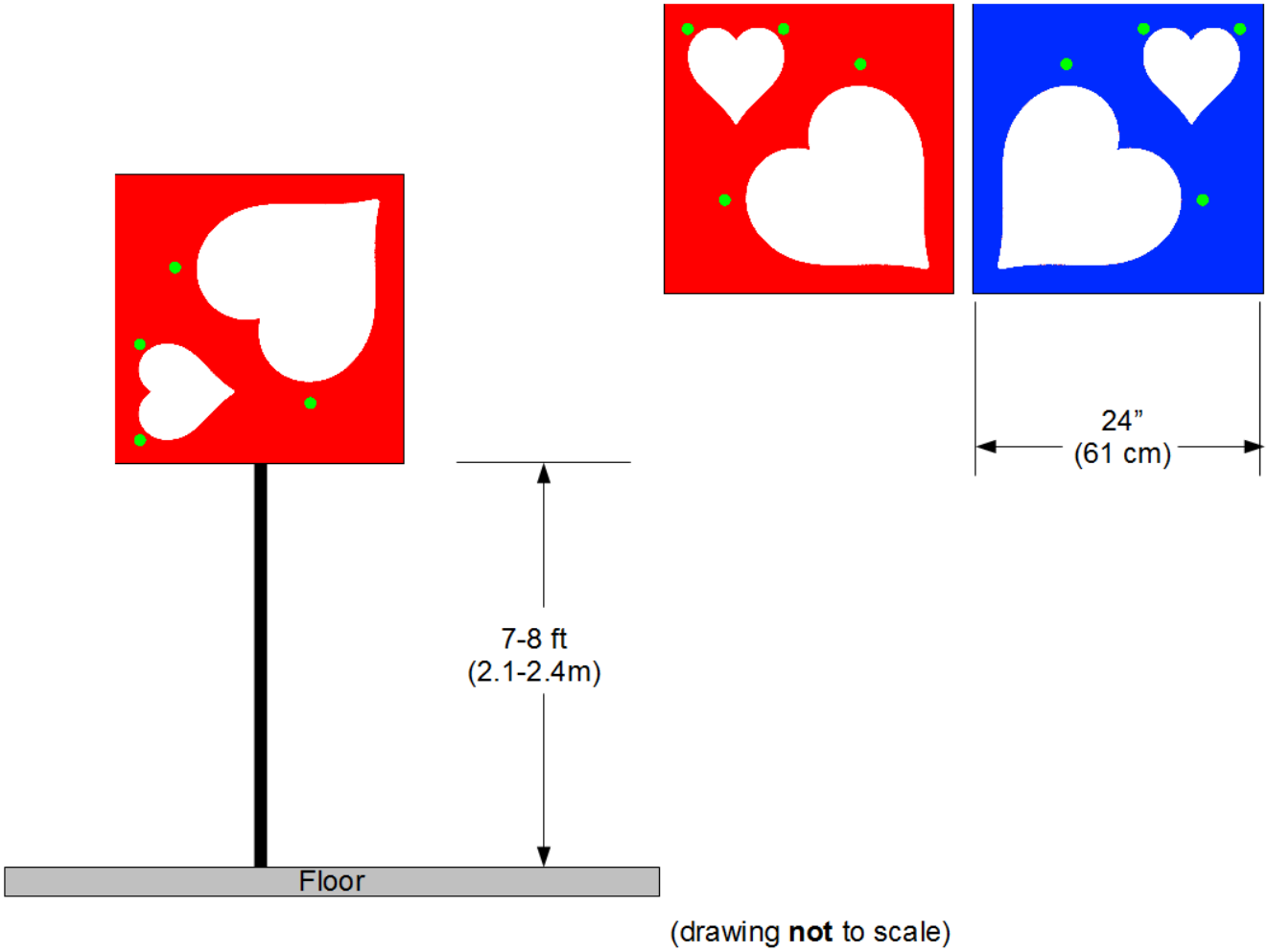
Drawing 8: Lovers Lane (PVC pipe) and mooring lines



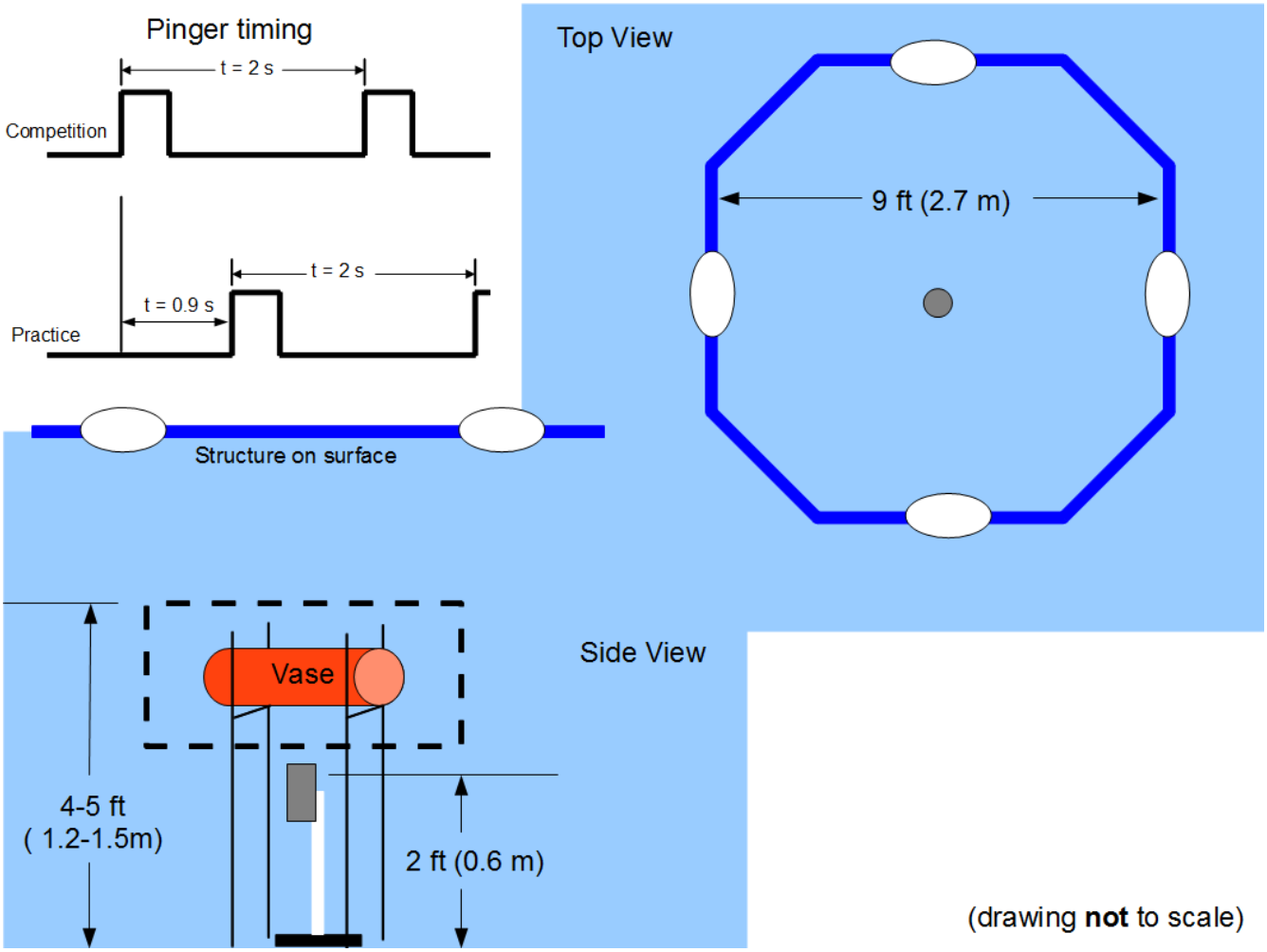
Drawing 9: "Path" and Love Letters (target bins). Distance between the path segments will vary.



Drawing 10: Expected distance and angles for the path segments



Drawing 11: Cupid (PVC structure) and mounting.



Drawing 12: Vase and Sweeties House. Sweeties House is marked on the surface with a floating 1/2" PVC pipe. The acoustic pinger is mounted on a pole in the center of this area. The vase to be recovered is positioned directly above the pinger and held in place in such a way that you have to lift it to remove it from it's base.