2019 Square One Education Network Underwater Innovative Vehicle Design Challenge Competition Parameters

2019 Underwater Innovative Vehicle Design Challenge

OVERALL OBJECTIVE:

To challenge the Engineering and Technological skills of students through underwater courses that stress speed, agility, fun, problem solving and teamwork.

PURPOSE:

- Engage youth in an exciting project that purposefully blends engineering, science, math, and advancing technologies.
- Provide schools with an enjoyable, challenging and unique project focused on engineering, science, math and technology in a marine environment.
- Link excellent teaching and learning practices with increasing corporate demands for skilled, creative and energetic employees.
- Showcase the creative engineering strengths of today's students at a regional competition that focuses on vehicle performance and endurance.
- Honor marine engineering and innovation through fun competition

UNDERWATER - INNOVATIVE VEHICLES

Square One UNDERWATER-*IVD* vehicles may begin as a collection of miscellaneous PVC pipes, bilge motors, camera, electrical wire and rope. Instructions are provided to engineer a basic ROV (Remotely Operated Vehicle) that can fully function in a sub-marine environment. It must meet specific design and safety rules (See below). Alternate materials may be used, but they must be pool appropriate, i.e. non-contaminating/hazardous. Each school originated with the same off-the-shelf materials provided by SQ1 via the teacher workshops. This program has grown from this initial endeavor.

SAFETY

Safety is of key concern at all events. The design of the vehicles is only one variable in the safety of an event. Inspection of the vehicles to ensure that they meet safety rules, having an operations area that is free from obstructions, and making sure participants and spectators are not in harm's way are some of the requirements of sanctioning and of these regulations.

Notes:

- All team members are REQUIRED to wear safety glasses during the performance of each ROV. Additionally, the team is required to follow other common safety procedures during the design, build and performance portions of Underwater IVD.
- **A 12-volt power limit is in place for each U-ROV entered into this IVD competition. Use of more than one power unit at the same time is not permitted. The power source must be a jump box style device, not an auto or marine style battery.**

OVERVIEW:

- **Elementary, Middle and High School students** incorporate innovation and creativity into their design of an Underwater Remotely Operated Vehicle (U-ROV).
- Square One (SQ1) supports each participating team through the teacher workshops that are provided in several communities in the Great Lakes region.
- Each design team is **REQUIRED** to develop a plan to excite younger students about engineering, science and math around the IVD project in their school (SQ1

Engineering Ambassadors). Additional points will be earned based on the effectiveness of this element.
- U-IVD Performance Showcase will be held on **Saturday, March 23, 2019.** This competition was created by Square One as a component of their *Signature Series* of Innovative Vehicle Design programs for students.

Three Divisions in which you may register to compete!
- **Grades 3 – 8: Junior Class Division**…Basic ROV's – (Similar to those developed as a part of the SQ1 teacher workshops)
- **Grades 9 – 12: Senior Class Division**…Basic ROV's – (Similar to those developed as a part of the SQ1 teacher workshops)
- **Grades 3 – 12: Advanced Technology Division**…Digitally controlled ROV's…RC/ Microcontrollers/other complex technologies utilized.

SCHOOL DESIGN TEAM DETAIL:
- Teams/Clubs must consist of at least 5 students and one dedicated, certified teacher.
- Teams can be comprised of a dedicated class within an existing curriculum.
- Teams should develop a well-articulated, professional plan toward the innovative designs of their vehicle.
- Teams must register and commit to the Performance Showcase no later than March 1, 2019. Teams are expected to keep this commitment, unless extreme last minute circumstances prevent participation.
- Teams must meet all safety requirements as outlined in the U-IVD Teacher's Guide, Assembly Manual authored and presented during the aforementioned workshops by Keith Forton, Traverse City Central High School, MI, or Bill Grimm, Oak Park High School.
- No pressure accumulators (purchased or homemade) are allowed. Pressure accumulators are chambers or cylinders that accumulate and store compressed air at high pressures. They are essentially pressurized bombs that if ruptured, would spray fragments into the surrounding area.
- All travel and associated fees are the responsibility of the team/school

SQUARE ONE EDUCATION NETWORK DETAIL:
SQ1 will provide all coordination of the U-IVD Performance Showcase.
SQ1 will develop the parameters/guidelines of the U-IVD Performance Showcase.
SQ1 will provide appropriate awards based upon scoring by judges.

OUTCOMES
Square One Education Network sees valuable outcomes through student participation in Underwater Innovative Vehicle Design. These include:

- Increased interest in science, technology, engineering and mathematics
- Understanding of electrical circuitry
- Understanding of buoyancy, results of pressure as it relates to the marine environment
- Safe and proper usage of hand tools such as wire cutters, strippers, PVC cutters, and soldering iron as well as safe use of adhesives.
- Teamwork, presentation skills, and problem solving
- Budgeting

Additionally, please find pertinent Next Generation Science Standards for high school students at the end of this document.

Underwater Innovative Vehicle Design Challenge – Becoming a Master of Mobility!

Creating a culture in "Masters of Mobility" while developing talent that will transcend moving things from A to B, staying connected to everything and anything, plus education that begins with the basics...starting from **"Square One!"**

Mobility in Michigan:

Taking a systems approach to mobility would mean that vehicles and infrastructure would communicate to avoid imminent safety hazards, minimize congestion and maximize traffic flow across entire regions, help enable driverless and shared vehicles, and allow individuals to coordinate seamlessly with other modes of transportation including, buses, trains, bicycles, boats or pedestrians. It would have major implications for the environment, trade, urban planning, vehicle design and manufacturing, user accessibility to goods and services, and the ease and efficiency of moving people and goods from place to place via land, water or air. This year's Underwater Innovative Vehicle Design challenge focuses on this movement and mobility.

Students are to engineer (or re-engineer) an underwater ROV that will successfully meet the performance demands necessary to complete the following challenges. Each team is allowed two opportunities to meet each challenge.

Challenge 1: Surveying

Background: Surveying is a skill used by civil and architectural engineers in planning roadways and construction sites.

Task: Your surveying challenge consists of taking accurate measurements at depth. **In your** ROV team's mission the ROV must dive several feet beneath the surface and maneuver to an underwater device where you will measure horizontal distance between a red and yellow line and between a yellow and green line. Each measurement must be recorded in cm.

Description: With his or her back facing the pool, each ROV pilot will drive from the edge of the pool to the underwater device and take the aforementioned measurements. These will be recorded on the team's score sheet and turned in to the official scoring table. Points will be awarded based on level of accuracy, as in the team that gets the correct answer will receive 100 points for that measurement. A team that is 10% will receive 90 points, 20% 80 points and so on. The two scores will be averaged for the final team score in this challenge. The team must keep the answer secret until after the competition is completed. Failure to do so will result in assessment of penalty.

Teams will self – schedule this event and are limited to **one ten (10) minute opportunity**. Challenge diagrams to follow.

Challenge #1: "Carp" Diem!

Background: Due to global travel and trade, ships are often responsible for introducing invasive species to Michigan's Great Lakes. Asian Carp are an invasive species that could wreak havoc on Michigan's sport fishing industry should they make it here. Considerable planning has gone in to keeping them out of the Great Lakes.

Task: Successfully collect the Asian Carp eggs collected in the underwater nets connected to the PVC pier and bring them ashore.

Description: With their backs facing the pool, each ROV pilot will attempt to "un-hook" the nets filled with Asian Carp eggs (various sized and numbers of ping pong or other sphere shaped objects), releasing them to the surface. Secondarily, teams should drag the nets to the poolside for collection by a team member. Points are awarded based on number of nets released and the number of nets brought ashore.

Course Design: PVC structure (simulated pier) with four upward pointed stems will trap the nets at various heights via downward pointed 1⁄2 inch PVC elbows. Each net will house various numbers/sizes of extremely positively buoyant objects with different point values. The mesh nets will be attached to the PVC structure's downward turned 1⁄2" elbow via 4" rings. The ROV must remove the 4" ring from the downward turned 1⁄2" elbow to release net to surface. (Graphic representation will be released soon)

Scoring: Each bag will be marked with its point value—small 25 points, medium 50 points, large 75 points, and extra large 100 points. Points are awarded when the mesh net of carp eggs reaches the surface. Additional points are awarded when an onshore team member takes possession of the net (small 25 points, medium 50 points, large 75 points, and extra large 100 points). The team member may only reach down to take the bag, not extend into the pool. **Time:** The team will have a total of 15 minutes to complete the task. To ensure consistency, ROV batteries will be disconnected at the 15-minute mark.

Allowances: Each team has the opportunity to place additional team members at any point along the side of the pool to assist the pilot during the competition. No team members may enter the water at any time during the competition.

Clock: Once the 15-minute clock starts, it will not stop. Should a failure occur during the competition, the team has the option to remove the vehicle and attempt necessary repairs. Should the ability to re-enter the race become an option, the ROV must be placed in the water at the starting point and reassume the tasks.

Disqualifications: If, at any time, the judges rule that a team is not taking extreme safety precautions when in the pool area, they may opt to disqualify that team for that portion of the competitions.

Penalty: 1 point will be deducted each time the U-IVD pilot is observed looking at or into the pool during the 15-minute race window.

Challenge #3 – Traffic Jam!

It is key for the civil engineer to avoid traffic snarls and back ups by programming the red, green and yellow of the traffic light. Even barges use red and green lights to manage traffic.

Task: In this challenge the red, green and yellow of the traffic lights are simulated by latex, air-filled balloons floating on the water's surface in the middle of the pool, as well as 2 bonus purple balloons. Each "traffic light" balloon will be attached to a nearly 1 meter long wire, weighted by a 1 inch pvc fitting that is color coded to the color of the attached balloon (photos to follow). **The "Tee" provides the only allowable capture point** for the student built ROV to grab hold and return the "traffic light" balloon to a team member at the side of the pool. **ONLY ONE** balloon may be collected at a time. If a "Tee" is lost along the way the pilot can make additional attempts to re-capture it as long as time allows. How is this a traffic jam? **Four ROVs (2 on each side of the pool) will be competing for the same traffic light balloons at the same time!**

Description:

- Multiple balloons in red, yellow and green will be available to capture
- They will each have a stiff wire and 1" Tee of PVC in appropriate color weighing them down.
- The balloons must be transferred from the middle of the pool via the ROV to a teammate on the side of the pool.
- **Each rescue team is REQUIRED to switch pilots at the 7-minute mark of the adventure, yet may do so more frequently if desired.**
- Teams may ONLY collect balloons singly. The ROV may return to the middle of the pool to capture balloons as many times as possible during the 15 minute traffic jam challenge.
- Captured balloons will not be re-released during one time challenge. When all balloons have been collected the challenge is over.

Scoring: 20 available Red balloons = 5 points each, 15 available Yellow balloons = 10 points each, 10 available Green balloons = 20 points each and 2 available Purple balloons = 50 points each.

Each team will have two opportunities to meet this challenge.

Time: The team will have a total of 15 minutes to complete the Traffic Jam challenge. To ensure consistency, ROV batteries will be disconnected at the 15-minute mark. **Each team is REQUIRED to switch pilots at the halfway mark of the exploration, and may do so more frequently if desired**

Allowances: Each team has the opportunity to place additional team members at any point along the side of the pool to assist the pilot during the competition. No team members may enter the water at any time during the competition. Teams may switch pilots as many times as they wish during the race, should they choose to do so.

Clock: Once the 15-minute clock starts, it will not stop. Should a failure occur during the race, the team has the option to remove the vehicle and attempt necessary repairs. Should the ability to re-enter the race become an option, the ROV must be placed in the water at the starting point.

Disqualifications: If, at any time, the judges rule that a team is not taking extreme safety precautions when in the pool area, they may opt to disqualify that team for that portion of the competitions. If, at any time, the judges

Penalty: 1 point will be deducted each time the U-IVD pilot is observed looking at or into the pool during the 15-minute mission window.

Optional Challenge #4: Underwater IVD Drag Racing!

Each team has the option to re-fit their existing ROV, or bring a second ROV to compete in this first-ever racing competition. In order to qualify for this third challenge, each team MUST compete in each of the other challenges. ONLY ONE DRAG RACE ENTRY PER SCHOOL. Considerations for the U-IVD Drag Racing teams are:

- This will be a single elimination competition, with four ROV's racing simultaneously.
- Each lane will be that of a standard swim lane, and the distance of the race will be 20 feet from the edge of the pool.
- No additional power can be supplied to the vehicles. The same base power systems apply to the racing competition. In other words, you may **NOT** ramp up the voltage for this challenge.
- This racing ROV can be of any size **(see limitation below)**, with no limitations on numbers of motors, types of motors, propellers, or other adaptations considered to be appropriate but SAFE for the challenge.
- The race will begin with the ROV touching the side of the pool with one team member holding the unit firmly against the pool's edge.
- At the sound of the signal, each ROV will travel straight ahead until **the rear of the ROV** crosses the finish line. The first ROV to completely pass the finish line wins.
- Please note for this challenge, the ROV "pilot" will be facing the pool.
- The racing ROV does NOT have to have a camera unit.
- The length of the racing ROV may NOT exceed 24 inches.
- If the team has any concern about the legality of their ROV being outside the parameters of this competition, be sure to contact Square One representatives prior to the day of competition.
- REMEMBER THAT THIS IS A NEUTRALLY BUOYANT ROV…SCOOTING ALONG THE BOTTOM LIKE A ROCK OR SCOOTING ACROSS THE SURFACE LIKE A BOAT WILL RESULT IN DISQUALIFICATION.

Challenge diagrams and photos to follow.

SHOWCASE AWARDS (Combined Event Scores)

Judges will evaluate each scoring category using a 1 – 100 rating scale, with 100 being the greatest value: (500 points maximum possible)

1. Design Innovation

How creative or innovative were the students with their design approach? Did they think "out of the box"? (Even if in the end the innovation became a detriment to the device)

Design Innovation	Guideline	
Judges will score Innovation as follows:	Max Points	Score
1. Innovative design (risk taking)	30	
2. Innovative or unique use of materials	20	
3. Execution of Innovation	30	
4. Style (overall pizzazz!)	20	
Total	100	
Comments:		

2. Engineering/Craftsmanship

How well did the design translate into performance? Was the device robust and built in a high quality manner or barely able to make it through the competition?
Were there design attributes that could be seen to solve problems or overcome issues with the target performance?

Engineering and Craftsmanship:	Guideline	
Judges will score Engineering and Craftsmanship as follows:	Max Points	Score
1. Craftsmanship- construction, quality of assembly, structural integrity	30	
2 Use of space and materials	20	
3. Applied reasoning, effectiveness, problem solving	30	
4. Style (overall pizzazz!)	20	
Total	100	
Comments:		

3. Ambassadorship: (REQUIRED)

What did the team do to share their learning and inspire younger students?

Guidelines:	Max	
How well were 100 younger students involved and inspired:	40	
How innovative was the ambassadorship:	40	
Were 100 students engaged:	0 or 20	
Comments:	100	

3. Presentation:

Each team will present to the judges for 10 minutes and will formally explain what makes their design, engineering, craftsmanship, and ambassadorship unique.

Again this year: Teams MUST have visual aides, including but not limited to a tri-fold board which will be displayed at the team's pit space throughout the day.

Judges will score the oral presentations as follows:	**Maximum Points**	**Score**
1.Clear and understandable explanation of ambassadorship, innovations and engineering.	25	
2. Logical organization of the presentation.	10	
3. Effective use of graphic aids (Don't block them from view, use large print rather than tons of tiny text, etc.) including team designed tri-fold display	20	
4. Articulation (Speaking clearly and with forethought)	15	
5. Team support (Multiple team members are able to speak to questions)	10	
6. Response to questions (knowledgeable, clear, concise)	10	
7. Enthusiasm and pride	10	
Total	**100**	

4. Square One Nation Award

Who demonstrated the overall best combination of Design Innovation, Engineering and Craftsmanship plus team dynamics, including enthusiasm and spirit to produce a superior device and outcome for the competition? This is the **"Convergence of Innovation, Engineering and Team Work"** to provide a superior solution to the challenge of the competition.

Guidelines:	Max	
Vehicle Performance	25	
Team dynamic, Leadership, Cooperation, Collaboration	25	
Engineering and Craftsmanship	25	
Design Innovation	25	
Comments:	100	

5. Performance:

How well did the rover and the entire team perform in each of the challenges? Scores/times will be used to determine these placements. Score sheet samples will be released prior to the event day.

Supporting Graphics will be shared in a Separate file as requested

ADDITIONAL PARAMETERS

- These parameters are provided to promote safe and fair competition.
- Since safety is of key concern, these parameters should be considered minimum requirements. These parameters will be in force and must be maintained during the entire competition.
- Any vehicle should be able to pass inspection at any time during a demonstration.
- Experimentation of design and ingenuity are encouraged, but keep in mind the intent of safe competition for the operators and the other participants of an event.
- If a new concept is being attempted that does not fit the rules exactly, it may be wise to contact a Square One U-IVD official before proceeding with construction. It would be unfortunate to complete a vehicle and then have it disqualified at a competition.
- Please remember that safety and high quality, innovative designs are our primary goals.

RESOURCES AND MATERIALS

(www.squareonenetwork.org)

U-IVD Contacts:

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Many thanks to Keith Forton for his innovative thinking and dedicated leadership in STEM education through the marine environment

SQ1 Underwater IVD Performance Challenge
Safety Reminders and Event Clarifications

Safety is of key concern at all events. The design of the vehicles is only one variable in the safety of an event. Inspection of the vehicles to ensure that they meet safety rules, having an operations area that is free from obstructions, and making sure participants and spectators are not in harm's way are some of the requirements of sanctioning.

If you have any questions regarding your project's design and execution, contact Bill Grimm or Barb Land as soon as possible. We do not want anyone to be disqualified on event day for having a device that does not fit within the challenge parameters.

Safety Reminders:

The use of safety glasses is **required** when working on or around the ROV, **and** when on the pool deck. Penalties WILL be assessed for noncompliance.

Appropriately ventilated work areas and other common safety procedures are expected during the design and construction of the ROV as well as the performance and competition phase of the competition.

A 12-volt power limit is in place for each U-ROV entered into this IVD competition. Use of more than one power unit is not permitted.

An Inline fuse (25 Amp Maximum) must be place within 30 cm (approximately 12") of the power supply. All power servicing the ROV and any of its components must pass through this fuse. Teams will not be allowed to participate without the fuse protection. This inline fuse is in addition to any built in fuse protection that may exist on the power supply.

Use of any type of 120 V AC devices during the competition or along poolside is not permitted. This includes plugging in and charging the power supply while being used during the competition.

No pressure accumulators (purchased or homemade) are allowed. Pressure accumulators are chambers or cylinders that accumulate and store compressed air at high pressures. They are essentially pressurized bombs that if ruptured, would spray fragments into the surrounding area.

No oil filled devices or chambers. This includes any fluid that if leaked would compromise or contaminate the pool water.

Onboard power supplies (i.e. batteries) are not allowed.

No 12V car or boat batteries along poolside. This is at the request of our host facility. All power servicing the ROV is to come from a 12V "Jump Pack" style battery pack.

Event Clarifications:

Teams are required to use the same ROV for each performance mission. Multiple ROVs for different mission parts are not allowed. The exception is the 20' drag race event. A separate ROV can be built specifically to compete in the drag race portion of the event.

Does the drag racer have to have camera mounted on it? No.

Does the drag racer have to be submersible or can it float on the surface? The intent here is to be appropriately neutrally buoyant underwater during the race, staying between the floor of the pool and surface of the water. **Momentarily** breaking the surface or touching the bottom of the pool would be permissible. Having the ROV act like a boat and rest on the surface or drive along the floor of the pool would not be permissible.

Is there a limit to the number of motors or size of the motors on the drag race ROV? No there is no limit to the size or number of motors or propellers; however the ROV is limited to one 12V battery pack.

Can Go Pro or other cameras that do not require cables be used on the ROVs? Yes as long as they do not have an onboard battery. GoPro cameras are a great addition to any ROV, however they would violate the "onboard power supplies (i.e. batteries) are not allowed" event guideline.

If yes, is it OK for us to use a laptop as our TV? Yes, provided it is not powered from the wall outlet.

High School NGSS Addressed Through the UIVD Competition

HS.Engineering Design

HS-ETS1-1. Analyze a major global challenge to specify qualitative and quantitative criteria and constraints for solutions that account for societal needs and wants.

HS-ETS1-2. Design a solution to a complex real-world problem by breaking it down into smaller, more manageable problems that can be solved through engineering.

HS-ETS1-3. Evaluate a solution to a complex real-world problem based on prioritized criteria and trade-offs that account for a range of constraints, including cost, safety, reliability, and aesthetics, as well as possible social, cultural, and environmental impacts.

RST.11-12.7 Integrate and evaluate multiple sources of information presented in diverse formats and quantitative data, video, multimedia) in order to address a question or solve a problem. (HS-ETS1-1),(
RST.11-12.8 Evaluate the hypotheses, data, analysis, and conclusions in a science or technical text data when possible and corroborating or challenging conclusions with other sources of informa 1),(HS-ETS1-3)
RST.11-12.9 Synthesize information from a range of sources (e.g., texts, experiments, simulations) in understanding of a process, phenomenon, or concept, resolving conflicting information when poss 1),(HS-ETS1-3)
Mathematics –
MP.2 Reason abstractly and quantitatively. (HS-ETS1-1),(HS-ETS1-3),(HS-ETS1-4)

HS.Structure and Properties of Matter

HS-PS3-3. Design, build, and refine a device that works within given constraints to convert one form of energy into another form of energy.*

HS-PS3-2. Develop and use models to illustrate that energy at the macroscopic scale can be accounted for as a combination of energy associated with the motions of particles (objects) and energy associated with the relative position of particles (objects).

HS-PS2-3. Apply scientific and engineering ideas to design, evaluate, and refine a device that minimizes the force on a macroscopic object during a collision.*

WHST.9-12.7 Conduct short as well as more sustained research projects to answer a question (including a self-generated question) or solve a problem; narrow or broaden the inquiry when appropriate; synthesize multiple sources on the subject, demonstrating
understanding of the subject under investigation. (HS-PS2-3),(HS-PS2-5)
WHST.9-12.2 Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes. (HS-PS4-5)
HSN-Q.A.2 Define appropriate quantities for the purpose of descriptive modeling. (HS-PS1-8),(HS-PS2-6)
HSN-Q.A.3 Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. (HS-PS1-3),(HS-PS1-8),
(HS-PS2-6)
SL.11-12.5 Make strategic use of digital media (e.g., textual, graphical, audio, visual, and interactive elements) in presentations to
enhance understanding of findings, reasoning, and evidence and to add interest. (HS-PS1-4)

Mathematics –
MP.2 Reason abstractly and quantitatively. (HS-PS1-5),(HS-PS1-7)
HSA-CED.A.4 Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (HS-PS2-1),(HS-PS2-2)